

# GLOBAL SOCIETY AND NEW MEDIA

Universitas  
Multimedia  
Nusantara  
*Indonesia*

NOVEMBER 25<sup>th</sup>  
27<sup>th</sup>

INTERNATIONAL CONFERENCE ON NEW MEDIA 2015





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# **DSS-ES, Business Intelligence and Management**

# THE USE OF WEB SCRAPING IN COMPUTER PARTS AND ASSEMBLY PRICE COMPARISON

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**Abstract** – If originally computers were used only as a tool to perform some calculations, nowadays computers has a lot of functions to help people finish their tasks in almost every aspect of human life. As a lot of various functions computers have, they also need different specifications for each computer so they can do their tasks according to their functionalities. Therefore the author builds this application with a purpose to recommend a solution to its users in assembling computes suited to their needs. This application also has a price comparison feature based on data sources retrieved from five computer shops so the users can save the costs of purchasing PC parts and assembling the computer easier. This comparison feature is based on a basic consumer's principal which are basically they wanting to buy items not only with the lowest price but also expect the best quality as possible.

The research starts with the deployment of questionnaires to some respondents who had bought computer parts or assembled a computer online. This questionnaire is made to assure that all features which previously has been specified by the author is appropriate to user needs. Then, in order to obtain required data from five computer shops, the author use Pentaho Software as a tool to do web scraping and web grabbing method. These methods allow the application to obtain data from those five computer shops. The result of this research is a web-based application built in PHP and javascript with MySQL as its database.

**Keywords:** Computer assembly, computer parts, price comparsion, web scraping, website, PHP, MySQL, Pentaho.

## I. INTRODUCTION

Nowadays, it is not difficult to find a computer because there are many computers around us that help many people so they can finish their task easier. If originally computers were used only as a tool to perform some calculations, these days computer has a lot of functions to help people finish their tasks in almost every aspect of human lives. It takes a various computer components if we want to build a unit of computer. As a lot of various functions computers have, they also need different specifications for each computer so they can do their tasks according to their functionalities. For example, a

computer that use to editing photos and videos certainly has a different component specification with a computer that used by the cashier. Therefore, if we want to assemble a computer, we should know what kind of computer that we will build so it will be easier for us to choose an appropriate computer component according to our needs.

Especially, nowadays we can easily find either a computer shop or online computer shop that sells many computer components and assembly service with various prices that they offer to us. However, basically as a consumer we want to buy items not only at the best price, but also expecting the best quality as possible too. Therefore, the author builds this application with a purpose to recommend to its users in assembling computer that suit their needs so they can get a better price from build a computer that they need.

## II. LITERATURE REVIEW

The implementation of web scraping as a technique for data retrieving that the author used in this research has been conducted before by other researchers who did other researches with different purposes and objects. Eloisa Vargiu and Mirko Urru (2012) previously have utilized web scraping in a web-based advertising application with a purpose to discover if the ads that will be posted in a webpage is well-suited to the content of the webpage itself. Another research was conducted by Maxim Bakaev and Tatiana Adveenko. They utilized web scraping in a research about data retrieval of job applicants, candidates which will be used by the management of labor market in Novosibirsk, Russia. By using this application, the organization of labor in Novosibirsk can analyze the requirements of labor that any company need in that city with the compatibility of labor that related with the requirements.

Other research that has implemented web scraping was conducted by three college students from Universitas Bina Dharma, Ahmat Josi, Leon Andretti Abdilah, and Suryayusra. The background of this research was to ease the searching of scientific articles needed by the users. They conducted a research to build an application that can provide various scientific articles by using web scraping. There is also a research that was utilizing web scraping to analyze the weather condition in Canada by Charmaine Bonifacio et al (2014). The application that was resulted from this research

was named Canadian Climate Data Scraping Tool (CCDST) where the data of the weather were directly obtained from the organization of weather forecasts in Canada.

### III. METHODOLOGY

#### A. Research Methodology

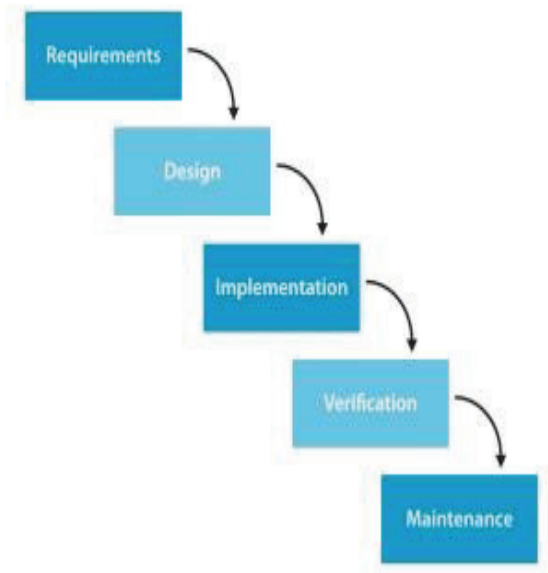


Fig. 1 Waterfall Model ([www.waterfall-model.com](http://www.waterfall-model.com))

The method that the author used in the application design is a waterfall model SDLC method. According to its name, this model has five sequential phases that is modeled like a waterfall. In this model, if there is one phase that has not been finished yet, then the process cannot be continued to the next phase. This method is well-suited with the application design in this research because the process in this method doesn't need any iteration process to do at any phases.

#### B. Data Retrieval Methodology

##### 1. Web Crawling

The author uses web crawling as the first method to retrieve the data. Based on the results of observations that have been conducted before, the author decides to use five online computer shop websites as sources of the data retrieval, i.e. [www.enterkomputer.com](http://www.enterkomputer.com), [www.viraindo.com](http://www.viraindo.com), [www.bengkelpc.com](http://www.bengkelpc.com), [www.nanokomputer.com](http://www.nanokomputer.com), and [www.rakitan.com](http://www.rakitan.com). The first thing that the author do in conducting web crawling is obtaining HTML script which is

the source pages of every websites. After obtaining the source pages, the author analyzes whether the HTML script has similar pattern or not. The result of obtaining certain patterns inside the HTML scripts is a special tags that will be used in pentaho software to conduct web scraping. The process of web crawling conducted in this research has been illustrated to flowchart diagram as pictured in Figure 2.

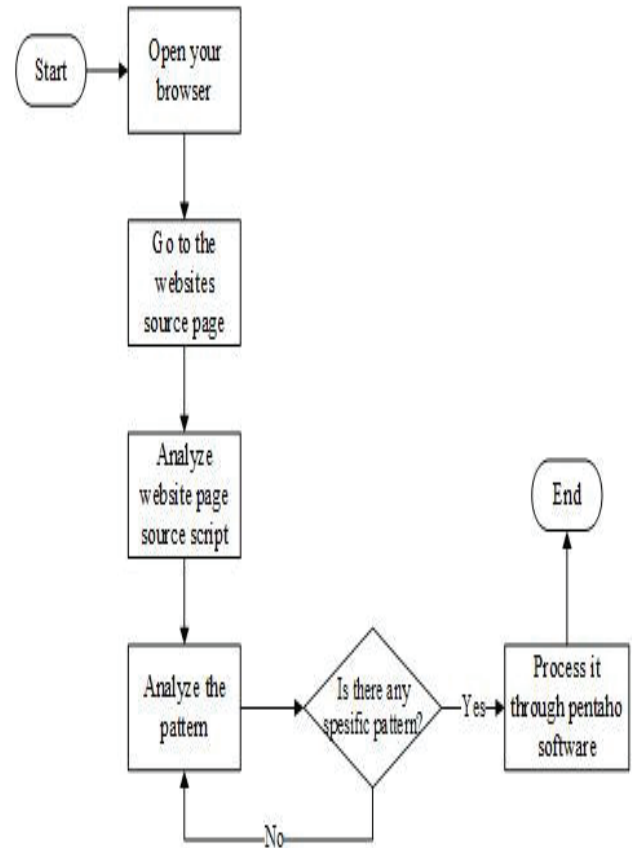


Fig. 2. Flowchart Diagram of Web Crawling

##### 2. Web Scraping

The second method that the author uses in retrieving the data is web scraping. The pattern that has been obtained in previous method will be processed to get specific information such as computer components name, price of computer components, and computer components category. Usually, the data that has been successfully obtained still contain a data noise. Therefore, the author conducts data cleaning to assure the data that has been obtained before is free from a noise and suitable with the requirements that application need.

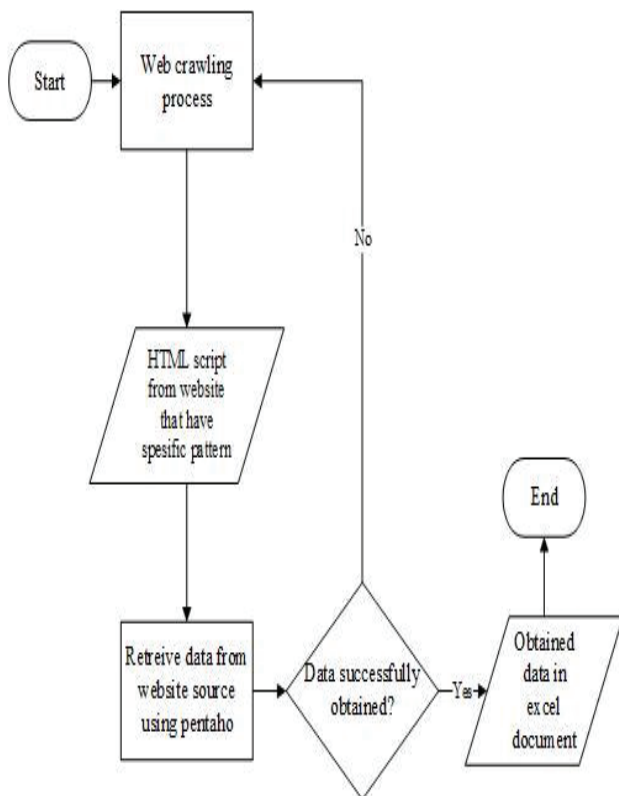


Fig. 3. Flowchart Diagram of Web Scraping

### 3. Data Cleaning and Data Transformation

Data cleaning or data cleansing is the last step that the author do in data retrieval. The objective of this step is to obtain the only needed information from data retrieval process. The data cleaning is conducted using Pentaho Data Integration software by using a lot of steps to clean the data from other HTML tags or other information that are not needed. After the data is cleaned, it will be transformed into a Microsoft Excel document which will be inserted into the database. The result of data cleaning process is all of necessary information of computer components that required by the application.

## IV. ANALYSIS AND DESIGN APPLICATION

### A. Requirement Analysis

The first phase in the waterfall model is requirement analysis. In this phase, the author analyzes the requirements that will be made for the application and determines the features of the application. The requirement analysis phase is using three methods to obtain information about how should the application be made. The methods is observations, questionnaires deployment, and references studies.

### B. Requirement Analysis Result

The questionnaires deployment is conducted online by using Google Form. This survey is conducted to discover the interest of application that the author builds from the respondents.. This survey involves 101 respondents. The questionnaire consists of 11 questions related to information about the users, their experience in doing online transaction, the experience in purchasing computer components, and ensures if the features which was determined before is needed by the users.

The results of observations and questionnaires deployment conducted by the author generate some points:

1. The application is web-based.
2. The methods used for data retrieval are web scraping and web crawling
3. The application provides three features, i.e. presenting price recommendations for the procurement of computer components, presenting price recommendations of computer assembly, and price calculation of computer assembly
4. The application obtains the data from five computer shops, i.e. enter computer, quantum, nano computer, bengkel pc, and vira jaya
5. The application updates the price of computer components daily.
6. Buy and sell feature is not included in the application. This feature is implemented in the websites which is the data source of the application.

### C. Design

In the design phase, the author creates unified modeling language (UML) diagrams such as use case diagram, activity diagram, and sequence diagram. The purpose of this activity is to illustrate the process that runs in the application and the relations between entities in the application. The output of the design phase is conducted to illustrate the application. The author also designs the database of the application and illustrates the architecture of the database using entity relationship diagram (ERD).

### D. Implementation / Code

In the implementation/code phase, there are two activities that the author do. These two activity is data retrieval and application code. The author uses Pentaho software when conducted data retrieval. The sources of data retrieval is five computer online shop. Each data sources need different amount of stage to generate data for the application. The amount of stages depends of the level of difficulties in conducting data cleaning from each source websites. The results of implementation/code phase is a web-based application that have price comparison feature.



## 1. Study Case 1 (Grabbing data from www.Enter Komputer)

### a. Stage 1

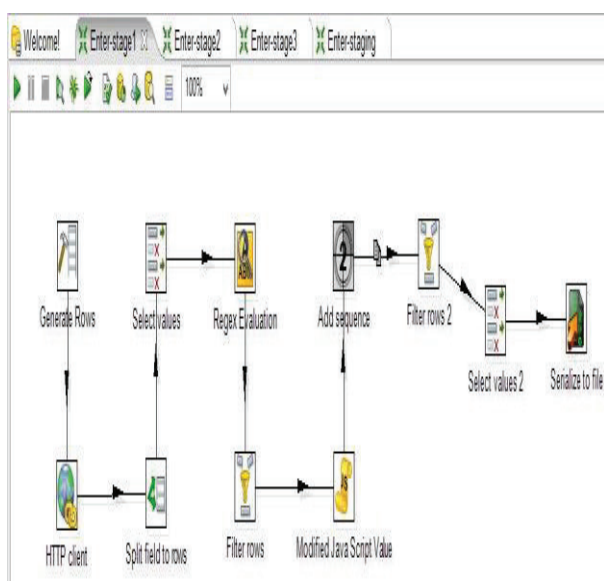


Fig. 4. First Stage in Grabbing Data From www.enterkomputer.com Using Pentaho Software

The main focus of data retrieval process on stage 1 is to obtain URL and categories from each products. The result of stage 1 will be stored in temporary file called cube file. This cube file will be used in the next stage.

### b. Stage 2

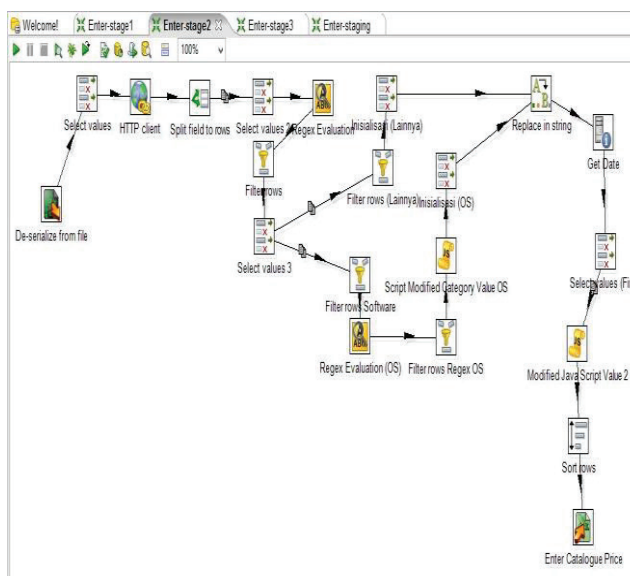


Fig. 5. Second Stage in Grabbing Data From www.enterkomputer.com Use Pentaho Software

The main purpose of stage 2 is to obtain the product data from each category and perform data cleaning process. The result of stage 2 is a Microsoft Excel document contain all of the data that has been successfully obtained from www.enterkomputer.com that has been free from data noise. In the next stage, this document will be imported into database that used by the application.

### c. Stage 3

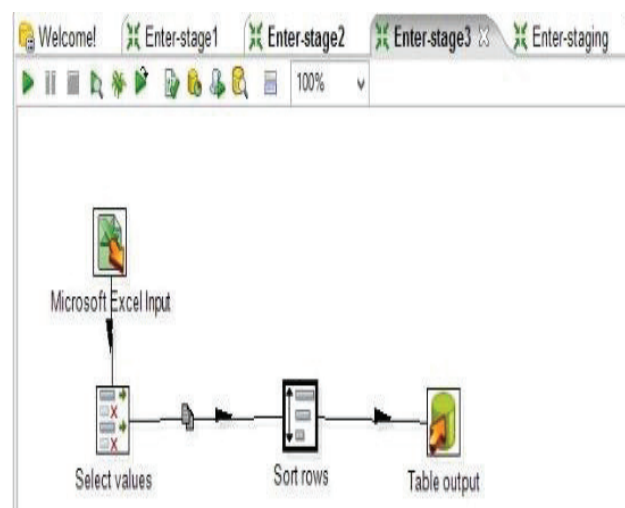


Fig. 6. Third Stage in Grabbing Data From www.enterkomputer.com Use Pentaho Software

The main focus of stage 3 is to insert the final data of computer components that previously has been successfully obtained into an application database. First, the author use microsoft excel input step to input Microsoft Excel document that previously has been obtained in stage 2. Afterwards, to sort the data ascendingly based on product name and price the author used sort rows step. Finally, all of the data that has been obtained will be inserted into a database. To assure that the data has been successfully inserted, the author manually checked in local database used by the application

## 2. Match Table

Match table is an important process in comparing prices method from this five online computer shops. Match table are created by the author to synchronize the different product names from each websites so the application can recognize each product with different name. The match table is created manually using Microsoft Excel.

## 3. The result of the research

The result of this research is a web-based application of computer parts and assembly price comparsion. This application has three features:

- Price comparison from five computer shops based on the highest prices to the lowest prices.

- b. Feature that giving the user a recommended PC build based on three category that is home PC, office PC, and gaming PC.
- c. Feature that enable user to do PC assembly simulation.



Fig. 7. Homepage of the application

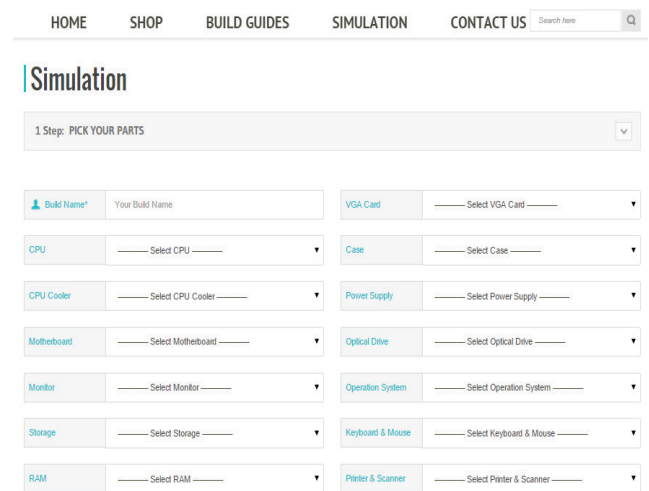


Fig. 8. Build guides page

User can do a simulation of pc assembly through this page. After the user submit each part they need to build a pc, the application will generate a price comparison from 5 computer shops. The application will also give a recommendation to the user about which shop that give a best offer. The user also can get the price comparison feature when they search for only single computer component.

#### E. Verification / Testing

Verification / testing phase is the phase where the author conducts user acceptance test for this application. The user acceptance test participant are some respondent who have been participated in filling questionnaire for the development of the application before. Based on the user acceptance test that conducted at 4th and 5th of June 2015, the application has been accepted well by the users.

#### F. Maintenance

Maintenance phase is the last phase of waterfall model SDLC method. In this phase, the author doing maintenance of the application which means that the author also have to make sure that the computer component product stock and price are always up to date. Furthermore, in case if there any changes in the design structure of the website sources, the data grabbing process which is conducted before using the same pattern will be failed to obtain the data. This failure can be detected if there is an indication the data that obtained in grabbing data process are decreased or the grabbing pattern cannot obtain data at all. If any of this condition happen, the author need to reanalyze on every stage of data retrieval so it can be discovered which stage that has to be changed.

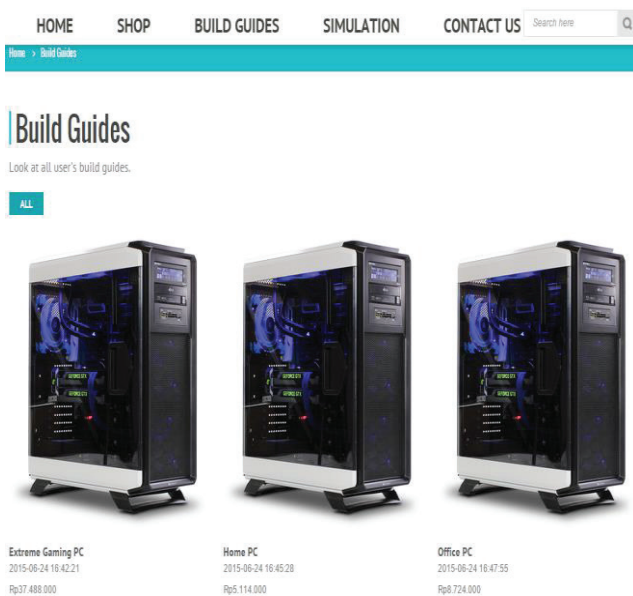


Fig. 8. Build guides page

This page contain a recommended guides for the user. Basically, the application provide three kind of guides i.e gaming pc, home pc, and office pc. The user also can submit their own guide through simulation menu. The guide that the user create in simulation will also appear in build guides page.



## V. CONCLUSION

Based on the results from user acceptance test which is conducted by the author to ten respondents before the application design is started, the application has been succeeded in answering the problems in the background chapter and the formulation of the problems of this research where the result is a web-based application of price comparison of computer components and computer assembly. This application will help the users to get the recommendation if they want to build a PC. This application also allow the user to get the lowest price if they want to buy computer components or build a pc.

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# DECISION SUPPORT SYSTEMS FOR THE TRAVELING SALESMAN PROBLEM ON THE PICK UP OF GOODS SHIPPING COMPANY BASED ON GENETIC ALGORITHM

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**Abstract**— Delivery service companies in Indonesia have begun to grow quite rapidly and some shipping companies already provide a process of pick up the goods. In this process there are some difficulties in determining the best path and the fastest route in the process pick up of the goods. Pick up of goods to customers carried to various places. There are many possible combinations of distribution of goods that can be used to optimize the time and cost of travels. In pick up the goods, the company must determine the best route for each journey that can save travel costs. To overcome this problem, an algorithm is required to perform calculations of distances and time. An appropriate algorithm for this problem is genetic algorithm. Genetic algorithm can be utilize to produce the best route based on distance and time. The spiral solving software development method is conducted by using Netbeans to obtain the desired results. Results from this study could assist any companies in determining the decision in finding the best and fastest route service in the process of pick up the goods.

**Keywords**—*Pick-up Delivery, the best and fastest, genetic algorithm*

## I. INTRODUCTION

Indonesia is a country that developed at this time. Indonesia has a convenient area to trigger the rise of industries. One of the industry who has had enough of the big influence is the delivery service industry. Freight shipment service industry in Indonesia is the industry's growth rate was rapidly year by year. It can be seen from the growing number of service companies that continue to grow. The growth of these shipping services company considerable impact given to the community to be able to experience the ease of delivery of the goods. This development could also provide a positive impact against the corporate world in the distribution to consumers with more efficiency.

With the rapid development of the service industry is currently shipping, the company claimed to be able to provide delivery service with fast, precise, and safe. This is intended to facilitate the public to reach the venue to hire service delivery.

Dissemination of company giving services wider with increasing needs. The more increasing request service quality service quality also of course also has to support.

Support good quality in the service of the company now has a set of features for company to pick up items to be sent by the customer. This feature is a brilliant idea of the company so that it can facilitate customer in the process of shipping and customer service feature is greatly helped by this. This is indeed a good service to the customer, but in making such items needed are also a few things that need to be considered in the pick-up of the goods. This process still has obstacles because there are a number of factors such as how the path is to take the goods, how far the distance, how traffic jams on their way. Of this problem the author doing research that is expected to tackle the existing problems using the creation of a system to assist decision making in the search for the best and fastest route to pick up goods from the customer will be sent.

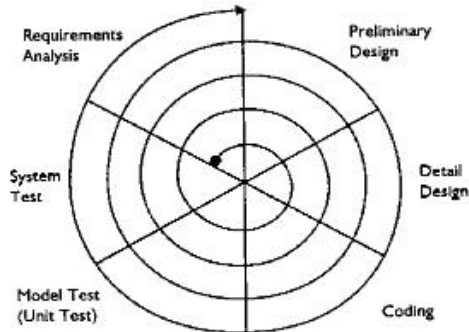
## II. LITERATURE REVIEW

### *Selecting a Template (Heading 2)*

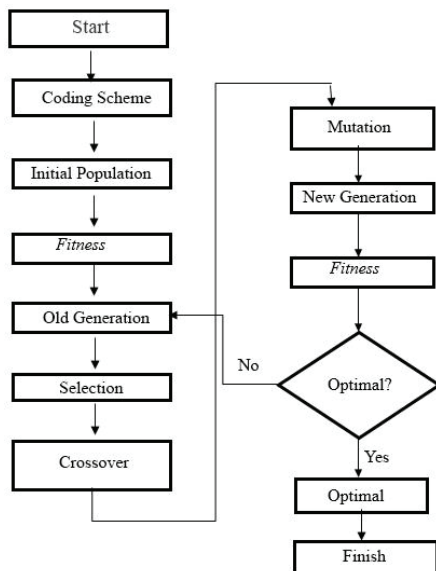
Search the best line in the process of distribution I actually there have been several studies done on earlier. The research was published in a journal called "A Genetic Algorithm Based Approach to the Profitable Tour Problem with pick-up and Delivery" by Lee, Ferdinand, Kim, and Ko (2010), doing research for searching the best line that has a focus on the calculation of profit. Another study in the journal called "the application of Genetic Algorithms in the optimization of the distribution of Fertilizer in PT Pupuk Iskandar Muda in Aceh." By Fachrurrazi, s. (2010), focusing on the manufacture of distributing fertilizer in Aceh. Research conducted by Baskara, D. M., and Nurcahyawati, v. (2013) keep a journal called "the shortest Distance on the determination of the distribution of the goods on the island of Java by using Genetic Algorithms", did the creation of the distribution of goods in the area of Java and the making of the program until the stage that can be easily understood by the user.

### III. RESEARCH METHOD

Decision support system or DSS is a system that is able to provide problem-solving ability as well as the ability of communicating to problems with the condition of semi structured and unstructured. This system is used to assist decision-making in situations of semi structured and unstructured situations, where no one knows for sure how the decision should be made according to Turban (2001).



The spiral model is a model of the process that his approach are unrealistic on a large piece of software because the process from start to delivery and repair process can be understood by both by client and developers. This model has a working set of iterations (improved model) the initial prototype and then the next iteration will be a development of the earlier models. This model can continue to be used even though the software had already been delivered because the process (cycle) can spin again if there is a change in the software until there is no change in the software by request of client.



This research requires a method to resolve the problem. The method used is the genetic algorithm. This research is looking for the quickest, shortest paths, and the best that can be used based on the genetic algorithm. Looking for the best and fastest track has several stages to do in genetic algorithm:

1. Formation of the chromosome formation of chromosomal genes requires using the binary number in the process of genetic algorithms.

2. Initialization in this process the genes given a value on each chromosome is correspond to the variables used.

3. Evaluation of chromosome Genetic Algorithm information objective function (fitness), as a way to evaluate the individual who has the best solution, rather than the derivative of a function.

### IV. NUMERICAL EXAMPLE, IMPLEMENTATION AND RESULT

In this process the specified place in the Tangerang region at three locations in Gading Serpong, Alam Sutera, and Bumi Serpong Damai. To determine the best routes using genetic algorithms, it needs a reference to become the benchmark in producing the best path. A chromosome is a pretty important part in genetic algorithms. Chromosome itself used in binary form that consists of the numbers 1 and 0. The chromosome will be compiled and used in this study, namely:

1	2	3	4	5
---	---	---	---	---

FIGURE 1. Number chromosome

Numbers 1 to 5 this represents the location of the address of the item pick-up. The figure will be transformed into a binary number.

TABLE 1. Number to binary

Number	1	2	3	4	5
Binary	001	010	011	100	101

Table above shows the change initiation into binary numbers to be genes in the formation of chromosomes.

TABLE 2. Binary Chromosome

0	0	1	0	1	0	0	1	1	1	0	0	1	0	1
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

This is the map of Gading Serpong including with 5 addresses.

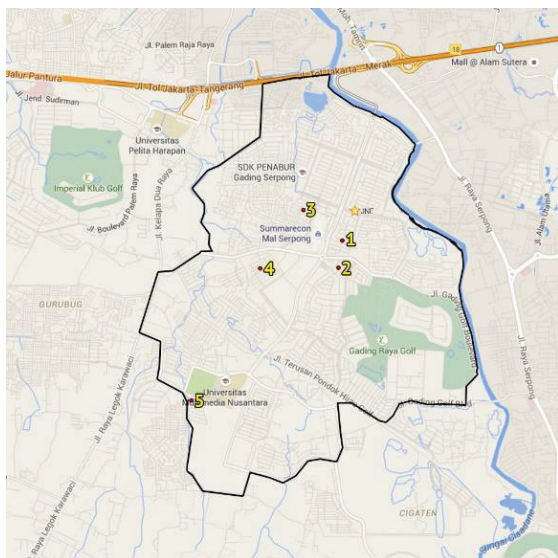


FIGURE 2. Map of gading serpong..

This is the coordinates of address in Gading Serpong. To get this coordinates.

TABLE 3. Gading serpong address coordinates

Address	X	Y
JNE	629	635
1	607	580
2	600	531
3	537	635
4	459	530
5	335	292

This table is a table that shows the distance between addresses in Gading Serpong. Each number in the table is in units of kilometers.

TABLE 4. Distance between addresses in

0	1	2	3	4	5
1	0	2.3	1.9	2.7	4.2
2	2.3	0	2.8	1.8	2.9
3	1.9	2.8	0	1.7	4.3
4	2.7	1.8	1.7	0	3.1
5	4.2	2.9	4.3	3.1	0

This table is a table that shows the distance in time between addresses in Gading Serpong. Each number in the table is in units of minutes.

TABLE 5. Distance between addresses in gading serpong in time

0	1	2	3	4	5
1	0	6	8	7	10
2	6	0	7	6	8
3	8	7	0	8	11
4	7	6	8	0	9
5	10	8	11	9	0

After going through the process of calculation, following the results of the best route of Gading Serpong simulated with coordinates is:

TABLE 6. Coordinates of the best route in gading serpong

Coordinate		Address
X	Y	
629	635	JNE
607	580	1
600	531	2
335	292	5
459	530	4
337	635	3

Research done in the area of Serpong for 2 weeks produced some routes that traverse the following routes in the area could be in Gading Serpong:

TABLE 7. Routes frequency of gading seprong in 2 weeks

No	Route	Frequency
1	1-2-5-4-3	1
2	1-5-3-4-2	1
3	2-4-3-1-5	1
4	2-4-5-1-3	3
5	3-4-1-5-2	1
6	4-2-3-1-5	1
7	5-4-3-2-1	2

The results of the total conducted 10 times over the past 10 days in 2 weeks in the area of Serpong, had obtained three times the route taking freight route is through JNE – 2 – 4 – 5 – 1 – 3. The result of this route will be transformed into the final chromosome regions of Serpong in binary form.

TABLE 8. Binary Chromosomes of the best route in Gading Serpong

0	1	0	1	0	0	1	0	1	0	0	1	0	1	1
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

The route of the JNE – 2 – 4 – 5 – 1 – 3 drove on average 3.9 kilometers with takes on average 10 minutes to do the taking of the goods to the place of the sender.

## V. CONCLUSIONS

From the results of the process of research done author can be concluded that the process of making this program can help determine the best route path from various points in place. With information line where the best route that should be taken, then the process of delivery of the goods will be more quickly and can better facilitate distributing goods. It also helps to reduce travel costs in distributing goods. Expected with results of this research can give satisfaction to the company against reducing shipping costs and can give you satisfaction as well as consumers in the speed of sending or receiving the goods, so the goal of this research is achieved.

## Acknowledgement

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# Decision Support System for Inventory Management in Pharmacy Using Fuzzy Analytic Hierarchy Process and Sequential Pattern Analysis Approach

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**Abstract**—A pharmacy typically store pharmaceutical products in warehouses before being sold to the customer. Stacking of products in the warehouse can reduce the efficiency of the warehouse and increase the costs associated with inventory, which raised the problem of how to predict the stock of each product to the right in order to avoid excess/shortages. Therefore, this study aims to develop a decision support system for inventory management in pharmacy, especially to predict next inventory using FAHP and SPA approach, so the prospect of inventory management will be more optimal. The study also proposes a model to predict inventory. These results indicate that the inventory prediction accuracy using this model approach more accurate 18% than the inventory prediction accuracy by a pharmacy inventory manager, so this approach can be referred to as a decision support system.

**Keywords**—inventory management; pharmacy; FAHP; sequential pattern analysis

## I. INTRODUCTION

In the pharmaceutical world, inventory is the largest investment in a pharmacy, whose value continues to increase due to the growth of varieties and the cost of pharmaceutical products [1]. In order for the inventory to be maintained, then the pharmacy should be able to predict the next inventory quantity.

Previous studies indicate that the neural network [2], [3], a mathematical model [4], [5] or data mining [6–9] can be adopted to predict future inventory.

In the field of data mining, Sequential Pattern Analysis (SPA) is an effective approach for identifying recurring patterns of products included in time series [6]. But other factors affecting inventory management in pharmacy should be included in the SPA, so that inventory management can be efficient [10]. The importance of these factors can be identified through experts opinion [11]. Experts opinion will be analyzed by the Fuzzy Analytic Hierarchy Process (FAHP) method, which can overcome the uncertainty and inaccuracy in the decision-making process [12]. FAHP method is adopted to minimize subjectivity of experts assessment matrix [13].

Generally, studies using the FAHP method discuss the issue of selections [14–16], location [17], services [18], [19], classification [20], evaluation [21], [22] and valuation [13].

While studies using the SPA method, generally try to find patterns of buying customers behavior [6], [9], [23].

In addition, most studies of inventory management is associated with the Supply Chain Management (SCM) in an industry. Meanwhile, the studies that implement inventory management in the pharmacy is still very little [1], [24].

Therefore, it is developing a decision support system (DSS) for pharmacy inventory management in a way to predict the next period of purchase of pharmaceutical products with FAHP and SPA approaches, in order to reduce excess stock and avoid shortages, so the costs associated with inventory management in pharmacy can be minimized.

## II. LITERATURE

### A. Decision Support System

The concept of Decision Support System (DSS) was first disclosed in the early 1970s by Michael S. Scott Morton with the term Management Decision Systems [25].

DSS is a system of specific information intended to assist the management to take decisions relating to issues that are semi-structured, and does not replace the function of the decision maker to make decisions [25].

### B. Inventory Management

Inventory management is a branch of business management focused on planning and inventory control [26].

Inventory management is a function that is responsible for all decisions regarding the stock in an organization. In inventory management made policies, activities and procedures to ensure the proper amount of stock of each product for a certain time [27].

From a financial and operational perspective, efficient inventory management plays an important role in the

pharmaceutical world [28]. From a financial perspective, efficient inventory management increase in gross profit and net profit by reducing the cost of pharmaceutical products obtained and related operational costs [28]. In addition, cash flow will increase purchases and generate cost savings of storage of the product is lower, so the cash flow can be used to pay operating costs and invest in other services [28]. From an operational perspective, an effective inventory management can satisfy customers and meet the demands of patients [28].

### C. Fuzzy Analytic Hierarchy Process (FAHP)

FAHP is the insertion of fuzzy theory into AHP method developed by Thomas L. Saaty (2008) in the 1970s [14].

FAHP is a further analysis of AHP to overcome uncertainty and ambiguity in human decision to the next level [29]. Because of the uncertainty or ambiguity of human decision-making can lead to errors in the results of analysis of the model [14].

Basically the steps in FAHP method similar to the AHP method. AHP uses a scale of 1-9 for pairwise comparison criteria, while FAHP method using Triangular Fuzzy Number (TFN) for pairwise comparison criteria, and alternative made through linguistic variables [14]. TFN and linguistic variables corresponding to the Saaty scale shown in Table I [15].

TABLE I. DEFINITION AND FUNCTION OF TFN [15]

Saaty Scale	Fuzzy Num.	Definition	Membership Function
1	~1	Equally important (sama penting)	(1, 1, 3)
3	~3	Moderately more important (sedikit lebih penting)	(1, 3, 5)
5	~5	Strongly more important (lebih penting)	(3, 5, 7)
7	~7	Very strongly more important (sangat penting)	(5, 7, 9)
9	~9	Extremely more important (mutlak lebih penting)	(7, 9, 11)
2, 4, 6, 8		Intermediate Values (nilai yang berdekatan)	(1,2,3),(3,4,5), (5,6,7),(7,8,9)

TFN in Table I is denoted by  $M = \{l, m, u\}$ , where  $M$  is a set of fuzzy numbers, while  $l$  declare the smallest possible value,  $m$  declare value of the closest, and  $u$  declare the greatest possible value. The value of  $l$ ,  $m$ , and  $u$  can also be determined by the decision-makers themselves [15].

TFN can be applied after the consistency of the hierarchical model has been tested in advance by calculating the value of Consistency Ratio (CR) using (1), and its value should be less than 10%. If the value is more than 10%, the assessment procedure must be repeated and improved to increase consistency.

$$CR = \frac{CI}{RI} \quad (1)$$

Where:

CR = Consistency Ratio

CI = Consistency Index

RI = Random Index for each matrix of order  $n$

Consistency Index (CI) of the matrix pairs can be calculated by (2).

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (2)$$

Dimana:

CI = Consistency Index

$\lambda_{\max}$  = the largest eigenvector value of the matrix order  $n$

$n$  = number of elements compared/order of matrix

Application of FAHP method in this study adopts the Chang analysis, because the steps of this approach is relatively easier, less time and computational cost than most other FAHP approaches, and at the same time, can overcome the shortcomings of AHP method [16].

In the proposed method of Chang, if  $X = \{x_1, x_2, x_3, \dots, x_n\}$  represents a set of objects and  $G = \{g_1, g_2, g_3, \dots, g_m\}$  represents the set of goals and there are a number of criteria that would  $m$  used for analysis are obtained  $M_{gi}^1, M_{gi}^2, M_{gi}^j, \dots, M_{gi}^m, i = 1, 2, \dots, n$ , where the whole  $M_{gi}^j$  ( $j=1,2,\dots,n$ ) is the TFN [16].

The steps in the FAHP method with further analysis of Chang in [16] as follows:

**Step 1:** Calculate fuzzy synthetic extent (Si) using criteria to  $i$  according (3).

$$S_i = \sum_{j=1}^m M_{gi}^j \otimes \left[ \sum_{i=1}^n \sum_{j=1}^m M_{gi}^j \right]^{-1} \quad (3)$$

$g_i$  = goal set ( $i = 1, 2, \dots, n$ )

$M_{gi}^j$  = fuzzy triangular number ( $j = 1, 2, \dots, m$ )

Where  $\sum_{j=1}^m M_{gi}^j$  is obtained by performing the addition operation of the fuzzy value in the matrix using (4)

$$\sum_{j=1}^m M_{gi}^j = \left( \sum_{i=1}^n l_i, \sum_{i=1}^n m_i, \sum_{i=1}^n u_i \right) \quad (4)$$

and  $\left[ \sum_{i=1}^n \sum_{j=1}^m M_{gi}^j \right]^{-1}$  obtained using (5).

$$\left[ \sum_{i=1}^n \sum_{j=1}^m M_{gi}^j \right]^{-1} = \left( \frac{1}{\sum_{i=1}^n \sum_{j=1}^m u_i}, \frac{1}{\sum_{i=1}^n \sum_{j=1}^m m_i}, \frac{1}{\sum_{i=1}^n \sum_{j=1}^m l_i} \right) \quad (5)$$

So that (3) into (6):

$$S_i = \left( \sum_{i=1}^n l_i; \sum_{i=1}^n m_i; \sum_{i=1}^n u_i \right) \otimes \left( \frac{1}{\sum_{i=1}^n \sum_{j=1}^m u_i}, \frac{1}{\sum_{i=1}^n \sum_{j=1}^m m_i}, \frac{1}{\sum_{i=1}^n \sum_{j=1}^m l_i} \right) \quad (6)$$

Where:

$l$  = lower limit value (lowest possible)

$m$  = the value of the most promising (possibly the middle)

$u$  = upper limit value (possibly top)

**Step 2:** calculate the degree of possibility of  $S_2 = (l_2, m_2, u_2) \geq S_1 = (l_1, m_1, u_1)$  where  $S_2$  and  $S_1$  obtained from (3). The degree of possibility between two fuzzy synthetic extent stated in (7) and (8).

$$V(S_2 \geq S_1) = hgt(S_1 \cap S_2) = \mu_{S_2}(d) \quad (7)$$

$$\mu_{S_2}(d) = \begin{cases} 1 & , \text{ if } m_2 \geq m_1 \\ 0 & , \text{ if } l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & , \text{ otherwise} \end{cases} \quad (8)$$

In (7) dan (8),  $d$  represents the coordinates of the point D which is the highest point of intersection between  $\mu_{S_1}$  and  $\mu_{S_2}$ . Comparison between  $S_1$  and  $S_2$  requires the values of  $V(S_2 \geq S_1)$  and  $V(S_1 \geq S_2)$ .

**Step 3:** Compare the degree of possibility among criteria between fuzzy numbers  $M_i (i = 1, 2, \dots, k)$  through (9).

$$V(S \geq S_1, S_2, \dots, S_k) = V[(S \geq S_1) \text{ dan } (S \geq S_2) \dots \text{ dan } (S \geq S_k)] \\ = \min V(S \geq S_i), i = 1, 2, \dots, k. \quad (9)$$

**Step 4:** Calculate vector  $W'$  is given by (10)

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_k))^T \quad (10)$$

Assuming that  $d(A_i) = \min V(S_i \geq S_k)$  for  $k = 1, 2, \dots, n; k \neq i$ .

After the vector weight in (10) are normalized, then the normalized vector weight obtained shown in (11).

$$W = (d(A_1), d(A_2), \dots, d(A_k))^T \quad (11)$$

Where  $W$  is not a fuzzy numbers for each comparison matrix.

#### D. Sequential Pattern Analysis (SPA)

Data mining is the process of extracting information or patterns in large data bases [30], which is done by using the association, classification, prediction, sequential pattern, and a similar time sequences [31].

Sequential pattern analysis is inspired by the sequential pattern mining, which is generally applied to the forecasting and decision support commercial [32], which was first introduced by Agrawal and Srikant in 1995 [33].

According to [34], studies using the SPA can be divided into two main categories, namely (1) improve the efficiency of mining processes; and (2) to propose additional time-related patterns, such as: frequency, recency, and others [23].

Related to the pattern associated with the extra time, Hughes and Stone in [8] introduces the analysis of recency, frequency, and monetary (RFM), which have been widely used in database marketing and to measure the values of customers according to their previous purchase history, where recency is the time interval between the time of the last transaction at this time, the frequency is the number of transactions that occurred in the history records, and the total monetary value of the rupiah payments [6], [9].

Set a number of criteria in this study refers to research on RFM [8], [35–37] and identical with research on QFR [10].

Further, RFM scores can be defined as (12), where  $\alpha$ ,  $\beta$  and  $\gamma$  show FAHP weight of each R, F and M are not the same, because of differences in industry [8].

$$\text{RFM scores} = \alpha \cdot R + \beta \cdot F + \gamma \cdot M \quad (12)$$

### III. METHODOLOGY

Research conducted at the X pharmacy is quantitative, with research steps as follows:

#### A. Data Collection

The collection of data is the most important stages in the research. The early stages of data collection, using questionnaires concerning the criteria that affect the inventory system to the three experts who are directly involved in the process of inventory management in pharmacy. Results of the questionnaires processing at the initial stage is the classification criteria that affect inventory management.

The next stage is to conduct the second questionnaires to the three previous experts, to determine the pairwise comparisons among the criteria obtained from the questionnaires at an early stage before.

The last stage, the third questionnaires conducted for the inventory manager to acquire the rules of assessment criteria which have been obtained from the previous second questionnaires.

The data used in this study is the result of three questionnaires to the stock administration, inventory manager, and system analyst of X pharmacy, as well as databases of product, sales and purchases transactions from January until April 2015.

#### B. Stages of Data Analysis

Stages of data analysis to predict the pharmacy inventory using FAHP and SPA approaches as shown in Fig. 1.



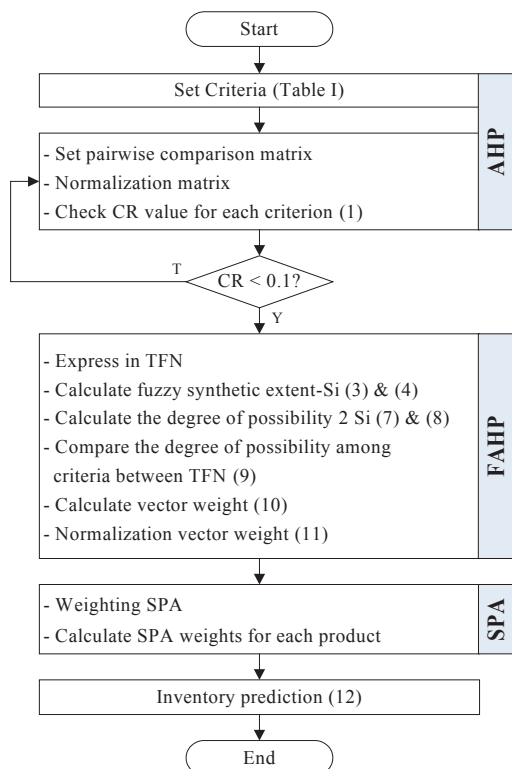


Fig. 1. Flowchart of DSS Using FAHP and SPA Approach for Inventory Prediction

### C. System Design

The system design is done by modeling the use case diagram like Fig. 2.

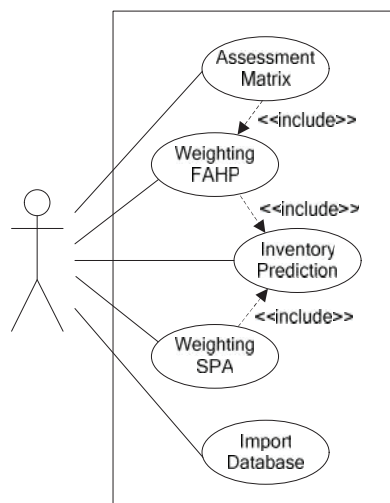


Fig. 2. Use Case Diagram of DSS for Inventory Management

### D. Database Design

SPA system database is processed from the database pharmacy, namely Ms Jual, Detil Jual, Ms Beli, Detil Buy and Ms Produk, based MySQL database as shown in Fig. 3.

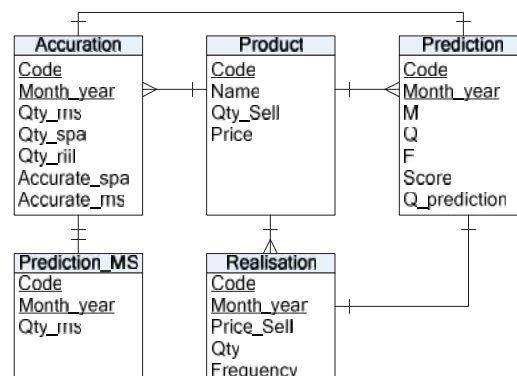


Fig. 3. Entity Relationship Diagram of DSS for Inventory Management

## IV. RESULTS AND DISCUSSION

### A. Results of Data Analysis Using FAHP Method

After the recapitulation of questionnaires of criteria selection is completed, then the results will be used to create a second questionnaires in the form of pairwise comparison matrix for each criterion.

The whole value generated pairwise comparisons will be normalized before checking the value of Consistency Ratio (CR) using (1), where the value of Random Index (RI) is 1.49 [15].

After the entire value of  $CR < 10\%$ , then the value of the pairwise comparisons can be expressed with Triangular Fuzzy Number.

Referring to Fig. 1, the first step in the FAHP method is define the value of fuzzy synthetic extents (Si) with the criteria i using (3) and (4) through the addition operation fuzzy. Then the results of the addition operation fuzzy calculated the inverse matrix using (5) to (0.003, 0.006, 0.011) for AF, (0.003, 0.005, 0.010) for MS and (0.003, 0.006, 0.010) for AS.

The next step is to calculate the degree of possibility of two TFN by (7) and (8).

Assuming  $d(S_i) = \min V(S_i \geq S_k)$  for  $k = 1, 2, \dots, k; k \neq i$ , then will be obtained the value of the weight vector using (10) and a normalized weight vector using (11), so that the results of the ranking is based on the weighting values as shown in Table II.

TABLE II. CRITERIA RANKING BASED ON WEIGHT

Weight	Criteria	Description	Value	Rank
W <sub>1</sub>	K <sub>1</sub>	Moneter	0.154	1
W <sub>2</sub>	K <sub>2</sub>	Lead time	0.097	6
W <sub>3</sub>	K <sub>4</sub>	Quantity	0.153	2
W <sub>4</sub>	K <sub>8</sub>	Season	0.100	5
W <sub>5</sub>	K <sub>11</sub>	Services	0.066	9
W <sub>6</sub>	K <sub>13</sub>	Check of stock	0.103	4
W <sub>7</sub>	K <sub>15</sub>	Frequency	0.142	3
W <sub>8</sub>	K <sub>17</sub>	Discount	0.078	8
W <sub>9</sub>	K <sub>19</sub>	Management	0.087	7
W <sub>10</sub>	K <sub>20</sub>	Speculation	0.019	10

Based on Table II was obtained MQF weight was (0.154, 0.153, 0.142). If normalized then obtained (0.343, 0.341, 0.316) as the ( $\alpha$ ,  $\beta$ ,  $\gamma$ ).

### B. Results of Data Analysis Using SPA Method (MQF)

Results of sales database processing to generate an average record number of sales transactions per product per month (frequency) in 2015 amounted to 1,750 records, the average size of the sales transactions of products per month is Rp 97,412,000, the average of products quantity amount per month 10,736 and the average of number of products items sold as many as 201 products items of 439 products items.

### C. Results of Data Analysis for Prediction

Inventory prediction using the rules of Monetary-Quantity-Frequency (MQF), which is based on the agreement of experts as indicated in Table III, where the Monetary represent the total of sales transactions per month in thousands of rupiahs, Quantity is the number of products sold per month, and the Frequency is the frequency products sold per month.

TABLE III. RULES OF MQF

Criteria	Rules of Assessment				
	5	4	3	2	1
Moneter	$\leq 100$	$100 < X \leq 250$	$250 < X \leq 500$	$500 < X \leq 1000$	$> 1000$
Quantity	$\geq 6000$	$3000 \leq X < 6000$	$1500 \leq X < 3000$	$750 \leq X < 1500$	$< 750$
Frequency	$\geq 600$	$300 \leq X < 600$	$150 \leq X < 300$	$75 \leq X < 150$	$< 75$

The user interface for entry of the DSS weights as shown in Fig. 4.

Fig. 4. User Interface for Entry of the DSS Weights

### D. Testing and Evaluation

Testing was conducted by comparing the predictive accuracy obtained from inventory manager and the DSS predictions obtained from the data processing in the past month against sales real data in pharmacy this month as shown in Fig. 5, with the percentage of the prediction accuracy of inventory is calculated using (13) [38].

$$\begin{aligned} \text{Accuracy} &= 100\% - \text{error percentage} \\ &= 100\% - | \hat{e} - e | / e * 100\% \end{aligned} \quad (13)$$

where  $e$  is the real quantity, and  $\hat{e}$  is quantity prediction.

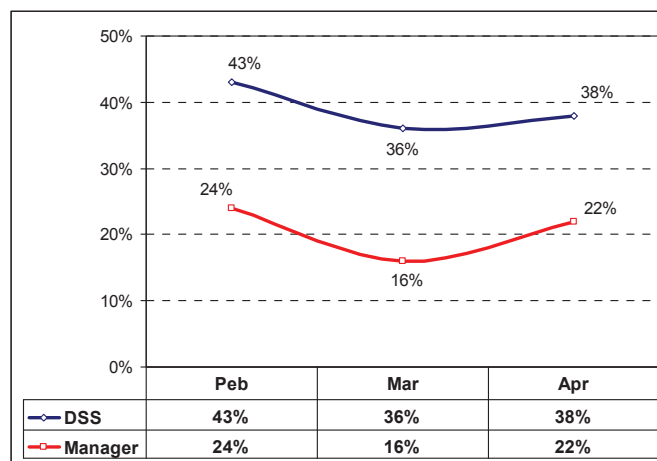


Fig. 5. Graph of Prediction Accuracy Percentage Inventory

In general, a small percentage of accuracy due to the interval difference between real sales data with predicted results of DSS and inventory managers predicted results.

In addition, safety stock in inventory also affects the percentage of prediction accuracy. For example: Sterizyme Sterine is stocked 2 gln, then in the same month sold 1 gln, so stay 1 gln as safety stock remaining. This is not a problem (even better), if viewed from the aspect of customers service. But if the calculated percentage of the error, it will obtain a percentage of prediction error 100% (accuracy = 0%).

If the average of inventory prediction accuracy of DSS compared with the average of inventory prediction accuracy of inventory manager, then the percentage of inventory prediction of DSS more accurate 18% compared to the percentage of inventory prediction of inventory manager.

There are external factors that cause results of inventory predictions of DSS are more accurate than the results of the inventory prediction obtained from inventory manager. For example: when there is a promotion/discount on a particular product, then the inventory manager purchases some products or adding inventory over their logical predictions.

## V. CONCLUSIONS AND SUGGESTIONS

### A. Conclusions

The results of research have proved that the DSS using FAHP and SPA approaches can be used to predict inventory, where the average percentage of accuracy that is higher than the average percentage of accuracy of pharmacy inventory manager. This means that the approach FAHP and SPA can be used as a decision support system to optimize inventory management at the pharmacy.

In addition, the result of this study also showed that the average accuracy of inventory prediction of DSS is more accurate than the inventory manager prediction (DSS: 39% and

MS: 21%), so the development of DSS using FAHP and SPA approaches to predict inventory management is able to optimize inventory in pharmacy

### B. Suggestion

Inventory prediction accuracy can be improved by using a database obtained from several months earlier as a basis for predicting inventory. The patterns of inventory prediction is identical to the training methods used by the artificial neural network (ANN), so that further research can integrate FAHP and SPA methods with ANN to improve the prediction accuracy of inventory.

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# Character Education Beyond Classroom in Higher Education: A Case Study in Student Community Engagement

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**Abstract**— Weblog has been proved to be an effective Educational Technology tool. In this study, we examined students blogging contents reflecting their participation in community engagement programs as part of their character education course. We investigate how blogs facilitate students to freely express their learning experience and what they really learned to relate with other people, with themselves and solve problems. The results show that blogging is easy for students to use and report their learning experience in community engagement. A majority of the students perceived that the programs have improved their understanding of and care for the needy, and some even resolved to keep giving back to the society.

**Keywords**—weblogs, character building, community engagement

## I. INTRODUCTION

The use of weblog (blog) in higher education has been popular. Professors and students can both use blogs for instructional purposes [1]. Blogs allow students to reflect on their learning and experience. They are alternative forms of contact among students, and between student and tutor, instead of face-to-face discussion or using instant messaging applications [2].

This paper describes how Binus University, a private university in Indonesia, incorporates Service Learning, Student Community Engagement and blogging in its Character Education. It is undoubted that Character Education is immensely important. In fact, Martin Luther King, Jr. asserts the function of education is to teach one to think. It develops both intelligence and character [3]. Lickona (2015) contends that we need good character to lead lives. Indeed, the recovery of ancient wisdom about the importance of character has been one of the most important ethical development recently [3].

However, despite of many attempts by government, religious and educational institutions in Indonesia, juvenile misbehavior statistics has stubbornly increased. The Raoul Wallenberg Institute of Human Rights and Humanitarian Law reports the following crimes committed by juveniles: sharp weapon possession, drugs, rapes/molestation, mass beating,

murder, torture, reckless riding/driving, theft, extortion, embezzlement [4]. This is in line with a list of juvenile misbehaviors in the US and UK: suicides, especially of young males; teenage pregnancy and abortion; the crime rate, particularly theft by minors; alcohol and drug abuse; sexual activity and sexual abuse; teenage truancy and mental health problems [5]. Thomas Lickona (1996) lists a further set of indicators of youth problems: untruthfulness; cruelty among peers; lack of respect for adults and parents; self-centeredness; self-destructive behavior, and ethical problems [6].

## II. LITERATURE REVIEW

### A. Character and Character Education

The English word “character” originated from the Greek word “to mark” or “to engrave” and is linked with the teachings of Greek philosophers, especially those of Plato’s and Aristotle’s. According to Dewey and Tuff (1910), character is “body of active tendencies and interests” that makes one “open, ready, warm to certain aims and callous, cold, blind to others” [7]. People are known by their behavior. When they have good character, they normally display good behavior [8]. The Character Education Partnership (CEP) defined character as — human excellence. It comprised of all the qualities that enable us to be and to do the best we can [9]. The social aspects of character are also important. A person with good character does not automatically mean that he or she is a competent individual. One has to commit to making positive contributions to the society, promoting good life, equality and respect others. However, it does not always mean that the person has to always conform to the status quo, but it is acceptable to “break the rules” when demanded by conscience [10].

Character education is a multi-disciplinary effort. It demands proponents and critics to keep asking various questions and employ different methods in delivering the subject [5]. It is “.... the deliberate effort to develop good



character based on core virtues that are good for the individual and for society.” [11].

Anne Lockwood (1979) defined character education as “any school-instituted program, designed in cooperation with other community institutions, to shape directly and systematically the behaviour of young people by influencing explicitly the non-relativistic values believed directly to bring about that behaviour” [5]. The aim of cultivating (moral) character and virtue through virtue education in schools continues to be described as controversial. Yet various negative conceptions about the notions of character, virtue and virtue education remain in academic circles [12].

### *B. Evidence of Character Education Effectiveness*

Prior research has found significant correlations between character education and positive behavior. Catalano et al. (2004) found a countless of positive youth development programs that resulted in promoting positive youth behavior effects and preventing youth misbehaviors. Some of the positive outcomes recorded were improvements in academic achievements, interpersonal skills, cognitive competencies, self-efficacy, self-control, quality relationship with peer or adult, problem solving and decision making skills, and commitment to studying (Catalano, Berglund, Ryan, Lonczak, & Hawkins, 2004). Similar findings were reported by Payton et al. (2008). A meta-analysis of 317 studies showed children’s improvement in their hard skills (academic performance) and soft skills like social-emotional skills, positive behavior, and positive relations with school [13]. Goss et al. (2014) proved character education improved in students’ attendance, discipline; they understand what types of behavior are socially accepted not only in school, but in the global community that they are a part of [14].

Character education programs are also attributed to significant decrease in youth misbehavior. A number of programs were found significantly improved students behavioral problems, including use of drugs and alcohol, misbehavior, aggressiveness, violence, truancy, smoking and risky sexual behavior [15], and reduced students’ conduct problems and emotional distress [13]. According to Bailey and Krejewski (1999), research showed that Character Education contributed to a decrease discipline problems, teen pregnancies, and adolescent use of drugs, tobacco, and alcohol [16]. Character education programs in general are as effective as more specific programs focusing on particular misbehavior [10].

### *C. Beyond Classroom Learning*

Moravec et. al. (2013) asserted that education should not focus on knowing “what” but “how”, education should produce a creative generation rather than a generation more prone to set answers. It should contribute to developing a generation who are more persevere in facing challenges [17].

Therefore, university professors have to reform the whole course work for students. They should creatively construct

new instructional designs to support Character Education and behavioral change programs. These programs cannot take place in the traditional university settings [18].

The Character Education Partnership proposed 11 principles in shaping individual’s character. One of them is it must engage families and community stakeholders (Principle 10) [7]. There are at least two ways for students to connect with the community stakeholders: service learning or community engagement. The National Service-Learning Clearinghouse (2005) defined “service-learning” as a “teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities” [19]. Service learning programs teaching methods that progressively connects students’ community engagement and academic endeavors. Service learning is a unique opportunity to strengthen students’ personal growth and civic responsibility [20]. Service learning programs integrate academic materials and community needs into community-based service programs. They engage students, faculty, staff and members of the community to predetermined learning objectives as well as to develop the community [21]. The service provided engage students in activities that focus on achievement the objectives. It generally benefits both the service recipients (members of the community) and the providers (i.e. the students involved). Students learn from the community, the activities and the outcomes of the programs [22]. Community service can be defined as any form of volunteerism, whereas community service-learning pairs a particular service project with coursework focused on the issues or skills related to this project [23].

### *D. Evidence of Service-learning and Community Engagement*

Service-learning is found to have a positive effect on understanding of social issues; personal insight; and cognitive development [24]. It functions to broaden students understanding of issues in the community they serve. Service-learning also helps them to reflect on their perceptions, views, biases; make them more aware of their responsibility to the community and provide them an opportunity to improve their hard skills and soft skills [20]. Similar results are reported in student-community engagement. Student-community engagement founded on principles of mutual reciprocity also enhances student attributes and is an important aspect of the modern university [25]. Celio et al. (2011) conducted a meta-analysis of 62 studies which involved 11,837 students and revealed that students who participated in service learning programs significantly gained five areas of improvements: their attitude toward themselves, their attitude toward school and learning, their civic engagement awareness, their social skills and academic achievements [26].

Huber et al. (2013) showed humatarian projects can develop students’ character when they work for the destined community. Preliminary evidence of how the project cultivates the five Cs, conceptual understanding and critical thinking

skills, community development skills, collaboration and communication skills, and character development skills [27]. Similar results are found in internationally organized service-learning initiatives. Bamber et al.(2011) found students who participated in service learning overseas learned the similarity of challenges to stereotypes, presuppositions and personal values in international settings [28].

However, cautions should be taken to generalize the outcomes. Hart et al. (2008) found no significant differences when comparing service-learning programs with curriculum integration to community service programs without curriculum integration. Second, students required to participate in community service seem to benefit from it as much as do students given freedom of choice. They also found little solid evidence to conclude that structured reflection is indispensable for adolescents to gain from service-activities [29].

#### *E. Incorporating Blogging to Reflect on Beyond Classroom Programs*

Students studying at the university at present belong a generation called the Millennial or the Digital Native generation. Considine et al. (2009) asserted that the Millennial has been influenced by digital media such as DVD, eBooks, the Internet, and mobile technologies [30]. Studying 470 first year university students in Australia in 2008, Corrin (2014) found that students engage with technology in their everyday and academic lives in very diverse ways, influence by their lifestyles, personal internists, social priorities, career aspirations and personal values.... They were not found to be using technology in new or innovative ways to support their study, instead using technology to supplement common study practices [31]. Margaryan et al. (2011) found that there were more students belonging to younger age group ("natives") who learn informally using blogging technology (20.1% of "natives" and 8.7% of "immigrants") and use blogging for socialization (45.6% of "natives" and 13.0% of "immigrants") [32].

A weblog or blog is essentially an online journal [33]. It records the "bloggers" diary and is hosted on the web. Williams et al.( 2004) posited that blogging has the potential to be a transformational technology for teaching and learning [34]. Yang et al. (2009) retreated that blogs are made simple for any user to constructs. One does not have to understand any programming language. Therefore, anyone who can use Microsoft Word, can create, use and maintain a weblog. Moreover, users can easily add pictures, video, or audio files to make their blogs more attractive [35].

Venkatesh et al. (2014) argued that numerous studies posit that computer-mediated instruction is as effective as face to face instruction, sometimes even exceeding the latter with regards to active learning when critical teacher-student interchanges in the classroom are restricted because of a high number of student presence in the [36]. Yan et al. (2010)

posited that educational blog has immense impact on education. It is worth implementing in the field of education. The process of implementation is also worth accelerating [37]. Although academic blogging is not very good at supporting dynamic online discussions, it has been found to strengthen individual expressions, reflection, networking and peer support. It provides a more expressive way of individual academic expressions [38].

Even though some studies have revealed that blogs contribute to students online learning engagement [2, 39], others studies find contradictory results. Divitini et al. (2005) have found that weblog technology failed to motivate students actively involve in the online learning activities [40].

### III. METHODOLOGY

The primary purpose of this investigation was to identify the outcomes of students' community engagement as part of their Character Education course. What are the outcomes of certain beyond classroom Character Education programs? [41]. Analysis is based on students' reflection published on their blogs. The publication is compulsory to ensure their ingenuity. Like other blogs, the student blogs record their programs, motivation, contribution and reflection. As a proof of their engagement, photos and videos are also uploaded on the same page of the web. The faculty member and an officer of the Student Community Development Center verify the reports. Once reports are verified, students may present their results to their respective class of Character Education.

The Community Engagement programs lasts for at least 6 weeks. Students can choose either to be engaged as a tutor for less-privileged primary school students, working for the blind, environment rehabilitation, and volunteering for a marathon run.

This analysis looks particularly into how students have cope with their assignment, especially at:

- How participants relate to other people (e.g., how they communicate, whether they are active listeners, how they relate to the people around them, how assertive they are, whether they are aware of their surrounding environment);
- How they reflect their learning to themselves (e.g., how they control themselves, whether they set goals, whether they relax themselves, whether they are aware of themselves and their personal emotions);
- How participants solve problems encountered [40].

Analysis focuses on keywords reported by the students and their reflection on the assignment. Similar keywords are grouped into one category. Only written words are analyzed.

### IV. RESULTS AND DISCUSSION

A total 39 weblogs were randomly selected and analyzed. One blog may have more than one keyword reflecting their

experience and learning. Results show that none of their reflection is negative. Fourteen (14) of the participants learned to care for others, especially the less-privileged citizens. They felt “privileged” when they met the people they served. Ten participants found that community engagement is fun and enjoyable. Few participants commented that they “almost gave up”. Table 1. summarizes the findings.

TABLE I. Keywords Found in Students’ Reports on Their Blogs

	Keywords	Occurrences
<b>Social skills and awareness</b>		
	Learned to respect the less-privileged	7
	Learned to care	14
	Learned to encourage the less-privileged	2
	Improved awareness	4
	Learned to stop discriminating against others	5
	Learned to work in team	4
<b>Personal improvement/ Self-management and awareness</b>	Learned to make friend with lepers	
<b>Problem-solving/ Decision-making</b>		

	Resolved to carry on helping others	2
	Resolved to encourage lepers	3
	Resolved to campaign for the benefits of lepers	2
	Learned to solve problems	3

#### A. Social Skills and Awareness

It is interesting to note that some of the participants became more aware of the needy. Most participants learned that they need to care, respect and stop discriminating the less-privileged. Engaging in the programs make them learned to live and make friends with lepers and allow them to learn to work as team. Two participants wish they could keep contributing to the society and give back to them.

Some of their comments are:

- 1) happy to be able to give back to the society
- 2) learn to respect others, especially the needy
- 3) encouraged to share the spirit to others
- 4) meet with lepers for the first time, only know the word lepers from the Bible.

#### B. Personal Improvement/Self-Management and Awareness

Ten of the participants found the programs enjoyable and fun. They felt happy after engaging in the programs. Five of the students understood more about leprosy and how to live a healthy life. Although it is not easy, some of the participants honestly admitted that they had to learn to be sincere when engaged in such a program. Others found the program to be experience enriching, motivating, exciting and they learn to self-discipline themselves, stand firm when facing problems. Some students felt sad after the program ended.

Some of their comments are:

- 1) Programs are useful
- 2) Meet with lepers for the first time
- 3) It is fun
- 4) Programs are unique (helping others while having fun)

#### C. Resolutions

Students learned how to solve problems on the spot, especially when they have to solve the problems in teams. Interestingly, some participants even resolved to carry on giving back to the society, encourage lepers and campaign for the good of the needy.

#### D. Limitation of the Study

This study is not without limitations. One limitation being that the data is obtained from the weblogs and based on students self-reporting. Secondly, students’ reflections may not represent the total perceptions understanding, and



contemplation of the whole program. One may write what he or she remembers at the time of reporting on their blogs.

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# Web Based Gastric Cancer Expert System Detection Using Forward Chaining

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**Abstract**—In 2012, based on data from World Cancer Research Fund International, gastric cancer was number 5 the cause of death for male or female. This is happen because most of gastric cancer patient didn't know the risk factor and symptoms of gastric cancer. Most of people just think that is only stomachache or ulcer. Because of that, this study is done. We built a website which will have the knowledge of internist that can make an early detection of gastric cancer. This system was made as a website system and used forward chaining method, so in this system there would be rules to determine the solution and the result of the detection of cancer. The solution is given based on the symptoms that have been chosen by the user. The result of the implementation of this expert system was this expert system could detect early symptoms of gastric cancer and the accuracy of this expert system was 96.7%. This accuracy value was gotten by calculating the average values of validation data from two experts.

**Keywords**—*expert system; forward chaining; gastric cancer; website*

## I. INTRODUCTION

Cancer is a disease in which the body cells growth abnormally and uncontrollably that is characterized by abnormality unique cell cycle [1].

Globally, based on data obtained by World Cancer Research Fund International, gastric cancer was the leading cause of death number 5 for men and woman in 2012. In the United States, gastric cancer was the leading cause of death number 7 and lot of gastric cancer found at 50 years old [2]. Because of that, gastric cancer was one of the deadliest disease in the world.

Gastric cancer is caused by unhealthy diet habit, such as the consumption of salted and smoked food, and rarely eats fruits and vegetables. Moreover, the other cause of gastric cancer was family medical history of gastric cancer, infection caused by *Helicobacter pylori*, chronic gastritis, *Pernicious anemia*, and smoking [3].

The symptoms of gastric cancer were very difficult to be detected because there were very few symptoms. The symptoms of gastric cancer could be detected at the advance stage such as vomiting and defecating with black color which is also a sign of bleeding [4].

The design and development of this research using forward chaining method. The reason the use of forward chaining method because this method was data driven and starting from the available information (in this case the symptoms of gastric cancer), then the conclusion obtained [5].

Forward chaining method was used in order to reach conclusion (solution), so the symptoms must be entered first [6]. After the symptoms were entered, the system can detect if someone has symptoms of gastric cancer and can give the solution for the user. In this case, the symptoms that entered by user is the symptoms of gastric cancer.

The implementation of this expert system was expected to detect gastric cancer symptoms earlier, so the action could be directly take an action based on the solution or suggestion that given by the system. Thus, in this paper will discuss about design and development an expert system for early detection of gastric cancer.

## II. RELATED THEORIES

### A. Artificial Intelligence

Artificial Intelligence is one area of computer science that utilize computer to behave like human [7].

Artificial intelligence technology can be learned in areas such as [7]:

1. Expert system.
2. Natural language processing.
3. Pattern recognition.
4. Speech recognition.
5. Computer vision.
6. Robotics.
7. Artificial neural system.

### B. Expert System

Expert system is computer program that imitate reasoning an expert with expertise in a particular knowledge area [8].

Expert system is one of the artificial intelligence technique area that quite attractive in various fields, both in the field of science and business. It is quite attractive because with expert system will be helpful for decision making and have very wide application [9].

Expert system has been developed for research purpose and business purpose from various disciplines such as economy, finance, technology, and medical. Expert system in the field of medical diagnosis has been developed since 1970s at Stanford University [10].

### C. Gastric

Gastric is a part of the digestive system. Gastric is a hollow organ located at the upper abdomen, below the rib. Gastric wall has 5 layer. The first layer is the innermost layer or core layer (mucosa). The second layer is the submucosal layer. The third is muscle layer. The fourth is subserosal layer. The last is the outermost layer or serosa [11].

Some types of gastric disease are irritable bowel syndrome, acute superficial gastritis, atrophic gastritis chronic, ulkus peptikum, gastroesophageal reflux (GERD), functional dyspepsia, malignant gastric tumor, and ulcers gaster [12].

### D. Cancer

Cancer is abnormal cells growth and happened when the original cells design is disrupted, and make these abnormal cells growing continuously and then turned the normal cells [13].

Many things affected someone has cancer disease such as change in environment (environment behavior), sexual behavior, life style, diet, and modern lifestyle [14].

The number of cancer patient in Indonesia has increased every year and could be proven as one of the leading cause of death. Cancer could be cured if the cancer still in early stage. The success of cancer treatment was influenced by the type of cancer, the stage of cancer, the general condition of the patient, and the effort of the patient to recover [15].

In the first step of cancer treatment, the cancer must be detected correctly so the lumps that found in the body was malignant cancer or not. Early detection of cancer could be done by biopsy checking (endoscopy). The next step, could give treatment such as surgery, chemotherapy, radiotherapy, and hormone therapy [16].

### E. Gastric Cancer

Gastric cancer according to Parkway Cancer Centre [17] is a cancer disease that starts in gastric (abdomen) and is ranked 2nd cause of death in the world. This cancer usually can occur in various location such as pyloric antrum, cardia gastric fundic region, and gastric.

Gastric cancer is caused by some factor such as age, sex, smoking, consumption of alcohol, reducing weight, eating a lot of salt, obesity, infection of *Helicobacter pylori*, and inheritance [18]. Gastric cancer disease usually occurs on human at age more than 55 and is more common in men than in woman [18].

Gastric cancer still has few symptoms so it is difficult to detect at early stage. Symptoms of gastric cancer can only be detected when it reaches an advance stage such as vomiting and defecating with black color which is also a sign of bleeding.

Gastric cancer could be detected in the following way [19].

- Fecal occult blood test → detected by testing the feces in the laboratory.
- Imaging studies → a method to observe an organ more clearly using X-Rays, ultrasonic sound, CT scan, or MRIs. This method is used to observe tumor or cancer in the patient's body.
- Gastroscopy → using a tube with a light and placed in the throat to see esophagus and gastric.
- Biopsy → detected by taking sample from tumor or abnormal thing and then examined with a microscope.
- Advance research → if the gastric cancer has detected, so the advance research could be done such as perform a biopsy on the gastric.

The solution for treating gastric cancer according to National Cancer Institute was to perform surgery to remove part of gastric, chemotherapy, and radiotherapy. There are two kinds of surgery depending on the location of the cancer. First is partial surgery that carried out by lifting tumor or cancer in the lower abdomen. Second is total surgery that carried out by remove or lifting upper abdomen. Chemotherapy was done to kill cancer cell by using drugs and could be done before and after surgery, whereas radiotherapy is similar technique such as chemotherapy to kill cancer cell, but using high-energy light [20].

## III. FORWARD CHAINING

Forward chaining is an inference method that doing reasoning from a problem to a solution, wherein the method is used to obtain the conclusion from a problem based on data or facts and move forward through the premises to obtain the solution [21].

Forward chaining is also a data driven because the inference starts from the available information and the new conclusion could be obtained [22]. Information that used in the system was given by input or by users and will be move in the logical network such as 'AND' and 'OR' to achieve the end result.

Forward chaining is using set of action-condition rules. In this method, data is used to determine which rule will be executed, and then the rule was executed. The process will be repeated until the result or conclusion achieved [23].

At figure 1 is shown how forward chaining works [24].

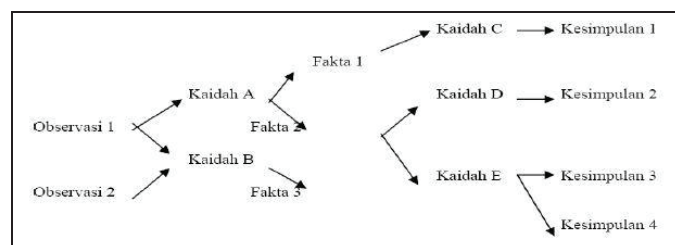


Figure 1. The working of forward chaining

In table 1, based on Suryadi [25] explains that forward chaining has the following concept :

Table 1. Forward chaining basic concept

Number	Forward Chaining
1	Planning, observation, control the present to the future
2	Antecedent to the result
3	Data-driven, reasoning on the base
4	Work forward to find
5	Solving the follow facts
6	The first breadth search made easy
7	Antecedent to determine search
8	The explanation that not easy

#### A. Knuth Shuffle Algorithm

Knuth Shuffle is taken from the name of Dibal Knuth, Knuth Shuffle is an algorithm for produce a random permutation from a finite set [26]. If this algorithm correctly implemented, the result will not be biased. So every permutation will have the same possibility [27].

Basic method that used on Knuth Shuffle [28]:

1. Writing number 1 until N.
2. Choose a random number K between 1 to the number that has not been crossed out.
3. The calculation is started from the bottom, then the number K crossed out, and write down the number.
4. Repeat step 2 and 3 until all the number crossed out.
5. Sort the number from step 3 that have been written down and this is the random permutation of the initial number.

Knuth Shuffle algorithm is not bias. Bias in this case is that the data will certainly generate a correct permutation. Beside of that, the basic process is similar with choosing a numbered ticket or card at random [29].

Table 2 is an example of Knuth Shuffle algorithm. Range is the amount of number that has not selected, scratch is set of number that has not selected, and result is the result of the permutation [28].

Table 2. Example of Knuth Shuffle Algorithm

Range	Roll	Scratch	Result
		1 2 3 4 5 6 7 8	
1-8	6	1 2 3 4 5 <b>8</b> 7	<b>6</b>
1-7	2	1 <b>7</b> 3 4 5 8	<b>2</b> 6
1-6	6	1 7 3 4 <b>5</b>	<b>8</b> 2 6
1-5	1	<b>5</b> 7 3 4	<b>1</b> 8 2 6
1-4	3	5 7 <b>4</b>	3 1 8 2 6
1-3	3	5 <b>7</b>	<b>4</b> 3 1 8 2 6
1-2	1	<b>7</b>	<b>5</b> 4 3 1 8 2 6

### IV. IMPLEMENTATION AND ANALYSIS

#### A. Specification

Expert system that was built in this paper, based on website. The website was built using HTML, PHP, CSS, Javascript, JQUERY, and MySQL database to store the risk factor of gastric cancer, symptoms of gastric cancer, and the suggestion that will be given to the user. The expert system also uses Google Chrome to open the web in order to run the application on Windows 8.0 Operating System.

#### B. Knowledge Base and Inference Engine

Knowledge base in this expert system is an expert knowledge representation, where every knowledge base that has been obtained from the expert has been applied in the form of questions of risk factor and symptoms of gastric cancer, then user will answer every question in the application.

Inference engine in this expert system application is using Forward Chaining method that acts as the brain of expert system. Forward Chaining method is used to determine what solutions will be provided in accordance with the symptoms chosen by the user.

At table 3 is shown symptoms code and risk factors or symptoms from the experts.

Table 3. Risk Factors and Symptoms List

Symptoms Code	Risk Factors or Symptoms
F001	<i>Helicobacter pylori</i> infection
F002	Consume foods that contain lots of salt and smoked frequently
F003	Drink alcoholic
F004	Smoking
F005	Have performed gastric surgery
F006	Anemia
F007	Family cancer history
F008	Obesity
F009	Gastric polyps
G001	Fullness in the stomach
G002	Unable to digest, have high acidity, and belching frequently
G003	Bleeding (blood vomiting and defecation with blood)
G004	Feeling pain and difficult in swallowing
G005	A lump in abdomen (abdominal swelling that leads to accumulation of fluids and cancer cells)
G006	Loss of appetite and not expected weight loss
G007	Feeling uncomfortable on the stomach

The explanation of rules in this system as below:

Facts:

- Chosen symptoms
- Chosen risk factors
- Amount of chosen symptoms
- Amount of chosen risk factors
- Empty solution

Premises used in this system:

- A : amount of chosen symptoms  $\geq 2$
- B : amount of chosen risk factors  $\geq 2$
- C : amount of chosen symptoms  $\geq 3$
- D : amount of chosen risk factors  $\geq 1$
- E : amount of chosen symptoms  $< 3$
- F : amount of chosen risk factors  $< 2$
- G : symptoms of gastric cancer is detected
- H : symptoms of gastric cancer is not detected
- I : symptom G005 is chosen
- J : symptoms G001, G002, G003, G004, and G006 are chosen

- K : symptom G007 is chosen  
 L : symptom G005 is not chosen  
 M : the solution is CT scan  
 N : the solution is Endoscopy  
 O : the solution are Endoscopy and CT scan

Rules:

- Rule 1: IF((A AND B) OR (C AND D)) THEN G  
 Rule 2: IF(E AND F) THEN H  
 Rule 3: IF(G AND I) THEN M  
 Rule 4: IF(G AND J AND L) THEN N  
 Rule 5: IF(G AND K AND L AND N) THEN O

### C. Implementation

This section describes the result of implementation of the interface that has been implemented. This expert system website consists of two parts. First, the frontend of the website that can be accessed or used by the user to detect gastric cancer and getting information about gastric cancer. Second, the backend is a place for administrations to set risk factors, symptoms, and solutions of gastric cancer.

At figure 2 is shown the view of home page.

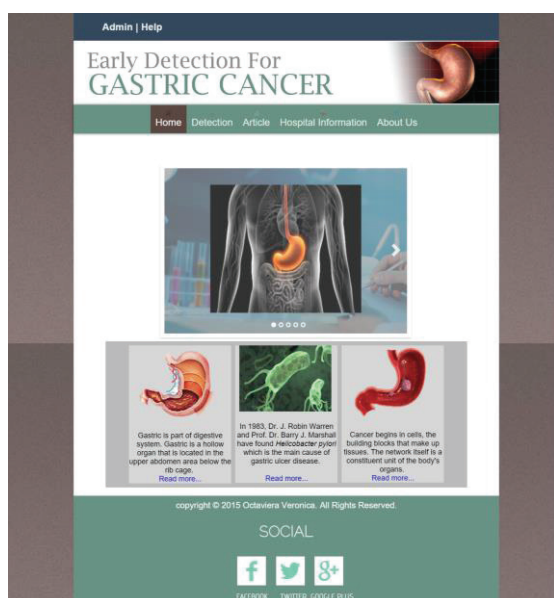


Figure 2. View of Home Page

At figure 3 is shown the view of page for add risk factor and symptoms data.

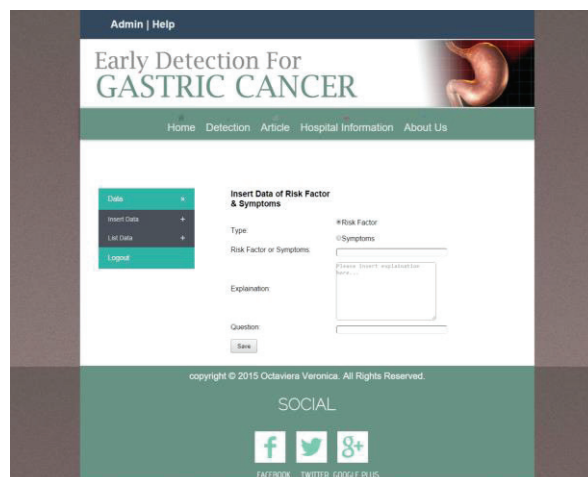


Figure 3. View of Page for Add Risk Factor and Symptoms Data

### D. Result's Analysis

Tests carried out by validating the data, where the result of detection performed by the expert, compared with the result of detection performed by the system. Testing in this application is done by taking 15 samples of common data that frequently occur. Data validation has been done by two experts. The first expert is Dr. Fajar Firsyada, Sp.B.KBD (expert I). The second expert is Dr. Nella Suhuyanly, Sp.PD (expert II).

At table 4, there are some cases, where the risk factors and symptoms columns contain different data. Risk factors column contains set of risk factor of gastric cancer. Symptoms column contains set of symptoms of gastric cancer. Detection system column explains the result of gastric cancer detection by the system that has been made and expert detection columns is the result of data validation by experts.

Table 4. Data Validation with Experts

Risk Factor	Symptom	Detected by System	Detected by Expert I	Detected by Expert II
- <i>Helicobacter pylori</i> infection -Smoking	- Difficult in swallowing -Defecation with blood (have black color)	Symptoms of gastric cancer is detected  Endoscopy	Symptoms of gastric cancer is detected  Endoscopy	Symptoms of gastric cancer is detected  Endoscopy
-Anemia -Drink alcoholic -Smoking	- A lump in abdomen	Symptoms of gastric cancer is not detected  Endoscopy	Symptoms of gastric cancer is not detected  Endoscopy	Symptoms of gastric cancer is not detected  Endoscopy
-Family cancer history -Smoking	-Weight loss - Defecation with blood (have black color)	Symptoms of gastric cancer is detected  Endoscopy	Symptoms of gastric cancer is detected  Endoscopy	Symptoms of gastric cancer is detected  Endoscopy
-Obesity -Smoking	-Difficult in swallowing -Weight loss	Symptoms of gastric cancer is detected	Symptoms of gastric cancer is detected	Symptoms of gastric cancer is detected



Risk Factor	Symptom	Detected by System	Detected by Expert I	Detected by Expert II
		Endoscopy	Endoscopy	Endoscopy
-Gastric polyps -Family cancer history	-A lump in abdomen -Fullness in the stomach -Feeling uncomfortable on the stomach	Symptoms of gastric cancer is detected  CT scan	Symptoms of gastric cancer is detected  CT scan	Symptoms of gastric cancer is detected  CT scan
-Consume foods that contain lots of salt and smoked frequently	-Loss of appetite and weight loss -Difficult in swallowing	Symptoms of gastric cancer is not detected	Symptoms of gastric cancer is not detected	Symptoms of gastric cancer is not detected
-Drink alcoholic - <i>Helicobacter pylori</i> infection	-Difficult in swallowing -Feeling uncomfortable on the stomach	Symptoms of gastric cancer is detected  Endoscopy and CT scan	Symptoms of gastric cancer is detected  Endoscopy and CT scan	Symptoms of gastric cancer is detected  Endoscopy and CT scan
-Smoking - Have performed gastric surgery	-Fullness in the stomach -A lump in abdomen -Belching with bad smells	Symptoms of gastric cancer is detected  CT scan	Symptoms of gastric cancer is detected  CT scan	Symptoms of gastric cancer is detected  Endoscopy
-Anemia -Smoking	-Bleeding - Belching with bad smells	Symptoms of gastric cancer is detected  Endoscopy	Symptoms of gastric cancer is detected  Endoscopy	Symptoms of gastric cancer is detected  Endoscopy
-Gastric polyps -Have performed gastric surgery -Smoking	-Difficult in swallowing -Fullness in the stomach -Feeling uncomfortable on the stomach	Symptoms of gastric cancer is detected  Endoscopy and CT scan	Symptoms of gastric cancer is detected  Endoscopy and CT scan	Symptoms of gastric cancer is detected  Endoscopy and CT scan
-Smoking -Drink alcoholic	-Fullness in the stomach	Symptoms of gastric cancer is not detected	Symptoms of gastric cancer is not detected	Symptoms of gastric cancer is not detected
-Family cancer history -Consume foods that contain lots of salt and smoked frequently	-Loss of appetite -A lump in abdomen	Symptoms of gastric cancer is detected  CT scan	Symptoms of gastric cancer is detected  CT scan	Symptoms of gastric cancer is detected  CT scan
-Obesity -Gastric	- Feeling uncomfortable	Symptoms of gastric	Symptoms of gastric	Symptoms of gastric

Risk Factor	Symptom	Detected by System	Detected by Expert I	Detected by Expert II
polyps	ble on the stomach -Bleeding	cancer is detected  Endoscopy and CT scan	cancer is detected  Endoscopy and CT scan	cancer is detected  Endoscopy and CT scan
- <i>Helicobacter pylori</i> infection -Gastric polyps -Smoking	-Bleeding -Difficult in swallowing -Fullness in the stomach	Symptoms of gastric cancer is detected  Endoscopy	Symptoms of gastric cancer is detected  Endoscopy	Symptoms of gastric cancer is detected  Endoscopy
-Obesity -Anemia -Smoking -Drink alcoholic - <i>Helicobacter pylori</i> infection	-Loss of appetite -Feeling uncomfortable on the stomach -Bleeding - Belching with bad smells	Symptoms of gastric cancer is detected  Endoscopy and CT scan	Symptoms of gastric cancer is detected  Endoscopy and CT scan	Symptoms of gastric cancer is detected  Endoscopy and CT scan

## V. CONCLUSION AND FUTURE WORKS

Based on the discussion above, it can be concluded that the expert system which can help to detect the symptoms of gastric cancer has been successfully implemented using forward chaining method.

This expert system is implemented based on data that has been obtained from experts. The experts are the internist, digestive consultant, and gastroenterohepatology consultant. Data obtained in the form of risk factors and symptoms of gastric cancer.

Based on data validation with experts that has been done, the accuracy of this expert system is nearly 96.7%. Hopefully, by using more accurate risk factors and symptoms, the system's accuracy can be increased.

Beside of that, expert system for gastric cancer detection can be developed with Adaptive Neuro Fuzzy Inference System (ANFIS) method. This method has more advantages than other methods such as: moving average (MA), linear regression, and exponential regression. Advantages of ANFIS method are has the least error than other methods and has the best RMSE (Root Mean Square Error) than all other methods.

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# **Computational Science and Technology**

# BI-based Approach for Computer Security

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**Abstract--** *Security is a challengeable concept for computer systems. Although, restriction the users access to assets is the simplest way, this way is not appropriate for user. Users need to information, but administrative of computer system may can not understand. This paper proposes an approach for administrative of computer system to recognize and understand users needs with BI. Business Intelligence (BI) introduces number of methods to administrative, so its decision becomes according to character of users. Proposed approach divides users into two groups: new users and old users. Users' character is found with BI for new users and Artificial Neural Network is used to retrieve suitable security level for old users.*

**Keywords--** *Computer security; Business Intelligence; Artificial Neural Network*

## I. Introduction

Computer systems are vulnerable with threaten, so they need to number security policies to protect them. Computer security policies can be divided into two categories: 1-hard policies and 2-soft policies. In hard policies, administrative of computer system restricts transactions within specific boundaries. In other words, when a transaction input to the system and wants to access some assets, administrative decides its request must accept or reject. Whether request is accepted or rejected, transaction can or cannot access to desired assets. In soft policies, there are number security levels and administrative decides which level is suitable for user. For example, a government may decide to band a site. Thus, all transactions which want access to this site are rejected. This is hard policy. In otherwise, a father want prepare internet connection for his family. Actually, he thinks some of sites are not suitable for them. Therefore, he needs to system that allows or does not allow to his family to access sites. This is soft policy. Actually, soft policy must according to characteristics of users. As a result, hard policy limits entire the pages, but soft policy hides some segments of pages which are not suitable for user according to his/hers characteristics.

After definition of soft policy, the natural question is "how can apply it?". The aim of this paper is propose an approach to apply the soft security

policy. For this goal we use *Business Intelligence* (BI) techniques and *Artificial Neural Network* (ANN). BI is used to found suitable security level for new user and ANNN is used to classify the old users.

The rest of this paper is organized as follow: section 2 is assigned to related works. In section 3, background is described briefly. In section 4, we discuss about problem and proposed algorithm. Experimental results are represented in section 5 and section 6 is conclusion.

## II. Related Works

The increasing of web technologies with complexity in process is focused in [13]. Gerardo Canforda et al, represents a scenario which confidential data are more exposed unlawful disclosure, thus they proposes a three level method for confidentiality. The highest level is represented by the privacy regulation (PR). The intermediate level is the set of privacy objectives (PO), which are semi-structured statements describing how data can be accessed by users. The formulation of POs depends on the entities, the particular relationships among them, and the specific domain dictionary. The lowest layer of the model is represented by the privacy rules set which implements a given PO. A rule assumes the form of a query that the user can or can not send to database. The three layer representing is also represented in [14]. An IoT (Internet of Things) system contains three layers: a physical perception layer that perceives physical environment and human social life, a network layer that transforms and processes perceived environment data and an application layer that offers context-aware intelligent services in a pervasive manner. Layered approach can be used in different media such as radio. In applied systems base on this scenario, administrator must decide to assign levels, so this method is not user-friendly.

[15] shows that it is possible to improve the security of a system by applying program transformations to the existing code base. Bottino (et al. 2006) suggests architecture for secure computers



[16]. [17] suggests security investments response to perceived and materialized threats rather than a response to more rigorous analysis of the effectiveness of solutions in combating such threat. Unfortunately, their computations are complex, so there is need to intelligent method.

Artificial Neural Network is used very effectively in pattern recognition. In [18], authors propose an approach to identify computer users using data from keystroke patterns. The aim of [19] is representing a method base on evolutionary neural network for intrusion detection. That method combines genetic algorithm with neural network. Since the performance of ANN in computer security is proved, we use this method in our proposed system.

### III. Background

Our proposed system is base on two methods: - Business Intelligence and Artificial Neural Network. The major feature of BI is their implicitly. In other words, since direct questions about security are not useful, BI can be used for decision about suitable security level for new users. In other side, ANN is used to classify old users into security levels.

#### A. Business Intelligence (BI)

Business Intelligence (BI) is set of disciplines include extract data, combination of data, analysis and discover knowledge which enable system to comprehend input/output environment [1, 2]. The aim of BI is preparing a document for verification of system, preparing a prototype for deployment and getting a strategic and applicable knowledge base on scientific view [10]. BI has five layers as show in Fig.1.

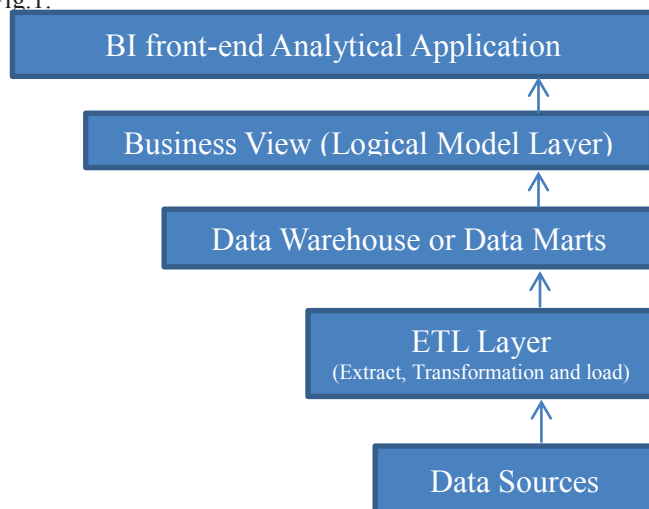


Fig. 1. Layers of BI

BI helps developers to [11]:

- 1- Fast data processing: BI can access, select and modify anytime. The speed is guaranteed.
- 2- Intelligent correlation analysis: BI uses mathematical models and declares scientific rules.
- 3- Multi-dimensional analysis: BI getting a combinational analysis in format of products, brands and ..., then construct a multi-dimensional data structure.

BI uses various intelligent tools such as: tools to gather implicational data and extract business knowledge from them [3], competing intelligent tools which try to get data from competing environments [2]. Constructing BI system includes the following steps [4]:

- 1- Planning and direction
- 2- Gathering released information.
- 3- Gathering resource from users
- 4- Analysis
- 5- Report and inform

There are two taxonomy types in BI: one-dimensional data and two-dimensional data [5]. List of results from hyperlinks belongs to one-dimensional data. Tree data and networking data belong to two-dimensional data. Two-dimensional data allows people to search base on human abilities.

Special text is displayed in BI system within three phases [6]. Firstly, according to users' attractive, necessary characteristic of text are extracted. This phase can be named 'Analysis'. In this phase some search techniques for analysis of text in network, are used. These techniques have responsibilities to discover resources and patterns from network [7]. In the second phase which is named 'Algorithm', an applicable and flexible structure with clustering is constructed. Algorithms can be divided into two categories [8]: 1-hierarchical and 2-partitional. Final phase is 'visualization' which data is displayed to users. Visualization means display coding data in special format as understanding with human eyes.

#### B. Artificial Neural Network (ANN)

Folk biology tells us that our brains are made up of a bunch of little units, called *neurons* that send electrical signal to one another. The *rate* of firing tells us how "activated" a neuron is. A single neuron might have some incoming neurons. These incoming neurons are firing at different rates. Incoming neurons are electrical signals from other neurons multiply to some *weights*. Responsibility of *Artificial Neural Network* (ANN) algorithms is tuning the weights.

It receives inputs from D-many other neurons, one for each input feature. The strengths of these inputs are the feature values. Each incoming

connection has a weight and the neuron simply sums up all the weighted inputs. Based on this sum, it decides whether to “fire” or not. Firing is interpreted as being a positive example and not firing is interpreted as being a negative example. In particular, if the weighted sum is positive, it “fires” and otherwise it does not “fire”. Mathematically, an input vector  $x = \langle x_1, x_2, \dots, x_D \rangle$  arrives. The neuron stores D-many weights  $w_1, w_2, \dots, w_D$ . The neuron computes the sum:

$$a = \sum_{d=1}^D w_d x_d \quad (1)$$

to determine its amount of “activation”. If this activation is positive (i.e.  $a > 0$ ), it predicts that this example is a positive example. Otherwise it predicts a negative example.

There are number methods to tune the ANN weights, famous of them is *Back Propagation* (BP). BP is doing on *multi-layered Neural Network*. It is a chain together a collection of neurons. BP is gradient decent plus chain rule. If the last layer of neurons is “output”, error is computed with (2).

$$E = \frac{1}{2} \sum_{j=1}^m [d_j(k) - y_j(k)]^2 \quad (2)$$

Where m is number of neurons in output layer, d is desired value and y is network output. Changing of weights in each iteration of training phase is equal to portion of error over those weights. Thus, changing of weights in  $n^{\text{th}}$  layer is represented in follow formula.

$$\Delta w^n = -\eta \nabla_{w^n}(E) \quad (3)$$

Where  $\eta > 0$  is a learning rate.

#### IV. Problem and Proposed Algorithm

There are some levels for security. Users inputs to the system and administrative must decides appropriate level for them. Users are divided into two groups; 1-JT (Junior Users): new users which are fresh for the system and 2-ST (Senior Users): old users which have records in the log.

The reaction of the system against users must be different and according to their type. In the first state, if user is new for the system, administrative must decides which level of security is suitable for it.

In the second state, if user is old for the system, it has a record in *log*. Administrative have to retrieve the associated information from log.

For the first state (when user is junior), administrative can not ask desired level of security from user directly, because answer may not be

loyalty or may not be carefully. Suitable approach for administrative decision is *Business Intelligence*.

For the second state (when user is senior), administrative uses *Artificial Neural Network* for retrieve record in the log.

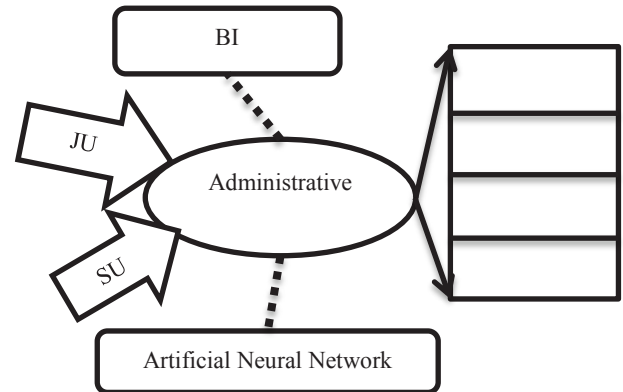


Fig. 2. The structure of proposed system

#### V. Experimental Result

We examine 100 users. Half of them are junior and others are senior. Junior users have to register in system. There are some questions in registration page which cause administrator comprehends the character of user.

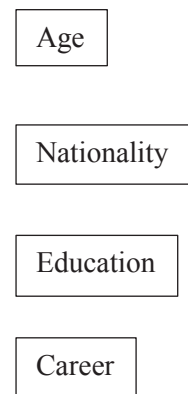


Fig. 3. Questions in registration page

The other users are senior. It means they registered in the system and administrator has their record. Let there are 4 security levels with names “L1”, “L2”, “L3” and “L4” in the system. After a user (with specific ip-address) registered in the system, administrator selects special security level for it base on BI. For this reason, we use a neural network with 3 layers: input layer with 16 neurons, hidden layer with 8 neurons and output layer with 4 neurons. Structure of proposed network is same as

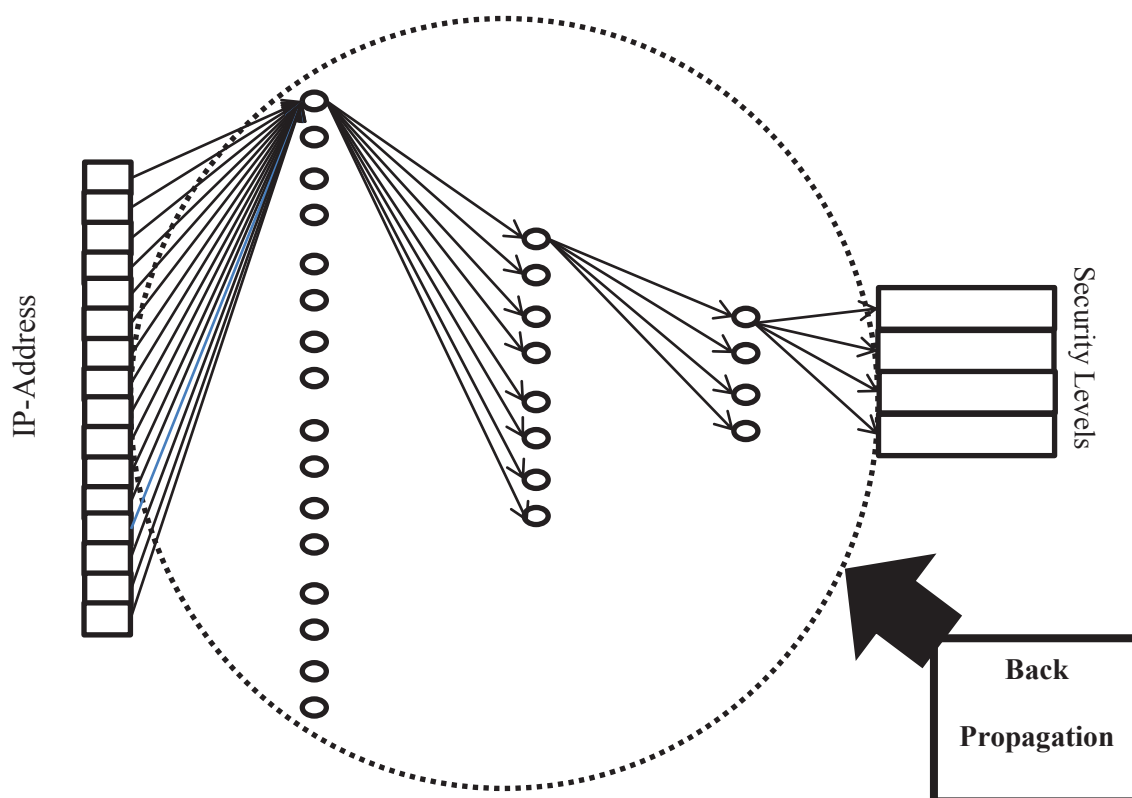


Fig. 4. Structure of neural network (For simplicity we show just connections of one node in each layer)

For implementation we use MATLAB. Fig. 5, describes instructions to create proposed network.

```
net=network;
net.numinputs=16;
net.numlayers=3;
net.biasconnect=[1;1;1];
net.inputconnect=[1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1;
0 0 0 0;
0 0 0 0];
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

Fig. 5. MATLAB instructions to implement the network

At first line, we create the neural network. Second and third lines define number of inputs and number of layers. The fourth instruction is a Boolean matrix and defines layers that have “bias”. The fifth instruction defines neurons that get signal from inputs. The last instruction specifies the connection between layers. When the network is created, there is need to train it. We use “traingd” to train it according to back propagation algorithm.

## VI. Conclusion and Future Works

In this paper we propose a system which assigns suitable security level to users. The main difference between proposed system and common security systems is about concept of “suitable”. In common computer security system, administrative decides about accessing. Users send request for accessing to needed information to administrator, then administrative decides to accept or reject this request. Problem of this method is reject situation. When administrative decides reject a request, entire the page (for example, in World Wide Web) becomes inaccessible for user.

In proposed method this problem is resolved with BI. Administrative comprehends the suitable information for user with BI techniques, so in reject situation just unsuitable information is inaccessible for user (part of page).

BI techniques include various ways. The simplest of them is asking some questions which we do in this paper. We can examine the other and more sophisticated ways. Another aspect of BI is decision making from data. In future work we can examine some methods for decision making support (such as fuzzy logic).

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# Integration of Risk Management into Engineering Project Management Education in Indonesia: Preliminary Findings from a Current Study

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**Abstract**—Deliver an effective Engineering Project Management education is a challenge that every educator face. The nature of Engineering Project Management that is multidisciplinary, combining technical and behavioral skill, also a discipline of cost, time, risk and communication. This constraint make the development of Engineering Project Management education innovate themselves to find the most effective way for this course. Integrating the Risk Management knowledge into Engineering Project Management is one of the options that can be use. Although the Risk Management is only one of the aspects in the Engineering Project Management, the importance of this concept is increasingly become required in many engineering project.

This paper is study the method to deliver the effective learning process for student to understand both of Engineering Project Management and Risk Management at the same time. The study develop a model that can be used by student and practitioner to understand the integration between this concept

**Index Terms**—Engineering Project, Project Management, Project Management Education, Risk Management

## INTRODUCTION

A project manager is expected that have a multi disciplinary skill from the time management, communication to procurement and risk management. Competent project manager require a skill set and experience, which some of the part can be acquired through education or training.

In practice, the course of project management education can be separated from the course of project management. The student can choose project management course and if they have interest in risk management then they can take the risk management course. In fact, some university is already combined into a single course.

From industry point of view, the project management competence can be acquired by having a certification for example Project Management Professional (PMP) certification from Project Management Institute (PMI). The risk management competence also can be acquired by having a certification for example Certified Information System Auditor (CISA) certification from Information Systems Audit and Control Association (ISACA).

Having observed this situation, there is a possibility to combine and integrate this two area into single course that

based on project management. The expected benefit can be from time perspective, which mean that the course will be more time efficient. Also from the understanding of the concept.

Study also indicated that along with integration, the course of risk management also require knowledge and experience with that having systematic and formal approach [1] it makes easier to understand the concept.

## LITERATURE REVIEW

The importance of risk management practice is strongly required for the success of the project. Research also indicated that effective risk management would have positive impact to the project [2]. Furthermore, as a project becomes very complex, including a large number of money, with tight deadline the risk management practice demand is become higher. Shangjuna also studied the necessary of risk management as part of a large scale project [3]. A lot of study also taken to identify which most important risk during the project, it can be many factor such as communication or knowledge transfer [4] that might affect the project.

Therefore, it can be argue the importance of risk management during the engineering project and how the process to integrate the concept of risk management knowledge during the education.

## RISK MANAGEMENT IN ENGINEERING PROJECT MANAGEMENT EDUCATION

EPM chosen as a focus of study due to the nature of the area that requires both of theoretical and practical group [5]. This background make a teaching of EPM challenging because from academic experience, the student lack of real life experience. While on the other side, from practitioner point of view, the topic also difficult since they are need to combine several technical knowledge which they don't have enough time to study.

Study also indicated that some of practitioner lack of awareness and knowledge in the risk management principle that result a judgmental errors [6].



Finding method for effective risk management education has been a topic that being research for many time. The risk management education also trying to find the most effective way to study this concept, which by performing interactive discussion indicated as the effective way [7].

The university and other academic institution begin to adapt the risk management knowledge into their engineering education. Usually it began as additional information during the project management lecture. Many universities began to invite professional speaker to speak in their class about importance of the risk management.

## *RISK MANAGEMENT IN INDONESIA*

### *I. Risk management in Indonesia*

Although the risk management practice and concept have been implemented in Indonesia a long time ago, however the beginning of the popularity of the risk management practice in Indonesia can be traced from 2003, where Indonesian central bank (Bank of Indonesia / BI) release a regulation number 5/8/PBI/2003 concerning application of risk management for commercial banks, which later on 2007 the regulation number 9/15/PBI/2007 being released concerning implementation of risk management in the use of information technology (IT) by commercial banks.

The period of 2007 also an increasing popularity of risk management practice especially after COBIT 4.1 (Control Objectives for Information and Related Technology) a framework created by ISACA (Information Systems Audit and Control Association) that usually used by many practitioners as reference for IT risk management released.

The demand of the company to have a good risk management practice increased during this period. From implementation of risk management system using software, combining software and manual or awareness by perform risk management training and certification. Company also begin to have a built in risk management capability in all of critical business from project development to business operation.

### *II. Risk management during engineering project*

Due to the nature of project that involving a large number of investment and the potential risk of failure during the development process. BI also began to perform in depth examination on the IT project for the commercial bank. It is required for the bank to submit the independent report of IT prior the product being launch to the public. This regulation increases the awareness to have risk management knowledge during the project.

According to BI, a bank should have implement effective risk management in the use of IT. Also BI stated that the implementation of risk management must become integral part during every stage of IT use, from the process of planning, construction, development, operation, maintenance, up to the discontinuation and the disposal of Information Technology (see PBI9/15/2007). This regulation increases the awareness

of both a proper project management and the risk management practice.

The industry respond on this matter is vary, but most of them agree to implement the risk management concept for the company. However some interpretation and the regulation matter might be different. The bank realize that the project of the bank, for example new internet banking or new banking channel system is high risk and need to be take care carefully.

The increasing demand for the risk management also based on fact that the e-banking application for bank is growing from internet banking, mobile banking to new banking channel being develop

## *INTEGRATION AND MAPPING FRAMEWORK*

### *I. Integration Mapping*

The challenge to integrate risk management is to have an effective mapping from this the duplication of the same subject during the lesson can be avoided. In this study, the integration and mapping of risk management and project management framework is by combining the framework from international best practice on project management, risk management and industry requirement on banking technology regulation.

The project management framework used in this study is Project Management Body of Knowledge (PMBOK) from Project Management Institute (PMI). The risk management framework that used in this study is COBIT 4.1 (COBIT) from ISACA.

The other candidate for framework that can be used is using PRINCE2 (Project in Controlled Environment) or Security Framework for ISC2.

### *II. Mapping between PMBOK and COBIT*

Integration and mapping of risk management into project management have been performed by many institution and researcher. One of mapping that can be used is based from ISACA "Mapping of PMBOK with COBIT 4.0" [8]. The idea of this mapping is that PMBOK and COBIT is interacting each other to provide the best practice during the engineering project.

As mention in the mapping PMBOK provide Project Management best practice on how to run the project, while COBIT provide which controls that required during the project. This combination will help both student and practitioner to understand this two concept together during a project. The single project case study can be used to understand this concept in effective way.

Integration of COBIT and PMBOK according to ISACA can be used to highlight specific IT practices that should be considered when applying PMBOK to project that involving IT.

## Controls Required for IT Projects



## Project Management Best Practice

Figure 1 Mapping between COBIT and PMBOK

### III. Mapping between BI stage of IT versus ISACA COBIT

One of the methodologies to integrate risk management concept during engineering project is during the development of commercial bank's mobile application. The mapping of BI requirement can be related with the ISACA COBIT Risk Management as below:

TABLE 1 PBI 9/15/2007 AND COBIT MAPPING

PBI 09/15/2007	COBIT	Process
<b>Management</b>	P01	Define a Strategic IT Plan
	P07	Manage IT Human Resources
	P05	Manage the IT Investment
	P09	Assess and Manage IT Risks
<b>System Development and Acquisition</b>	P10	Manage Projects
	A06	Manage Changes
	A02	Acquire & Maintain Application Software
	A07	Install and Accredited Solutions & Changes
	A05	Procure IT Resources
	A03	Acquire & Maintain Tech. Infrastructure
<b>IT Operational Activities</b>	A04	Enable Operation and Use
	DS03	Manage Performance and Capacity
	DS09	Manage the Configuration
	DS08	Manage Service Desk and Incidents
	DS10	Manage Problems
	P08	Manage Quality
	DS01	Define and Manage Service Levels
<b>Communication Network</b>	DS13	Manage Operations
<b>Information Security</b>	DS05	Ensure Systems Security
	DS12	Manage Physical Environment
<b>Business Continuity Plan</b>	DS04	Ensure Continuous Service
<b>IT Internal Audit</b>	M02	Monitor and Evaluate Internal Control
<b>The use of IT Service provider</b>	DS02	Manage Third-Party Services

By using this mapping, the lecturer could relate which aspect during the engineering project need attention from risk management side. For example during the system development phase, the project manager needs to take care on how to manage changes. This will solve the problem of missing link between project and risk.

During the implementation of the mapping for the industry, this mapping can shown which document or requirement need to be completed

## CONCLUSION

In this paper, we propose to integrated risk management concept into engineering education by using mapping between PBI 9/15/2007 and COBIT. This mapping would bridge between framework that widely used in Indonesia banking industry with the framework that widely used in university as standard risk management and project management knowledge.

The benefit for student which took the engineering education in the university such as:

1. Easier to understand on how the concept being used during the real life project.
2. Awareness of early risk management concept

The benefit for practitioner who took the further engineering course that has a risk management knowledge such as:

1. Having understood the requirement from regulator and know the prioritization of risk management that need to be implemented
2. Compliance to regulatory reporting such as having to submit a risk management related document and report is understood.

Furthermore, concept of risk management that consistent implemented during the engineering education will help both of student or practitioner to develop the learning path that can be refreshed or upgraded when needed. Further research in developing framework that encouraged student to learn the practical side of concept in practical work is required.

## FUTURE WORK

The integration of risk management during engineering project management is just a preliminary work, which still needed further work in the work. It can be develop a virtual learning system that integrated this concept by system therefore student can learn and have better understanding of this concept.

It is also can be improved by making the risk management component as part of project management information system. Therefore after learning process the framework can be used for practical day to day activity

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# Wiki CS Annotation

## Performing Entity Annotation within WordPress Plugin

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**Abstract**—Information in a document can be represented by tags generated by using entity annotation approach. Those tags can be used to organize documents in a collection. This organizing method is also used in a blog to manage their posts. In this study, a WordPress plugin (named Wiki CS Annotation) which implements TAGME's algorithmic technology is designed and developed to perform entity annotation by giving tag suggestions for post in a blog. In addition, this plugin creates hyperlink to Wikipedia page on word or phrase in the post, based on the selected tag suggestions which are wanted to be the tags of the post. This plugin uses an anchor dictionary which is created by the preprocessing application. Testing is carried out by involving 35 respondents to get their effectiveness when using the plugin. The result shows that approximately 56% of the tag suggestions given by the plugin are considered relevant, i.e. suitable to become post's tags or entities to be linked to Wikipedia. Moreover, user's effort when using the plugin is considerably small.

**Keywords**—entity annotation; plugin; TAGME; Wikipedia; Wordpress

### I. INTRODUCTION

Information in a document can be organized by performing indexing or "tagging". Here, each document in a collection is indexed with a set of keyphrases ("tags") that reflect its principal topics. However, assigning tag or keyphrase manually is so time-consuming and impractical [1].

Keyphrase indexing is an approach that maps a word or phrase in the documents to a related term in a controlled vocabulary. Wikipedia can be used effectively to build a controlled vocabulary, which is then used to perform keyphrase indexing. This approach is also called as topic indexing [2]. Thus, the resulting tag or keyphrase is a term in a controlled vocabulary built from Wikipedia.

Mihalcea & Csomai [3] define "text wikification" (shortly "wikification") as the task of automatically extracting the most important words and phrases in the document, and identifying for each such words and phrases the appropriate link to a Wikipedia article. Milne & Witten [4] also do research to resolve "wikification" by using machine learning algorithm. Thus, the problem of topic indexing is closely related to "wikification" when Wikipedia is used to build a controlled vocabulary.

TAGME [5] is the first software system that, on-the-fly and with high precision/recall, perform *entity annotation* [6] for short text. An example of a short text is the post of a blog. Reference [5] also explains that there are new challenges in performing entity annotation on short text, which (1) should occur on-the-fly and thus cannot be pre-processed and (2) should be designed properly, because the input texts are so short that it is difficult to mine significant statistics that are rather available when texts are long.

Basically, writing a blog can be viewed as managing the content of a website which can be done easily by using a Content Management System (CMS). One example of CMS that supports blog creation is WordPress. WordPress is the most used CMS (47.09%). Furthermore, it's also the most used CMS for blog management (97.78%) [7].

In this study, we want to extend the functionality of WordPress through plugin development. The writer of a blog post can use the plugin to specify tags automatically, which means tags is given by the system and thus they're also consistent. Moreover, the reader of that post can get the richer meaning of text representation because entites in that text is linked to articles in Wikipedia.

Thus, organizing the posts of a blog can be done with entity annotation approach, which uses tags to represent that blog posts. Challenges in entity annotation process can be solved with TAGME's algorithmic technology (shortly TAGME technology). Therefore, in this study, a WordPress plugin which implements TAGME technology is designed and developed to perform entity annotation on blog post.

### II. ENTITY ANNOTATION

Entity annotation is an approach to overcome the limitation of classic approaches which are based on "bag-of-words" paradigm in providing semantic representation for a text document. The key idea of this approach is to identify, in the input text, short-and-meaningful sequences of terms (also called mentions) and annotate them with unambiguous identifiers (also called entities) drawn from a catalog, such as Wikipedia [6].

The process of entity annotation involves three main steps [6]:



- parsing of the input text, which is the task to detect candidate entity mentions and link each of them to all possible entities they could mention;
- disambiguation of mentions, which is the task of selecting the most pertinent Wikipedia page (i.e. entity) that best describes each mention;
- pruning of a mention, which discards a detected mention and its annotated entity if they are considered neither interesting nor pertinent to the semantic interpretation of the input text.

The problem of entity annotation can be casted in two main classes: (1) the identification of (possibly scored) annotations, and thus the identification of mention-entity pairs; and (2) finding tags (possibly scored or ranked), and thus accounting only for the entities [6].

### III. PLUGIN DESIGN

The WordPress plugin which is designed and developed in this study, is named Wiki CS Annotation and performs entity annotation by using anchor dictionary which is created by preprocessing application used in [8]. The entity annotation process is performed by giving tag suggestion(s) to user based on the written input text and creating hyperlink on word or phrase in the input text to Wikipedia page based on the selected tag suggestion(s) which are wanted to be the tags of the post.

Reference [8] explains that Wikipedia bahasa Indonesia articles under Computer Science (Ilmu Komputer<sup>1</sup> in bahasa Indonesia) category structure are used to create the anchor dictionary. The resulting anchor dictionary is in the form of XML file and has records whose element structure shown in Figure 1.

```
<anchorentries>
  <anchor_entry>
    <anchor_text></anchor_text>
    <anchor_sense_maps>
      <anchor_sense_map>
        <sense_title></sense_title>
        <counter></counter>
        <in_page_title_set>
          <in_page_title></in_page_title>
        </in_page_title_set>
      </anchor_sense_map>
    </anchor_sense_maps>
    <link_a></link_a>
    <freq_a></freq_a>
  </anchor_entry>
</anchorentries>
```

Figure 1. XML element structure of an anchor dictionary record

#### A. Data Flow Diagram

The plugin's user can be divided to two groups, i.e. common user and administrator. This two groups are shown as

<sup>1</sup> [http://id.wikipedia.org/wiki/Kategori:Ilmu\\_komputer](http://id.wikipedia.org/wiki/Kategori:Ilmu_komputer)

external entities in context diagram of data flow diagram (DFD) in Fig. 2. The Administrator entity represents the role as Administrator in WordPress, who can activate the plugin. The common user (User entity) represents the role as Editor, Author, or Contributor in WordPress, whose ability to write post.

Fig. 2 shows that the Administrator also gives trigger to initialize the process of importing anchor dictionary and receives notification of that process when it is finished. Moreover, User receives data such as tag suggestion(s), selected tag suggestion(s) which become tag(s) of a post, and hyperlink data from the plugin. User also gives data such as pNA threshold value (i.e. value used to control the number of tag suggestion(s) given by the plugin) and selection of tag suggestion(s).

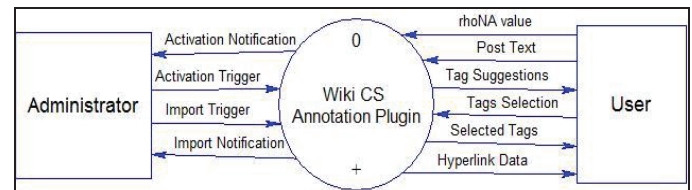


Figure 2. DFD context diagram

Level 0 diagram in Fig. 3 shows data flow of the plugin. Generally, this flow can be described as follow. Administrator activates the plugin, then imports the anchor dictionary. The importing process is carried out by creating a parser for XML file of that anchor dictionary, then inserting the records to four tables, whose structure and relation will be described in section B. When user want to get the tag suggestions, that imported anchor dictionary data is used by the plugin to generate the tag suggestions. Then, the tag suggestions which are selected by the user will be processed to create the hyperlinks.

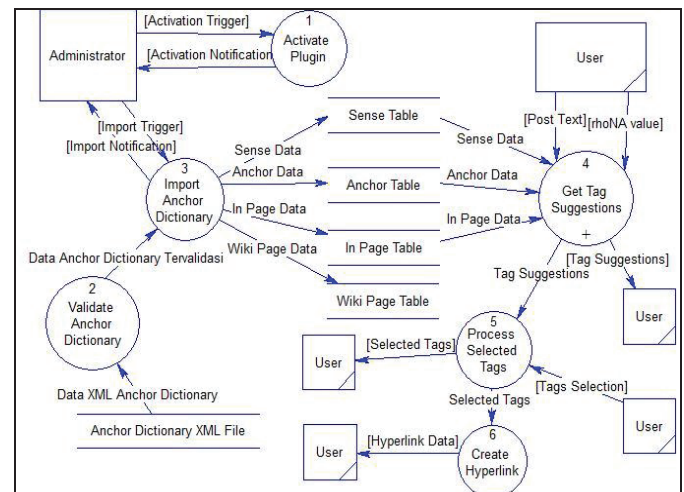


Figure 3. DFD level 0 diagram

Level 1 diagram in Fig. 4 shows that process Getting Tag Suggestions in Fig. 3 can be specified into three subprocesses, i.e. Anchor Parsing, Anchor Disambiguation, and Anchor



Pruning. These three processes are the main phase of TAGME technology to perform entity annotation.

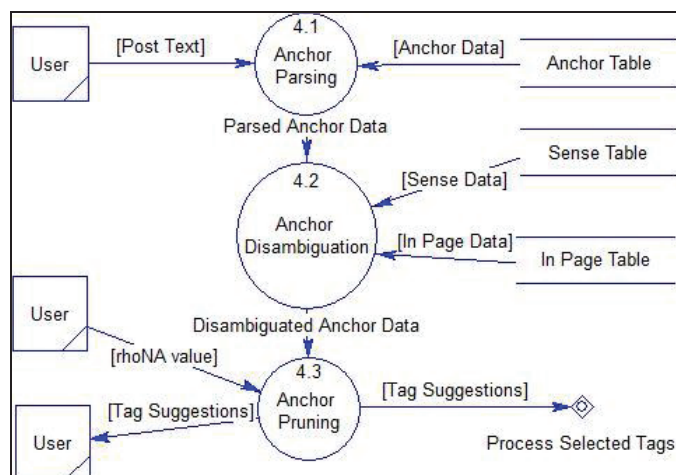


Figure 4. DFD level 1 diagram

### B. Database Design

Fig. 5 is an Entity Relationship Diagram (ERD) that shows structure and relation of tables which is used to store anchor dictionary records in database. Anchor table store anchor data. An anchor data can have one or many relation(s) with sense data which is stored in Sense table. A sense data can have one or many relation(s) with set of in page data which is stored in In\_Page table. In\_Page table stores *id* of sense data from Sense table and *id* of Wikipedia page title from Wiki\_Page table.

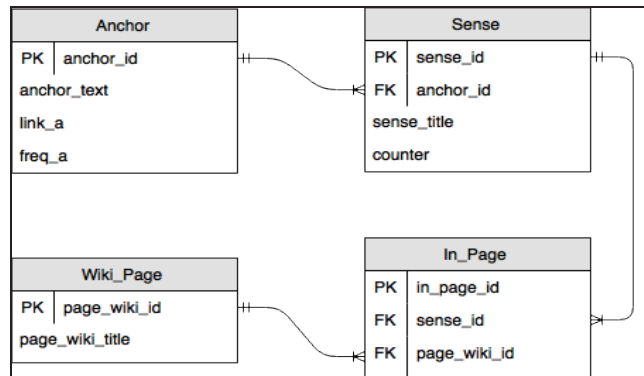


Figure 5. ERD of stored anchor dictionary in database

### C. User Interface Design

The plugin's user can be divided to two groups, i.e. common user and administrator, so there are two kinds of interface that are designed. (1) The interface for common user is displayed in the page of editing a post or creating a new post, below the text editor in WordPress. This interface allows user to request tag suggestion(s), select tag suggestion(s) given to become tag(s) of a post, delete the chosen tag(s), and change the pNA threshold value. (2) The interface for

administrator is displayed in the Settings page and used as the interface of anchor dictionary import facility.

Fig. 6 shows the user interface design for common user. Fig. 6 also shows that there are two buttons which can be used to get tag suggestions and reset pNA value. Moreover, there is a slider which can be used to adjust pNA value. There are also two areas, i.e. area below "Selected Tags" and "Suggested Tags", which are used to display the tag suggestion(s) which are selected by the user to become tag(s) of a post and the tag suggestion(s) given by the plugin, respectively.

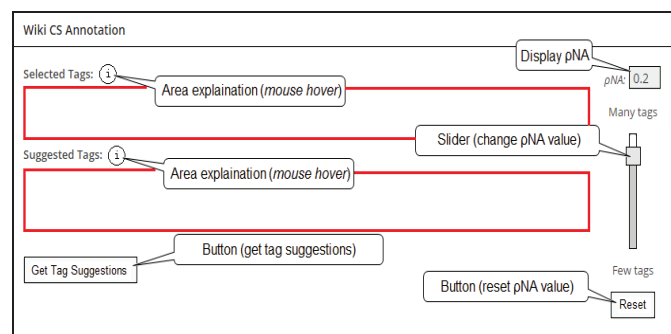


Figure 6. User interface design for common user

Fig. 7 shows the user interface design for anchor dictionary import facility. Fig. 7 also shows that there is a button which is used to browse the anchor dictionary XML file from local directory of the computer where the anchor dictionary is located. There is also a button which is used to start the importing process. During the importing process, the import facility page displays a progressbar at the bottom of the page which shows progress of the importing process.

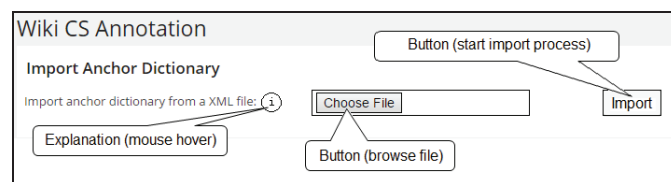


Figure 7. Anchor dictionary import facility UI design

## IV. IMPLEMENTATION

The plugin which is designed and developed is implemented on WordPress 4.1.5. This plugin can be used after the user installs the plugin by using Add Plugins page on WordPress. Then, user needs to activate the plugin which can be done through Plugins page on WordPress. The installation and activation process can be done by user who has privilege as an administrator.

Anchor dictionary which is created by preprocessing application contains 1,259 records [8] and needs to be imported into WordPress, so it can be used by the plugin. This importing process can be done by using anchor dictionary import facility which is provided by the plugin. The importing process can also be done by the user who has privilege as an administrator. The import facility is shown in Fig. 8.

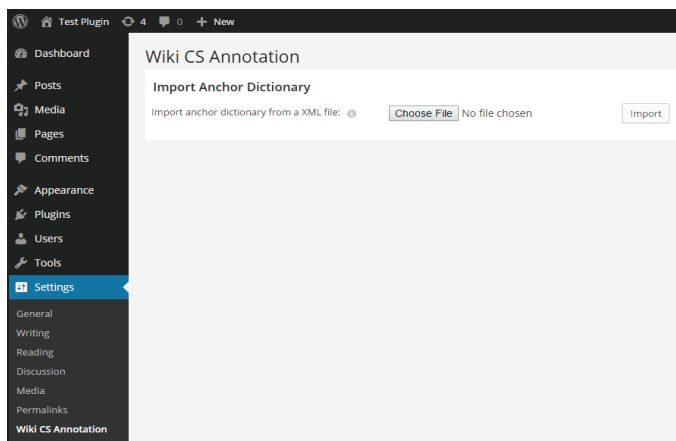


Figure 8. Anchor dictionary import facility page

The request of tag suggestions can be done from the page of editing a post or creating a new post as shown in Fig. 9. As an example of tag suggestions request result, Fig. 10 shows tag suggestions which are given by the plugin with input text about computer hardware.

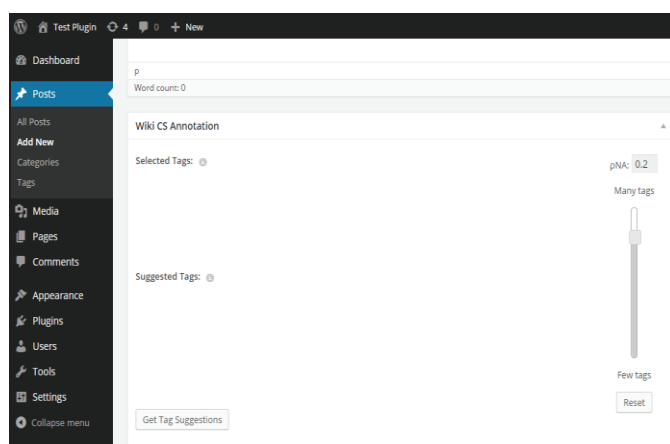


Figure 9. Plugin's interface for common user

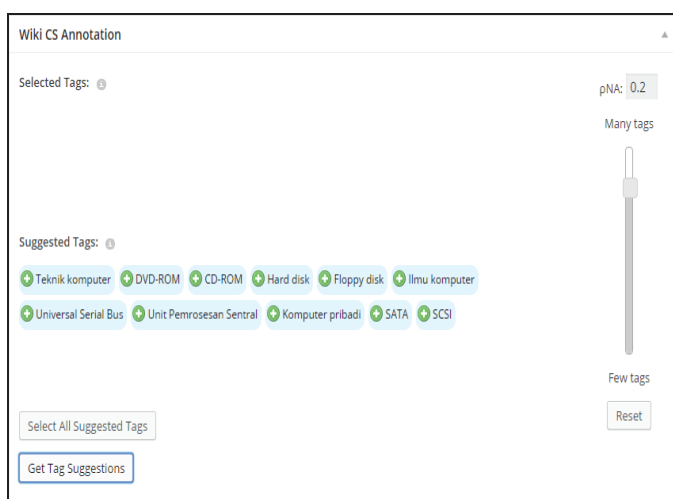


Figure 10. Tag suggestion given by the plugin for input text about computer hardware

If user wants to get more tag suggestions, it can be done by setting a smaller value of  $pNA$  by moving the slider upward toward the "Many tags". Conversely, if user wants to get fewer tag suggestions, it can be done by setting a larger value of  $pNA$  by moving the slider down toward the "Few tags". For example, Fig. 11 shows that when the value of  $pNA$  is set to 0.1 (smaller than 0.2), the plugin gives more tag suggestions.

Figure 11. The plugin gives more tag suggestions when smaller value of  $pNA$  is set

User can select a tag suggestion to become tag of a post by clicking that tag suggestion. Then, that tag suggestion will move from area below "Suggested Tags" to area below "Selected Tags" which indicates that tag suggestion has been selected. For example, using the tag suggestions shown in Fig. 11, the user selects "Perangkat keras" to become tag of the post as shown in Fig. 12.



Figure 12. Selecting a tag suggestion

A tag suggestion which is selected by the user will become a post's tag. When the user saves (as a draft) or publishes a post, before that process is executed by the WordPress, plugin will create hyperlink on word or phrase in the input text to

Wikipedia page based on the selected tag suggestions. For example, in Fig. 12, the "Perangkat keras" tag ("perangkat keras" means "hardware" in English) is selected, then user decides to save or publish that post (an input text about computer hardware). Before WordPress saves or publishes that post, plugin will create hyperlink on all "perangkat keras" phrase in the input text to Wikipedia page titled Perangkat keras<sup>2</sup>.

## V. TESTING

Testing is carried out in order to measure user satisfaction when using the plugin. The user satisfaction is influenced by factors such as user effectiveness and user effort [9]. In this study, we measure the user effectiveness by calculating the percentage of relevant tags, i.e. tag suggestions which are considered suitable to become post's tags or entities to be linked to Wikipedia divided by the total number of tag suggestions given by the plugin. The higher percentage of relevant tags, the higher the user effectiveness. Moreover, we measure the user effort by counting the number of pNA value change until the user finishes the task of selecting tags suggestions. The higher the number of change, the higher the user effort.

### A. Testing Data

In this study, testing involves 35 respondents who are all computer science students. Each respondent is given five plain texts and requested to do the entity annotation task, i.e. selects tag suggestions given by the plugin which are considered suitable to become post's tags or entities to be linked to Wikipedia. On each text, they are requested to calculate the percentage of relevant tags and count the number of pNA value change that is conducted until the respondent finishes the annotation task.

Five texts which are used for testing is built by selecting five Wikipedia articles in Computer Science category structure. Then, text in those articles are edited by discarding citation (if available), i.e. number between square brackets. We limit the text's length to around 200 words. This is done as follows: if the length of a Wikipedia article is less than 200 words, we take all text in that article as the testing data. Otherwise, we take only the first (around) 200 words with sentence as the window of selection.

In order to get more information about user's experience, each respondent is also requested to score [1-5] three statements as follow: (1) this application is easy to use, (2) this application's user interface is easy to understand, and (3) the tag suggestions which are given are considered relevant to the input text. The lowest score (i.e. one) indicates that the respondent is strongly disagree about the corresponding statement. Conversely, the highest score (i.e. five) indicates that the respondent is strongly agree about the statement.

### B. Result

From each respondent, we get five values of relevant tags percentage and five values of pNA change. In order to get one value for each percentage of relevant tags and number of pNA value change, we simply calculate the average of those five values, so we get two values that each of those represents each respondent's user effectiveness and user effort.

Since there are 35 respondents, we also calculate the average of the 35 resulted values from process described above. The result is 55.6% of tag suggestions are considered relevant, i.e. tag suggestions which are considered suitable to become post's tags or entities to be linked to Wikipedia. Moreover, the average number of pNA value change is 1.42. This value of change is considered small, so the user effort can also be considered small.

Table 1. Score recapitulation of user experience

Statement	Score				
	1	2	3	4	5
This application is easy to use.	0	1	7	22	5
This application's user interface is easy to understand	0	2	9	17	7
The tag suggestions which are given are considered relevant to the input text	0	0	8	18	9

Table 1 shows recapitulation of score given by the 35 respondents in order to measure their agreement of the given statements. Numbers in "Score" column is the number of respondent who gives the corresponding score to the statement in "Statement" column. This result shows that the plugin gives a good quality of experience since the score received is considerably good (score "4" gets the highest number of respondent for all statements).

## VI. CONCLUSION

This study describes how a WordPress plugin which implements TAGME technology is successfully designed and developed to perform entity annotation on blog post. Based on the testing result, approximately 56% of the tag suggestions given by the plugin are considered relevant, i.e. suitable to become post's tags or entities to be linked to Wikipedia. Moreover, user's effort when using the plugin is considerably small.

We realize that the user effectiveness measure result in this study is highly dependent on the used anchor dictionary. In a subsequent study, we intent to measure the user effectiveness when using other anchor dictionary, i.e. anchor dictionary which is created by using Wikipedia articles in different category structure.

In this study, the anchor dictionary is stored in an internal database, thus the user need to reimport the anchor dictionary when the newer version is available. In the future development, we plan to access the anchor dictionary through

<sup>2</sup> [https://id.wikipedia.org/wiki/Perangkat\\_keras](https://id.wikipedia.org/wiki/Perangkat_keras)

a database API (Application Programming Interface), thus the anchor dictionary is not necessarily imported to an internal database and can be considered as a service. Moreover, we also intent to extend the plugin's functionality with learning ability, so it can give higher score to tag suggestion(s) which is previously selected by the user as tag(s) for semantically similar text input.

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# Conversion-Map as a Solution for Converting Complex Hexadecimals into Octals

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**Abstract**—In order to be able to operate and communicate with computer devices, some user or programmer also need special skills to run machine language programs that primarily use binary numbers as a fundamental language for computer circuit operations that being translated into octal or hexadecimal numbers. Specifically, programs that use hexadecimal codes, have to written again in octal codes if the current machine or computer need to interact with other digital devices which is simpler and still using octal codes. The basic method and rule commonly used to convert octal codes into hexadecimal codes, or reverse, is by firstly converting it into binary. This paper shows a different method, but also conventional one, to convert hexadecimal numbers directly into octal numbers without changing into binaries. This method is presented in a conversion-map that will simplify the process of conversion, chiefly for complex hexadecimal numbers. This paper will give good contribution in related fields such as mathematics, digital technology, and computer system. This also aims to help people that need fast and accurate calculation.

**Keywords**—Hexadecimal to Octal Conversion, Number Conversion, Conversion-map

## I. INTRODUCTION

Microprocessor and Microcontroller use Assembly Language to communicate with computers or other digital devices. This makes Electrical Engineers, Computer Engineers, and Software Designers so familiar with octal and hexadecimal number. Although binary number is the most important part in computer or digital world, it is mainly applied for digital logic circuits design, and those two numbers should be considered important when creating a program or interface for hardware.

Computer circuits work with binary numbers. It is a little bit difficult because normally in daily life human works with decimal numbers. In order to be able to communicate easily with the hardware, computer programs are built in octal and hexadecimal numbers, to control and simulate the circuits.

Octal numbers are usually found and used by Mini computers in past centuries. At that time computers came with

a simple design of 8-bit data length and still have many limitations in operation and communication. [1,4,5,8]

Now computers have become more powerful with 16-bit data to 64-bit data length and offer many advantages. The technology of main processor has become better and better in almost every decades. The forms and models of Mini computers have changed into hi-tech microcomputers, PC computers and mainframes that use hexadecimal numbers for their programs.

Octal is a base-8 number. An octal digit ranges from 0 to 7. Hexadecimal is a base-16 number and its single hexadecimal digit ranges from 0 to 9, continued with A to F. The changes in computer world demands for the changes in octal number to hexadecimal number, but in some cases it also demands for the changes in hexadecimal number to octal number. [1,4,5,8]

These will always happen if hardware industries and manufacturers have to fulfill the need of combining traditional tools and new technologies for some specific reasons. Based on experience, some people and organization still use their good, unique, and traditional digital devices because of its excellent performance and capability to solve tasks and ease some difficult jobs. The old and limited tools should be integrated with trend technologies to be able to work with a new system, and together achieve the desired output.

## II. METHOD

Learning from the standard methods of hexadecimal-octal-binary conversions, the author will try to derive an analysis, make comparison, figure out the relationships, take several examples, and derive a conversion-map that could be used to make a directly conversion from hexadecimal to octal.

## III. BASIC CONCEPT

The standard method used for Hexadecimal-Octal conversion is like what have already learned in digital system,



i.e. by converting the Hexadecimal number into Binary number, and then converting the Binary number into Octal number. [1,2,3,4,5,6,7,8]

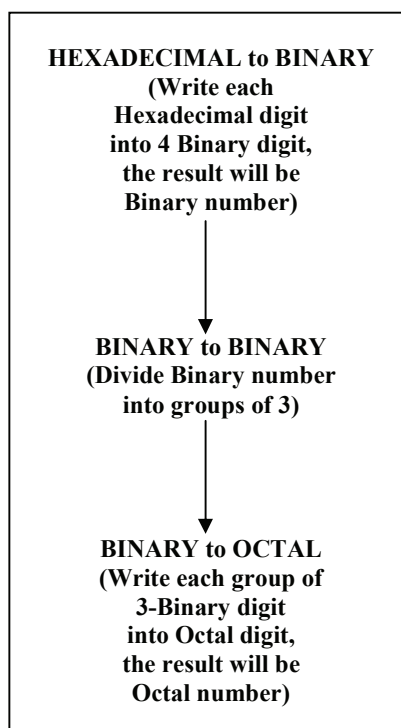


Fig. 1 Standard Method to convert a Hexadecimal Number into an Octal

Suppose it needs to convert a hexadecimal number A1F, follow the steps given above to come out with a result in octal number.

Let's see how the standard conversion of hexadecimal – binary – octal works:

$$A1F_{16} = \dots_8$$

$$\downarrow$$

$$\underline{1010} \quad \underline{0001} \quad \underline{1111}$$

The initial step is to convert A1F into 4-bit binary numbers. Each hexadecimal digit is written in their binary form. Digit A will have 1010, digit 1 will have 0001, and digit F will have 1111.

$$\underline{1010} \quad \underline{0001} \quad \underline{1111}$$

$$\downarrow$$

$$\underline{101} \quad \underline{000} \quad \underline{011} \quad \underline{111}$$

The next step is to combine all the binary digits, and then divided it into groups of 3-bit binary number.

$$\underline{1010} \quad \underline{0001} \quad \underline{1111}$$

$$\downarrow$$

$$\underline{101} \quad \underline{000} \quad \underline{011} \quad \underline{111}$$

$$\downarrow$$

$$\boxed{5037}_8 \quad \dots (1)$$

Finally the groups of 3-bit binary number are converted into octal digits, getting a result of an octal number, 5037.

Using the same method, convert a hexadecimal number 92FC into octal:

$$92FC_{16} = \dots_8$$

$$\downarrow$$

$$\underline{1001} \quad \underline{0010} \quad \underline{1111} \quad \underline{1100}$$

$$\downarrow$$

$$\underline{1} \quad \underline{001} \quad \underline{001} \quad \underline{011} \quad \underline{111} \quad \underline{100}$$

$$\downarrow$$

$$\boxed{111374}_8 \quad \dots (2)$$

The result shows that the octal number of  $92FC_{16}$  is  $111374_8$ .

This is the same method and same procedural steps that should always followed on hexadecimal-octal conversion. For small hexadecimals, it will not have much difficulty to calculate the result, except for great numbers.

Based on this consideration and the standard way to convert hexadecimal into octal, and usually hexadecimal only have few digits ranged from 0 to F, a 'lookup' alternative method can be derived for giving better solution.

## IV. DISCUSSION AND RESULT

## A. Basic Relationship

Consider the relationship between these binary numbers:

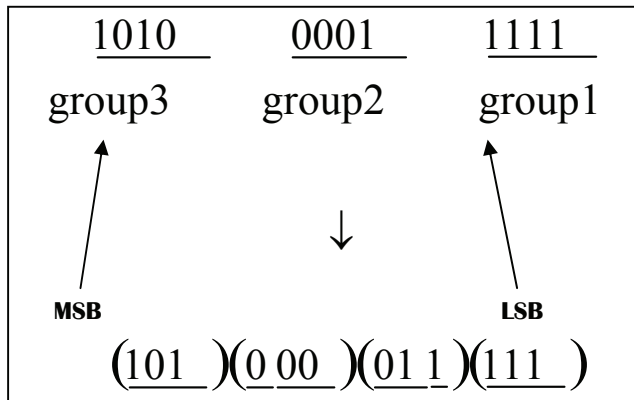


Fig. 2 Binary Numbers Relationship in Hexadecimal and Octal code

When converted binary number into groups of 3-bit binary number, started from the LSB (Least Significant Bit) position, which is on the right side of the number. From the relationship it can be seen that the first group of 4-bit binary number is changed into 3-bit binary number, left its first bit for the next group.

The similar step is applied to the third group of 4-bit binary number. Started from MSB (Most Significant Bit) position, the third group of 4-bit binary number is changed into 3-bit binary number, left its last bit for the other group.

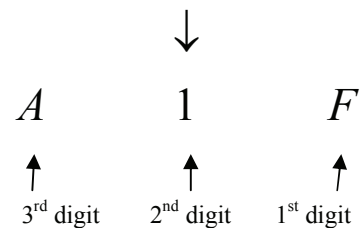
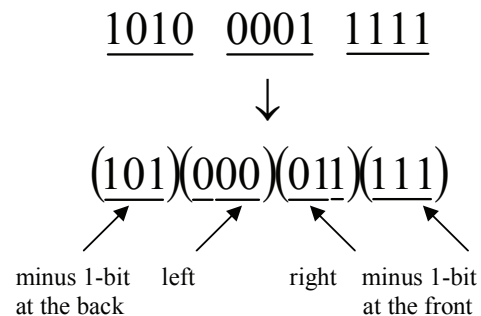
Both the first bit from the first group of 4-bit binary number and the last bit from the third group of 4-bit binary number will be grouped into bits of the second group. The second group of 4-bit binary number is divided into two 2-bit binary numbers. The left side will join the last bit of the third group of 4-bit binary number, and the right side will join the first bit of the first group of 4-bit binary number.

Based on this approach, the third hexadecimal digit should be divided by two to get the result in octal. If the hexadecimal number is odd, after divided by two, should be rounded down. For example:

A:  $2 = 5$   
 B:  $2 = 5$   
 9:  $2 = 4$   
 and etc.....

On the other side, the first hexadecimal digit should be subtracted by 0 or 8, depends on the value of hexadecimal number. If the hexadecimal number is equal or greater than 8, should be subtracted with 8, and if it is less than 8, should be subtracted by zero. For example:

F - 8 = 7  
 E - 8 = 6  
 8 - 8 = 0  
 5 - 0 = 5  
 and etc.....



the result: 5 0 3 7 ... (3)

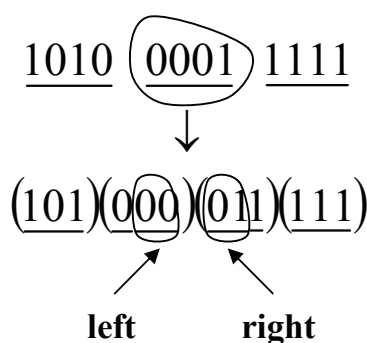
## B. Conversion-Map

From the relationship, the most important part is the second group of 4-bit binary number. To make it simpler, derive the process into a conversion-map:

	00	01	10	11
LEFT	0	4	8	C
	0	1	2	3
	1	5	9	D
RIGHT	4	5	6	7
	2	6	A	E
	8	9	A	B
	3	7	B	F
	C	D	E	F

Fig. 3 Hexadecimal to Octal Conversion-Map with Binary Reference

LEFT represents 2-bit binary number on the left side, and RIGHT represents 2-bit binary number on the right side.

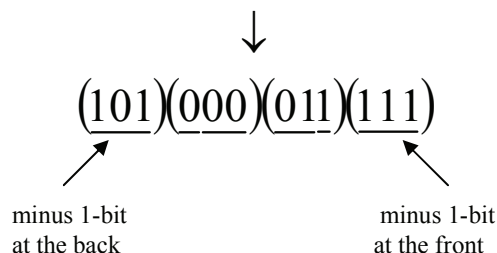


The second digit of hexadecimal number is 1, so using the conversion-map, look-up the LEFT and RIGHT that show a figure of 1. From the map, it can be read that the left side for 1 is 00 and the right side for 1 is 01.

Because the result should be in the form of octal number, it is better to write again the binary format in octal format. Now it can be read that the left side for 1 is 0 and the right side for 1 is 1.

Remember also to consider the other hexadecimal digits. The left side (the first 2-bit binary number from the second hexadecimal digit) will be added with the last bit from the third hexadecimal digit, while the right side (the rest 2-bit binary number from the second hexadecimal digit) will be added with the first bit from the first hexadecimal digit.

1010 0001 1111



If the last bit from the third hexadecimal digit is 0, it will not affect the 2-bit binary number, but if the last bit is 1, the 2-bit binary number should be added with bit 1 in front of it that equals to 4. If the first bit from the first hexadecimal digit is 0, the 2-bit binary number should be added with bit 0 at the back, which multiply by 2, but if the first bit is 1, the 2-bit binary number should be added with bit 1 at the back, which multiply by 2 and plus 1.

### C. Identify Problem 1

Let's try and solve some hexadecimal-octal conversion problems using this hexadecimal-octal conversion-map.

$$2C57_{16} = \dots_8 \quad \dots (4)$$

To solve this problem, divide first this hexadecimal number into groups of 3-digit.

$$(2) (C57)_{16} = \dots_8 \quad \dots (5)$$

Note those 3 digits as follows:

- First Number: C57  
The first hexadecimal digit is 7  
The second hexadecimal digit is 5  
The third hexadecimal digit is C

- Second Number: 2  
The first hexadecimal digit is 2

Now start using the conversion-map to solve the problem.

	0	1	2	3
LEFT	0 0	4 1	8 2	C 3
	1 4	5 5	9 6	D 7
RIGHT	2 8	6 9	A A	E B
	3 C	7 D	B E	F F

Fig. 4 Hexadecimal to Octal Conversion-Map with Decimal Reference

#### D. Essential Rules

Rule for the first hexadecimal digit:

**0 – 7: subtracted the number with 0**

**8 – F: subtracted the number with 8**

Rule for the second hexadecimal digit:

**LEFT : If the third decimal digit is Odd**  
 $\Rightarrow + \text{bit } 1 \text{ at the front (the octal number should be added with 4)}$

**LEFT : If the third decimal digit is Even**  
 $\Rightarrow + \text{bit } 0 \text{ at the front (the octal number should be added with 0)}$

**RIGHT : If the first decimal digit is between 0 – 7**  
 $\Rightarrow + \text{bit } 0 \text{ at the back (the octal number should be multiplied with 2)}$

**RIGHT : If the first decimal digit is between 8 – F**  
 $\Rightarrow + \text{bit } 1 \text{ at the back (the octal number should be multiplied with 2, and then added with 1)}$

Rule for the third hexadecimal digit:

**Divided by two and round down the number**

Then it will get the result:

a. First Number: C57

The first hexadecimal digit is subtracted with 0, **equals to 7**.

The second hexadecimal digit is 5, so according to conversion-map, **the result will be 2 and 1**, respectively from right to left.

The third hexadecimal digit is C, giving a **value of 6**.

b. Second Number: 2

The first hexadecimal digit is subtracted with 0, **equals to 2**.

The final result for 2C57 would be:

$$\boxed{26127_8} \quad \dots (6)$$

E. Identify Problem 2

$$18A5B9_{16} = \dots_8 \quad \dots (7)$$

Using the same procedure it can be derived an octal number for the problem stated above.

$$\boxed{18A} \quad \boxed{5B9}_{16} = \dots_8 \quad \dots (8)$$

a. First Number: 5B9

The first hexadecimal digit is subtracted with 8, **equals to 1**.

The second hexadecimal digit is B, so according to conversion-map, **the result will be 7 and 6**, respectively from right to left. The third hexadecimal digit is 5, giving a **value of 2**.

b. Second Number: 18A

The first hexadecimal digit is subtracted with 8, **equals to 2**.

The second hexadecimal digit is 8, so according to conversion-map, **the result will be 1 and 6**, respectively from right to left. The third hexadecimal digit is 1, giving a **value of 0**.

The final result for 18A5B9 would be:

$$\boxed{6122671_8} \quad \dots (9)$$

## F. Identify Problem 3

$$1E63A114_{16} = \dots_8 \quad \dots (10)$$

Again using the same procedure it get the result for octal number.

$$\boxed{1E} \boxed{63A} \boxed{114}_{16} = \dots_8 \quad \dots (11)$$

## a. First Number: 114

The first hexadecimal digit is subtracted with 0, **equals to 4**.

The second hexadecimal digit is 1, so according to conversion-map, **the result will be 2 and 4**, respectively from right to left.

The third hexadecimal digit is 5, giving a **value of 0**.

## b. Second Number: 63A

The first hexadecimal digit is subtracted with 8, **equals to 2**.

The second hexadecimal digit is 3, so according to conversion-map, **the result will be 7 and 0**, respectively from right to left.

The third hexadecimal digit is A, giving a **value of 3**.

## c. Third Number: 1E

The first hexadecimal digit is subtracted with 8, **equals to 6**.

The second hexadecimal digit is 1, so according to conversion-map, **the result will be 3 and 0**, respectively from right to left.

The third hexadecimal digit is 0, giving a **value of 0**.

The final result for 1E63A114 would be:

$$\boxed{\boxed{3630720424}_8} \quad \dots (12)$$

In conclusion, from the basic concept of hexadecimal to binary conversion and binary to octal conversion, it could

derive an alternative method that easily helps us to do the octal conversion of complex hexadecimal numbers.

This method is given in a form of conversion-map, and could be used for an easy to a very complex hexadecimal number task. The structure of the map is created with a simple and standard lookup, so it can be used as a basic format for solving hexadecimal-octal conversions.

The result of this paper could consider to be used as a fundamental research for advance applications in digital system.

## V. CONCLUSION

Using the Hexadecimal to Octal Conversion-Map, a solution has been derived for a hexadecimal-octal conversion, especially for complex problems. The conversion-map is being formed in a standard way so will be easy to learn how to use it. With a good understanding on how the algorithm being applied, just need little time to create program instructions and derive the output.

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# Motion Detection Using Frame Differences Algorithm With The Implementation of Density

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**Abstract** — There are several motion detection algorithms, frame differences algorithm is one of them. Normally frame differences algorithm works by comparing all pixels between two images, even if it's possible to detect motion this way, it's costly in the terms of CPU usage. Using a modified frame differences algorithm, it is possible to detect motion which can be run in a low-end system and does not require a lot of CPU usage. The frame differences algorithm's modification is made with the implementation of density. The idea of density comes from the concept of sequence of series. The modified frame differences algorithm doesn't need to check all pixels when comparing two images therefore it's faster. The tests were done using three scenarios involving human's motion detection test, speed test and accuracy test. The results of tests show that the implementation of density accelerates the frame differences algorithm and it's still possible to detect moving objects. With the implementation of density, frame differences algorithm's speed increases up to 97.78% and the accuracy of motion detection is up to 89.1%.

**Keywords:** frame differences, density, frames, web camera

## I. INTRODUCTION

Motion detection is done by comparing reference frame(s) to the current frame. There are several algorithms that is possible to compare images and detect motion, such as background subtraction, optical flows and frame differences. According to [1] the background subtraction algorithm works by subtracting the current frame to a reference frame and afterwards, the the result from the subtraction is segmented to produce a binary image that highlights the moving regions.

Another algorithm, optical flows works by estimating the motion vectors in each frame of the live video sequence and once determined, the motion vectors will be drawn over the moving objects [2]. Optical flows provides all information but it is usually too complex for real time usage and requires special hardware.

This study is focused on frame differences algorithm. Study in [3] explains if frame differences algorithm works by comparing the average RGB components of a reference frame to the current frame to find the difference value. This comparison is done for all pixels to find the difference value,

the value then will be compared to threshold value, if it's bigger than threshold then motion is detected.

There are several techniques to determine the reference frame to be compared with the current frame. In this study the dynamic adaptive template matching technique as proposed by [3] is used. The focus is to improve the frame differences algorithm even further, to implement density to frame differences algorithm that uses dynamic adaptive template matching. The idea of density itself came from the concept of sequence and series. The modified frame differences algorithm was implemented as a desktop application.

## II. UNDERLYING THEORY

### A. Frame Differences Algorithm

Frame differencing is a technique where computer checks for differences between two images [4]. Unlike background subtraction algorithm, frame differences algorithm does not require the filtering process to grayscale even if it's possible to use it. Frame differences algorithm uses RGB information, which are already available in the images themselves.

In this algorithm, there are two values that act as comparator to detect motion in pixels and overall image, those values are threshold and sensitivity. Normally, all the pixels between images will be compared. The usage of RGB information means the algorithm will check each pixels for the RGB value. RGB has three components : red, green and blue values that save colour information [5].

Formula (1) shows the calculation to get the average RGB value for the current frame ( $f_0(x,y)$ ) and formula (2) shows the calculation to get the average RGB value for the reference frame ( $g_0(x,y)$ ). Both of these formulas are explained by [3].

$$f_0(x,y) = \frac{f_R(x,y) + f_G(x,y) + f_B(x,y)}{3} \quad (1)$$

$$g_0(x,y) = \frac{g_R(x,y) + g_G(x,y) + g_B(x,y)}{3} \quad (2)$$

The value of  $g_0(x,y)$  then will be compared to  $f_0(x,y)$  to find the difference value. This value must be an absolute value

(positive). Once the difference value is found, it will be checked to see if it is higher than the threshold value. If it is bigger, then the pixel will be marked as detected.

The study in [3] also adds that after all the pixels between two images were checked, the motion detection is done using formula (3). Formula (3) is used to determine the percentage of detected pixels ( $D$ ). The  $D$  value will then be compared to sensitivity value. If it's higher than sensitivity then motion is detected.  $\sum f_i^R(x,y)$ ,  $\sum f_i^G(x,y)$  and  $\sum f_i^B(x,y)$  are the total of R, G and B values of detected pixels and  $\sum f_R$ ,  $\sum f_G$  and  $\sum f_B$  are the total of R, G and B values of all pixels.

$$D = \frac{\sum f_i^R(x,y) + \sum f_i^G(x,y) + \sum f_i^B(x,y)}{\sum f_R + \sum f_G + \sum f_B} \times 100\% \quad (3)$$

### B. Dynamic and Adaptive Template Matching

As stated before, there are several techniques to determine the reference frame to be compared with the current frame. The techniques are static template matching, dynamic template matching and dynamic adaptive template matching. Dynamic and adaptive template matching is used in this study as it is the most recent technique and was proposed by [3].

Static template matching uses static image without moving objects in it as reference frame [6]. Dynamic template matching uses the frame at  $t - x$  ( $x$  as a modifiable value) as a reference frame so the reference frame is always updated whenever there is a new input frame. Dynamic template matching has stronger detection than static template matching [7].

Dynamic and adaptive template matching is different from both static and dynamic and improves the accuracy of frame differences algorithm in detecting motion. The testing result in study [3] shows that with dynamic and adaptive template matching, the accuracy of motion detection is up to 95.5% whereas with dynamic template matching, the accuracy is only up to 89.9%.

Using the dynamic and adaptive template matching, the reference frame is a combination of reference at the time  $t - x$ ,  $t - n$  and a new reference image will be used if the environment undergoing change [3]. In this study, undergoing change means motion is detected within the captured area of the camera.

### C. Density

Density is a percentage value that determines which pixels need to be checked, which this study used to modify frame differences algorithm. The idea of density comes from the theory of sequence of series. Sequence is a formula that represents a pattern of numbers [8]. According to [9] sequence formula contains three components,  $a_n$  represents the value at order  $n$ th,  $d$  is a difference value and  $n$  is value that represents the order number.

Normally, frame differences algorithm checks all the pixels between two images but with the implementation of density not all pixels should be checked. Because of the position of pixels is two dimensional, there are two sequence formulas with

different difference values. Firstly, the  $d$  or the difference values in the sequence formulas needs to be calculated using formula (4) and (5).

$$d_{column} = density * width of picture \quad (4)$$

$$d_{row} = density * height of picture \quad (5)$$

There are also two sequence formulas that use each difference values. Nested loops are used to implement both of the formulas.

$$a_{n_{column}} = (d_{column} * n_{column}) - (d_{column} - 1) \quad (6)$$

$$a_{n_{row}} = (d_{row} * n_{row}) - (d_{row} - 1) \quad (7)$$

Assume that the *density* value is 1% and a picture has the size of 200x200 pixels, that means the difference values for each sequence formula is 2. Formula (6) will be used to determine the first row position with  $n_{row}$  starting from 1 and  $d_{row} = 2$ , the result is 1. After that the column position will be checked, so using formula (7) the column value will be calculated starting from  $n_{column} = 1$  and  $d_{column} = 2$ , the result is 1.

From those calculations, we get (1, 1) as the first position of the pixel that must to be checked. After that, the column checking continue with  $n_{column}$  value increased by 1, this continues as long as  $n_{column}$  in column loop is still smaller or equal to the width of picture. So the results will be (1, 1), (1, 3), (1, 5), .... When the checking for row 1 is finished ( $n_{column}$  value in previous column loop is already greater than picture width), the  $n_{row}$  value for the row loop will then be increased by 1, so the next row will be 2.

For row 2, the column loop will run with  $n_{column}$  value starting from 1 again. So the next positions of pixel that need to be checked will be (3, 1), (3, 3), (3, 5), .... Row loop will continue as long as  $n_{row}$  in row loop is still smaller or equal to the height of picture.

Below is an illustration of the usage of the density value of 1% for a picture with the size of 200x200. The difference values are the same, 2 for each sequence formula. Each square represents each pixel (not all the pixels are shown in the illustration). The numbered squares (pixels) are the ones that will be checked by frame differences algorithm. As the value of density increases, the number of pixels that need to be checked decreases.

(1,1)		(1,3)		(1,5)		(1,7)	
(3,1)		(3,3)		(3,5)		(3,7)	
(5,1)		(5,3)		(5,5)		(5,7)	

Figure 1. Illustration For Density Value of 2%

Normally, frame differences algorithm also uses sensitivity value, certain amount of pixels needs to be detected before motion detection is concluded. With the implementation of density, this is not possible due to not all pixels are checked. So, the modified frame differences algorithm does not use sensitivity value. When a pixel is detected then motion is detected. However, even if a pixel is detected the pixel checking process will continue so the object estimation (object marking) is still possible.

#### D. Object Estimation

The object estimation in this study is a simple estimation based on the locations of pixels that are detected during RGB comparisons. Values *top*, *bottom*, *left* and *right* are used to form a rectangle around the object. Values *top* and *left* are initialized with the value of picture's height and width respectively. These if rules determine if those values need to be adjusted or not, *x* and *y* are the current positions of pixel that is being checked.

$$\text{IF } x < \text{left} \text{ THEN } \text{left} = x \quad (8)$$

$$\text{IF } x > \text{right} \text{ THEN } \text{right} = x \quad (9)$$

$$\text{IF } y < \text{top} \text{ THEN } \text{top} = y \quad (10)$$

$$\text{IF } y > \text{bottom} \text{ THEN } \text{bottom} = y \quad (11)$$

### III. IMPLEMENTATION AND TESTING

#### A. System Specifications

The hardware and software used are as follows:

- 1) OS : Windows 7 Home Edition 64 bit
- 2) Processor : Intel® Celeron 1.9 GHz
- 3) Installed Memory (RAM) : 2 GB
- 4) Hard Drive : 40 GB of free spaces
- 5) IDE : Visual Basic 2008

#### B. Testing

There were three scenarios for three tests. First scenario was done to determine if it is possible to detect moving objects (humans) with various threshold and density values, scenario two was done to compare the modified frame differences algorithm with the unmodified one and third scenario was done to check the accuracy of the modified frame differences algorithm.

The first scenario was done for every combination of density and threshold, density value from 2% to 20% (2% increments) and threshold from 10 to 125 (5 increments). Below are the steps in first scenario :

- 1) Activate motion detection.
- 2) A human object is moving from the left side of camera to the right side of camera till the object is not visible anymore. The object is 1.5 meters away from web camera and has the height of 110 cm.
- 3) Non activate motion detection.
- 4) Write the detection result.

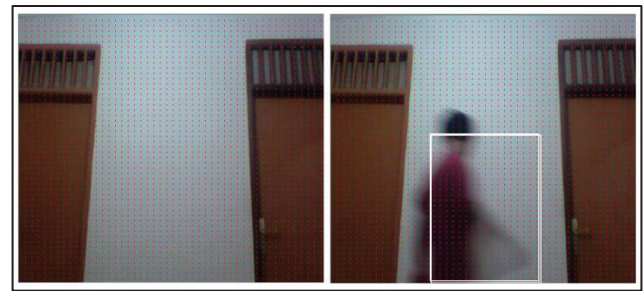


Figure 2. Empty Room (left) and Detection of Human Object (right)

The red dots in figure 2 marks the pixels that were checked during frame differences algorithm. Below are the test results, symbol O means that motion is detected while symbol X means that motion is not detected.

Table 1. Human Body Motion Detection

Threshold	Density Value (in percentage)									
	2	4	6	8	10	12	14	16	18	20
10	O	O	O	O	O	O	O	O	O	O
15	O	O	O	O	O	O	O	O	O	O
20	O	O	O	O	O	O	O	O	O	O
25	O	O	O	O	O	O	O	O	O	O
30	O	O	O	O	O	O	O	O	O	O
35	O	O	O	O	O	O	O	O	O	O
40	O	O	O	O	O	O	O	O	O	O
45	O	O	O	O	O	O	O	O	O	O
50	O	O	O	O	O	O	O	O	O	O
55	O	O	O	O	O	O	O	O	O	O
60	O	O	O	O	O	O	O	O	O	O
65	O	O	O	O	O	O	O	O	O	O
70	O	O	O	O	O	O	O	O	O	O
75	O	O	O	O	O	O	O	O	O	O
80	O	O	O	O	O	O	O	O	O	O
85	O	O	O	O	O	O	O	O	O	O
90	O	O	O	O	O	O	O	O	O	O
95	O	O	O	O	O	O	O	O	O	O
100	O	O	O	O	O	O	O	O	O	O
105	O	O	O	O	O	O	O	O	O	O
110	O	O	O	O	O	X	X	X	X	X
115	O	O	O	O	O	X	X	X	X	X
120	O	O	O	O	O	X	X	X	X	X
125	O	O	O	O	O	X	X	X	X	X

Based on table 1, it is still possible to detect moving objects even if not all pixels were checked. Density value can be adjusted, if the objects that need to be detected are small then density value can be decreased, if it's a big or medium sized object, then density value can be increased.

Increasing density can cause small objects to not to be detected but theoretically, should increase the algorithm speed because less pixels need to be checked. So, there's a tradeoff between speed and detection accuracy. The second scenario was done to see if the implementation of density value

improves frame difference algorithm's speed. Below are the steps for the second scenario (speed testing) :

- 1) Pick two images to be compared.
- 2) Start timer (in milliseconds).
- 3) Run the unmodified frame differences algorithm (without density) and the modified frame differences algorithm (with density value of 6%)
- 4) When the algorithm is finished, stop the timer.
- 5) Write the time result.

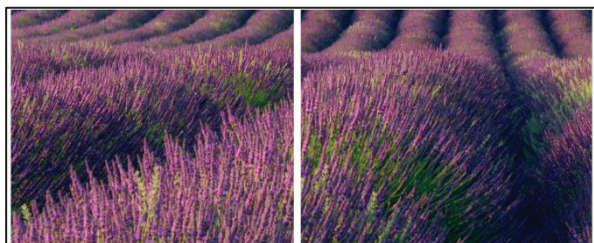


Figure 3. Two Images Used For Speed Testing.

The images stayed the same during speed testing and the threshold value of 40 was used. The modified frame differences algorithm with the density value of 6% was compared to the unmodified frame differences algorithm. For each algorithm, the tests were run 30 times. Table 2 shows the time comparison. The density value of 6% were used because it is the middle value of all values that can detect motion based on the result of first scenario, which makes it the optimum.

Table 2. Time Comparison

Test Number	Unmodified Frame Differences Algorithm	Modified Frame Differences Algorithm (density value of 6%)
1	4.07	0.09
2	3.83	0.09
3	3.87	0.09
4	4.17	0.09
5	4.34	0.10
6	3.78	0.09
7	4.21	0.10
8	3.77	0.09
9	3.99	0.11
10	4.29	0.09
11	3.86	0.09
12	4.08	0.09
13	4.21	0.09
14	4.11	0.10
15	4.34	0.09
16	4.13	0.09
16	4.24	0.09
16	4.37	0.09
17	3.74	0.09
18	4.01	0.12
19	4.11	0.09
20	4.21	0.09
21	3.82	0.09

22	3.96	0.09
23	3.91	0.09
24	4.06	0.09
25	4.31	0.10
26	4.37	0.09
27	4.22	0.09
28	4.07	0.09
29	3.83	0.09
30	3.87	0.09

Based on table 2, the average time then calculated. For each density, the total (sum) of time values were divided by number of tries (30). Table 3 shows the average time for the unmodified and modified frame differences algorithm.

Table 3. Average Time Comparison

Algorithm	Average Time
Unmodified Frame Differences	4.07
Modified Frame Differences (density value of 6%)	0.09

Based on table 3, the average time of the modified frame differences algorithm then converted to how much increase in time (speed) in percentage compared to average time of the unmodified frame differences algorithm. The percentage is calculated by using formula (12), this formula is explained by Bob Parker [10].

$$\text{Growth Rate} = \frac{\text{Past Value} - \text{Present Value}}{\text{Past Value}} \times 100\% \quad (12)$$

The result of growth rate calculation is 97.78%. This shows that modified frame differences algorithm with density value of 6% is faster than the unmodified frame differences algorithm, the increase in speed is 97.78%.

The third and last scenario was done to test the accuracy of motion detection of the modified frame difference algorithm. There are two kind of detection, true detection and false detection. True detection occurs when the application captures the correct image with a moving object in it while false detection occurs when the application captures empty room without any moving object.

During the test, the density value of 6% and threshold value of 40 were used, density value of 6% was used because the objects were mostly medium-big sized and threshold value of 40 was used so that little changes in lighting would not affect the detection.

Below are the steps for the third scenario (accuracy) :

- 1) Pick a room which is used for human activity.
- 2) Place web camera 3.2 meters from the door's room.
- 3) Activate motion detection and let the application run for two hours, set application to save picture whenever detection occurs.
- 4) When two hours have ended, stop motion detection.
- 5) Count the total number of false detection and true detection by checking the images captured during testing.



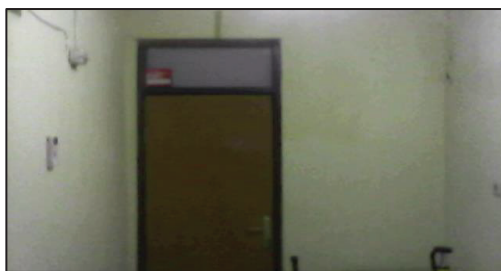


Figure 4. Example of False Detection.

Out of 1276 pictures that were captured by the application, 138 are the ones categorized as false detections (empty room pictures with no motion). So, in total there were 1138 true (89.1%) detections and 138 false detections (10.9%). From those results can be concluded if the modified frame differences algorithm has the accuracy up to 89.1% when the density value is 6% and threshold is 40.

#### IV. CONCLUSIONS AND SUGGESTIONS

The testing results concluded that the modification to frame differences algorithm was successful. With the addition of density the algorithm works faster, up to 97.78% with the density value of 6% and it's still possible to detect moving objects even if not all pixels are checked when two images are compared.

The algorithm has the accuracy up to 89.1% with the density value of 6% and threshold value of 40. This is lower compared to the accuracy result from study [3] which is 95.5%. So there's a tradeoff, with density the frame differences algorithm will work much faster but the accuracy will be lower. The modified frame differences algorithm could be a solution for a low end system to be able to detect moving objects. In the real world implementation, this algorithm could help to reduce the cost to build a security system.

Future research will be focused in the object classification, so only human or other type of objects are detected. The aim is to reduce the number of false alarm when frame differences algorithm is used to build a security system.

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# ***AB-FI: AUTOMATIC BATIK-PATTERN FOREGROUND IDENTIFICATION BASED ON GABOR FILTER AND NEURAL NETWORK***

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**Abstract**—*Batik is a traditional Indonesia textile art that contains complex pattern. Traditionally, batik has a unique pattern characteristic that symbolizes a cultural meaning corresponding to the region which the batik is produced. The patterns are usually interpreted using subjective opinion from experts. Many methods have been proposed to limit this subjectivity by means of quantifying batik patterns for classification, identification, decision approach, and expert system. These methods require data that is collected manually based on the collectors' subjective perception. The collectors select the batik's foreground patterns that are most likely to be the batik's characteristic. However, the process of data collecting using manual labor is also prone to the subjectivity of the collector. Furthermore, since the performances of those methods depend on their data, their performances depend on the collectors' subjective perception. In order to further limit the subjectivity we propose an Automatic Batik-pattern Foreground Identification (AB-FI) method. The AB-FI is based on Gabor filter for feature extraction and machine learning for localize the foreground. Using two batiks' patterns for testing, the method can achieve an accuracy of 89% to 98%. It is concluded that AB-FI offers an attractive alternative for batik's pattern segmentation.*

**Keywords** - *Gabor filter, Support Vector Machine, Neural Network, Batik*

## **I. INTRODUCTION**

Batik is one of Indonesia traditional textile art recognized by UNESCO World Heritage as one of the world heritage. Generally batiks are classified according to its patterns. The patterns compose by basic shapes and colors from simple to more complex patterns (Fig. 1). Traditionally, each pattern is corresponded to a certain cultural symbol and differs from one another (i.g. each area producing batiks have their own common patterns and cultural meaning). These patterns are interpreted by experts based on their subjective visual perspectives and experiences. The reliance on the subjectivity of the experts could make the interpretation less reliable.

Many methods are proposed to handle the problem caused by subjectivity, such as using decision tree approach. It works by cropping and converting image to binary image, and then using C4.5 algorithm for training using decision tree algorithm. Its output would represent a pattern and once it could be

classified, the information related would be displayed on phone screen [1]. These steps are relatively simple such that it can be implemented even on mobile phones. However, its effectiveness is still arguable since its lack of testing.

Another method uses rotated wavelet filter and/or discrete wavelet filter in conjunction with neural network to identify batik's pattern. It works by extracting feature using rotated wavelet filter and/or discrete wavelet from decomposition images. Then, the features are classified using neural network multi-layer perceptron to overcome massive parallelism from wavelet decomposition. The authors reported that their method reached high performance [2]. However, it is known that the methods that use learning models are naturally constrained by the condition in which they are trained. When the conditions change (i.e., the data used has different characteristic), then their performance could decay.

The aforementioned methods successfully solve the segmentation problem. However, when the patterns are subjectively chosen as data, then it cannot be guaranteed that the data are invariant in terms of positions, sizes, and orientations. Therefore even when given the same batik, we cannot guarantee that those methods use the same data. This condition makes it difficult to compare the effectiveness of batik's identification methods.

There are two approach to collect a less subjective set of batik pattern data. First, a straight forward approach to solve the data variation problem is to collect a large number of batik patterns and use them as experiment database. This approach is expensive, and requires substantial amount of time and batik's expertise. In our knowledge, currently there is still no such database available for public. Second, a more complicated (but less expensive) approach is to construct an automatic method to extract the pattern.

This paper proposes an automatic batik's pattern segmentation method. This method is called Automatic Batik-pattern Foreground Identification (AB-FI), which is based on Gabor filter and machine learning. The outline of the reminder of this paper is as follows. In section II we present the methodologies that would be used on this research.

Fig. 1. An example of a relatively simple batik pattern (a) [3] and a more complex pattern (b) [4].



## II. THE AB-FI METHOD

The AB-FI segments the batik's pattern based on the location of the batik's foreground, since the batik pattern characteristic is on its foreground pattern. AB-FI works in three steps: (1) it extract the batik's features using Gabor Filter, (2) then classify the features, and (3) it marked the location of the foreground based on the result in the classification step.

(1) To get a sample for training and testing purpose, a simple sliding window technique was used. It worked by sliding with a pre-defined distance in pixel using iteration to point its starting x-axis and y-axis. The result is a patch of images which has a noise that scattered around the image itself that could affect the performance of machine learning. To reduce its ability from alter the end result, the use of filtration technique is mandatory. From all other filtering technique, Wiener filter is one of the most optimal method. This technique had been converted and adopted to many kinds of variation [5].

Then, Gabor filter takes place as a method to extract signature from an image. It can be used to analyze texture-based process, such as classification, segmentation or an edge detection [6]. The way it work is by modulating sine graphic with Gaussian [7]. Extracting an energy from an image with Gabor filter wavelet can be accomplished by setting up a specific parameter. The result of this method is an array consisting of energy matrices with the same size as the image itself or in other word, pixel-by-pixel.

With a huge amount of image data, it was mandatory to reduce the size of its data to a smaller dimension before proceeding to the next process, which was support vector machine as machine learning tool. Principal component analysis was a tool that has been used generally for analyzing modern data [8]. It also can be presented on 1 dimensional to 3 dimensional data.

(2) Machine learning is one of the main method in this kind of image processing, it act as a virtual learning process with a set of sample for train material. It specifically used to approach a classification problems and represented as data-driven [9]. The hyperplane was drawn automatically as an optimal separating line by using greatest minimum distance towards training process. The performance result when using support vector machine was defined by the type of its kernel. There are different kind of kernel such as linear, quadratic,

polynomial, Gaussian, and a custom kernel. The choice of kernels were based on trial and error.

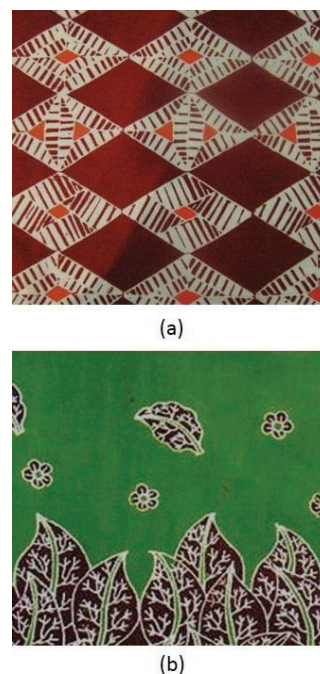
The other machine learning which were capable to process a huge amount of data was neural network. It was remodeled based on the biological neurons, like when a brain processing an information. All of the neurons are inter-connected accordingly to solve a specific problem. Using a back propagation as a multi-layer feed forward network train which was one of the neural network model that was widely applied [10]. When using neural network, user must input data that need to be processed and setting its desired output with the amount of hidden layer defined by the user, it represent how much processed required to acquire the end result.

(3) Then the images will be plotted using the best machine learning parameters from support vector machine and neural network. If it was a foreground, then it would be appeared as a white color, if it was a background, it would remain its original color.

## III. IMPLEMENTATION AND EVALUATION

AB-FI is implemented using Microsoft Windows version of Matlab R2013a. The implementations are done in two steps: first is the training of the machine learning, and second is the foreground classification. There are two main process, the first one is train and the second one is test. The methods are similar. The image that would be used was measured at 700 pixel by 650 pixel as shown in Fig. 2. Base on visual perception, two batik images was chosen, because it had a very distinctive differences between foreground and background. The following steps were based on previous methodology section.

Fig. 2. Batik image for identification (a) Malang origin (b) Jember origin [11].



### A. Training process

For train purposes, a patched of 100 foregrounds and 100 backgrounds with a size of 50x50 pixel are selected from thousands of cropped images (Fig. 3). Then we labeled them using ground truth. To reduced colors complexity and noise, all images were converted into grayscale before applying Wiener filter with a parameter of [5 5].

For Gabor filter wavelet, we were using 16 iterations every 22.5° and 8 loops of wavelength starting from  $\lambda = 3$ . From there, an array of matrices consisting energy value with the size of 50x50 dimensions as a result of every iterations would be summed and divided with a total of 128 iterations to get an average value for every single images. All 200 of patched images with a dimension of 50x50 matrices each, were stored in the array individually. The next step is to convert a 50x50 matrices to vector with the size of 1x2500 matrices for each images by force. Then each image will be vertically concated so it create a new set of data with the size of 200x2500 dimensions.

Before proceed to principal component analysis, all matrices must be normalized to orthogonal form, because it could affect the accuracy of machine learning [12]. 200 set of matrices normalized using mean subtraction. Then, the principal component analysis is responsible to reduce matrix dimensions until 2 dimensions with an x-axis and y-axis. All images would be divided into two category with “+” symbol to identify background and “o” symbol to identify foreground respectively (Fig. 4). Based on the representation, almost all of the energy from background images is gathered around on the center, with Jember being the best represented background energy. After reduced to 2 dimension matrices or on the size of 200x2 the next step was to input the data for machine learning.

The performance of support vector machine as a machine learning was based on its own kernel. The kernel that had been used on this research is a Gaussian kernel, because from 3 different kernel (linear, polynomial, and Gaussian) it is the only one which could gave the highest accuracy based on the image samples. To test its accuracy, there were a technique called cross-validation and based on the test given using holdout was the best, because it gives a high accuracy from 180 images for training material, with 20 images as testing. The last step from training process was to classify another machine learning, which is neural network.

The advantage of using neural network is they could processed a large amount of data, so all of the 200x2500 normalized matrices were input as is. With a target label of 1 as a foreground and 0 as a background. Then, 10 hidden layers, 80% of images for train, 10% for validation and 10% for testing, would get an accuracy of 100%. The result of all machine learning was a model that could be used for testing process.

### B. Evaluation

The process itself was basically similar with train process. The differences was there were no train samples from support vector machine, all of the images are using model from

previous process. All images were cut into patched using sliding window and with a parameter of 100x50 pixel so from an image with the size of 700x650 pixel would generate a 117 cropped image. Then, from that 117 images, all of them would be cropped again using a parameter of 50x50 pixel with a total of 50 images from each image the size of 100x50 pixel. So, from a single image the size of 700x650 pixel, it would generate 5850 patched of image. Each one will be individually labeled as foreground or as a background based on the ground truth.

Image were processed with the same methods as before, all of them would be applied with grayscale, Wiener filter, Gabor filter and principal component analysis for support vector machine only. By using a model from Malang support vector machine, it could get a high accuracy of 89.61% but if we cross the model using from Jember support vector machine, it would get a higher accuracy of 90.65% (Table I). The opposite of it was found on Jember testing process. When using its own Support Vector Machine model, it could get a high accuracy of 91.54%, but if it had been crossed it only get a 90.15% accuracy (Table II).

Fig. 3. A set of image sample. The upper category is a background and the lower is a foreground

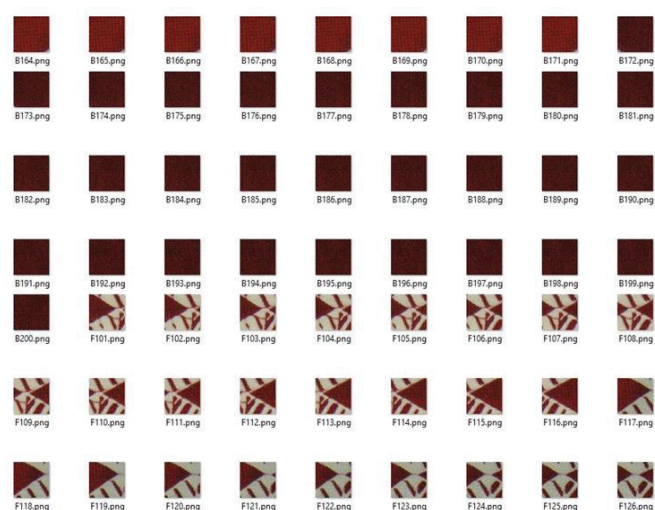
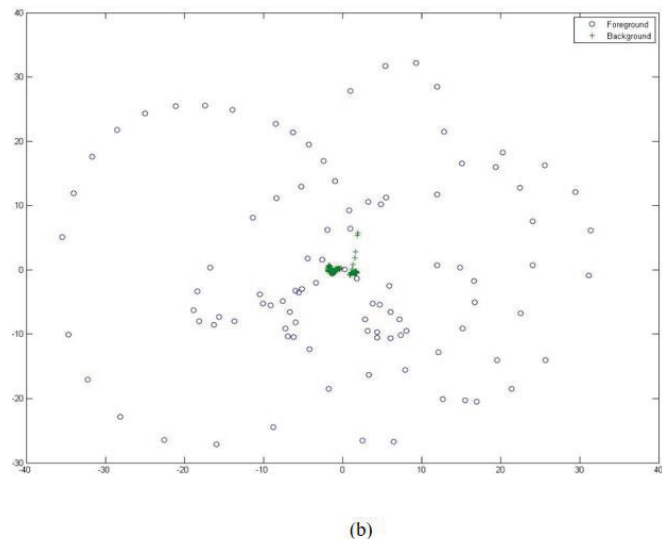
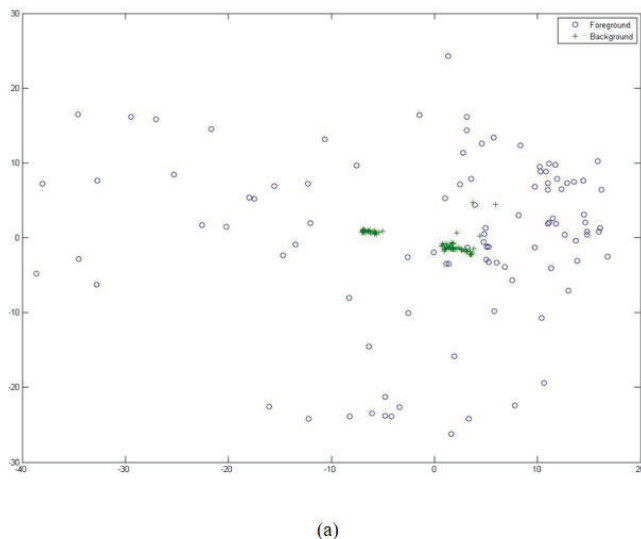




Fig. 4. 2-D PCA presentation (a) Malang origin and (b) Jember origin.



There are still many false recognition by using support vector machine (Fig. 5) (Fig. 6) even though by using Jember SVM model will increased accuracy slightly. Another machine learning which was neural network could process all 200x2500 matrices, so there isn't any reduction needed by using this method, in hope it can improve accuracy from previous method.

Neural network worked by defining its input and targets, in this case a matrices with a size of 200x2500 and a label as targets containing number 1 for foreground and 0 for background with 100 data each. By using model defined on previous process, we could defined neural network not to act randomly, by setting up a control random generated number. The number itself, is freely to choose based on trial and error and the accuracy it given.

Since there weren't any reduction in dimension size, the ability for computer to identified and classified an image was much greater, rather than using support vector machine. Neural network could identify foreground more precise (Table III). The accuracy itself could increase for about 6.96% compare with the best SVM model.

With a high accuracy result, many image had been classified successfully according to its label, only a small fraction of false recognition, all of them are under 100 images from 5850 images in total for each batik pattern. The biggest differences was the ability to identify foreground and background much more precise (Fig. 7).

Table I. The result of classifying image using Support Vector Machine for Malang subject

Malang (Malang SVM)		Malang (Jember SVM)	
Accuracy (%)	89.61	Accuracy (%)	90.65

Table II. The result of classifying image using Support Vector Machine for Jember subject

Jember (Jember SVM)		Jember (Malang SVM)	
Accuracy (%)	91.54	Accuracy (%)	90.15

#### IV. DISCUSSION

Defining label from which where they foreground or background is a very time consuming process, even with the largest image size the computer can handle it is still producing a thousands of images and in order to do it perfectly, it needed a good amount of data, for example when using principal component analysis along with support vector machine it could get a high accuracy by surpassing 50% mark both in train and test process, but when using neural network it could reach more higher accuracy in test process. The differences is the time it take to prepare the data before being processed to machine learning, using SVM take longer than neural network.

Fig. 5. Result using support vector machine (a) using Malang model and (b) using Jember model

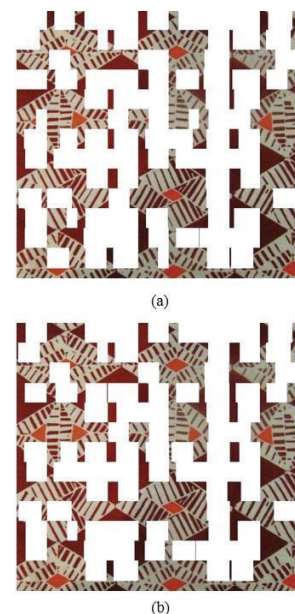


Fig. 6. Result using support vector machine (a) using Jember model (b) using Malang model

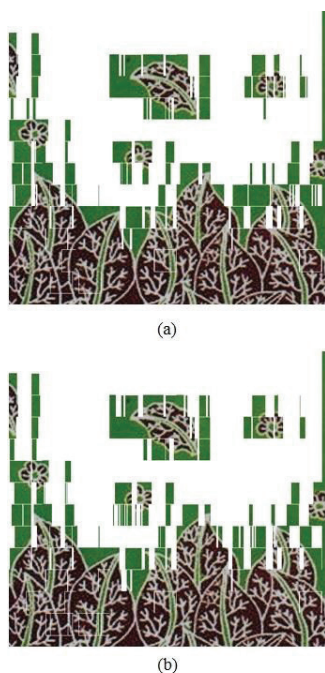


Table III. Neural Network accuracy performance for classifying images compare to Support Vector Machine

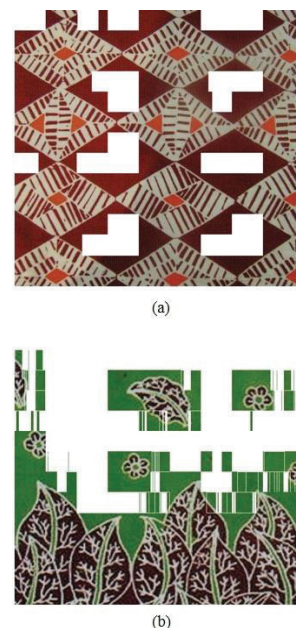
Classifier	Accuracy (%)
Malang (Malang SVM)	89.61
Malang (Jember SVM)	90.65
Jember (Jember SVM)	91.54
Jember (Malang SVM)	90.15
Malang (Neural Network)	98.50
Jember (Neural Network)	98.39

## V. CONCLUSION

Based on the accuracy result, neural network is a better method for classify an image rather than using support vector machine even though applying the best SVM model. But, nevertheless, both methods are surpassing a minimum accuracy of 50% and with a near perfect accuracy.

With the combination of grayscale, Wiener filter, and Gabor filter, as a method for feature image extraction along with principal component analysis and support vector machine, it will become a good system classifier. But, there is a drawback when using SVM which is a very time consuming process. For a better system classifier, we could use neural network but it needed a quite big amount of data to be able classify a data with a high accuracy. The result of this research is far from the finish program for user experience, it is a very time consuming and it needed a quite big computing resources. So, in the next research we hope to find a more efficient method to be able delivering it to the end user.

Fig. 7. Result using neural network as a classifier (a) Malang origin and (b) Jember origin



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# Sign Language Interpreter Application using Principal Component Analysis Algorithm

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**Abstract**— This paper describes the design and development of sign language interpreter application using Principal Component Analysis (PCA) Algorithm. Sign language is a communication method used amongs people with hearing impairment or between people with hearing impairment with normal people. There are several sign languages developed around the world and Bahasa Isyarat Indonesia (BISINDO) is one of that broadly used in Indonesia. This research focus on the implementation of PCA in order to translate the BISINDO body gesture into alphanumeric character. PCA algorithm converts the input image into a vector and then normalizing the result vector which only contains unique features. Normalized vector is transformed into eigenspace which is useful to calculate the distance. Futhermore, distance will be compared with threshold each training set. If the distance is bigger, the image cannot be recognized. However, if the distance is smaller than the threshold, the image is identified and the application will show the result of the translation. The application is tested under several different conditions. The best accuracy level is obtained in a white wall background trial with 67,65% success rate. Moreover, another result is achieved if white cloth is used as background with 53,23% accuracy rate. As a result, this research is succeed to design and develop an application that able to translate all alphanumeric character, except the J and R character.

**Index Terms**— BISINDO, Principal Component Analysis, Sign Language, Sign Language Interpreter, Webcam.

## I. INTRODUCTION

Disability is one of the issues that are important to note in Indonesia. People's with hearing impairment disability have a limitation to communicate with verbal language. According to the article from one of the disability community site, *kartunet.or.id*, there are around 602.784 hearing impairment in Indonesia [1].

Hearing impairment people use sign language to communicate amongs then and with other normal people. Nowadays, there are two sign languages known in Indonesia. Those two are Bahasa Isyarat Indonesia (BISINDO) and Sistem Isyarat Bahasa Indonesia (SIBI). Based on the article a disability community site, *gerkatin.com*, SIBI is recognized as official sign language in Indonesia but unfortunately, BISINDO is not. However, SIBI is actually created by normal people and SIBI is exactly the same as and

follows American Sign Language (ASL). Therefore, people with hear impairment in Indonesia have some difficulties in understanding SIBI. However, BISINDO is created by hearing impairment community in Indonesia so that it is easier to understand by Indonesian people with hearing impairment than SIBI [2].

Due to these backgrounds, developing an application to help hearing impairment people to be able to communicate with other normal people is deemed neccesary.

In this study, Principal Component Analysis (PCA) Algorithm is employed to translate the sign language into any corresponding alphanumeric character. PCA is an algorithm used to reduce the dimension using linear discriminant analysis (LDA) and generate fisherface. PCA algorithm converts the input image to a vector and then normalizing the result vector which only contains unique features. The normalized vector is transformed into eigenspace which is useful to calculate the distance. Futhermore, the distance will be compared with the threshold of each training set. If the distance is bigger, the image is not recognized. However, if the distance is smaller than the threshold, the image is identified and the application will show the result of the corresponding character [3].

## II. LITERATURE REVIEW

### A. Computer Vision

Human receives surrounding objects as three-dimensional objects and interpret these objects as three-dimensional objects. On the other hand, a computer can only receive a two-dimensional image [4]. In addition, researchers in computer vision field eager to develop a mathematical algorithm or technique to present a two-dimensional image received by the computer and visualized it into a three-dimensional image of the object resembled.

This study employes a computer vision methodology to recognize an alphanumeric character sign within an image. The image is received by a computer camera or a webcam. In addition, this research utilizes PCA algorithm to recognize any BISINDO sign within the serial of images that prepared as the training set data. After the training set data has been recognized by the PCA, the application

is ready to produce the corresponding alphanumeric character result.

### B. Image Recognition

Image Recognition is a methodology to identify objects, types, or relationships within a raw data. This statement means that an image recognition methodology should be able to identify an information or data contained inside an image [5].

Based *mathworks.com*, image recognition is a process to identify and detect an object or form of the digital image or video. Optical character recognition, pattern and gradient matching, face recognition, license plate matching, and scene change detection are several examples of the image recognition implementation [6].

### C. Principal Component Analysis

PCA algorithm developed in 1991 by Turk and Pentland. PCA is an algorithm used to reduce the dimension using linear discriminate analysis (LDA) and generate fisherface [2]. PCA algorithm is an algorithm that examines the relationship variables. This algorithm can be used to reduce the number of variables in the regression and clustering [7].

According Gerg Coombe (2006), Figure 1 is an example of pseudocode for an algorithm to determine the eigenvector PCA [8].

```

 $x_1 = \text{rand}(n,1)$ 
 $x_1 = x_1 / \|x_1\|$ 
repeat
     $x_{prev} = x_1$ 
     $x_1 = Ax_1$ 
     $x_1 = x_1 / \|x_1\|$ 
until  $\|x_1 - x_{prev}\| > \text{threshold}$ 
 $\lambda = \|x_1\|$ 

```

Fig. 1. PCA Algorithm's Pseudocode

PCA algorithm transforms the user supplied image into a vector. There are several steps that need to be done in order to normalize a vector. First, calculate the average of the vector in the training set is often called average vector or mean. After that, the average vector is used to form a unique feature of initial training set. The unique feature will be translated into an eigenvector. After that, the eigenvector sets will be reduced into a smaller eigenvector sets by seeking as much as k component, but it still can represent the training set as a whole set. The results of these calculations produce a weightvector of each training set. The normalization vector result of the input image will be compared with the weightvector to get the distance. Distance is a component used to determine whether the input image can be recognized or not. If the distance is smaller than the threshold, the image is recognized and the application will issue the results of the drawing. Conversely, if the distance is bigger than the threshold, the image is not recognized. Figure 2 shows the flow of PCA algorithm [9].

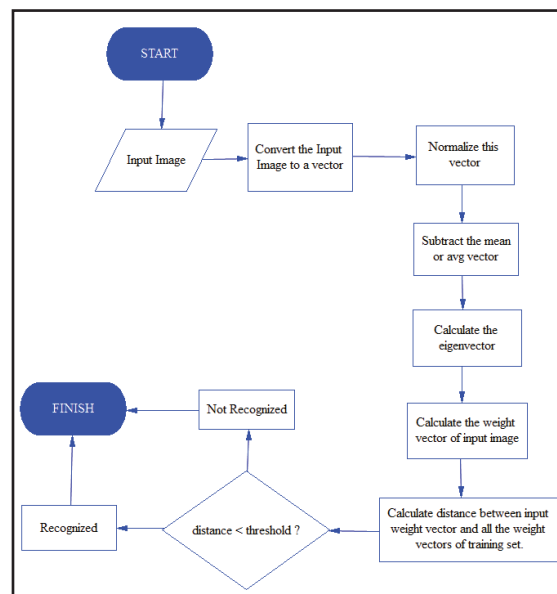


Fig. 2. PCA Algorithm Process

### D. BISINDO

One of well-known sign language studied by the people with hearing impairment in Indonesia is BISINDO. A disability community in Indonesia, Gerakan untuk Kesejahteraan Tunarungu Indonesia (Gerkatin), stated that BISINDO is easier to understand rather than SIBI amongs Indonesian.

Based on information obtained from gerkatin.com, Gerkatin has a fight for BISINDO to be acknowledged by the government since 1981. However, until now there is no official recognition from Indonesian government. Despite that BISINDO is a very important need for the hearing impairment people in communication. Figure 3 is an sign language of BISINDO.



Fig. 3. BISINDO Indonesian Sign Language

## III. APPLICATION METHODS AND DESIGN

The application methods and design used in this study starts from the literature analysis, systems analysis, application design, system programming, search sample data training, testing and evaluation, and reporting.

The stage of application design is done by designing the Data Flow Diagrams (DFD) and the flowchart of the application. DFD generally describes

the flow of data in the application and flowchart generally describes the application process flow.

This research focus is developing an application that can translate sign language into an alphanumeric character. The application implements PCA algorithm to translate sign language within a captured image. This application aims to translate letters and numbers quickly and able to add its own training data sets. However, the application is limited to letters and numbers training data sets.

The specification used in this study is a PC with an Intel i5 1.6 Ghz CPU, 4 GB DDR3 RAM, 1 TB SATA Harddisk. The software used as operating system on a the PC is Windows 8.1 64 bit. Microsoft Visual Studio 2012 (.NET 4.0) is employed as the primary IDE.

#### A. Data Flow Diagram

The data flow that occurs in this application is described within the System Context Diagram and Application DFD Level 1.

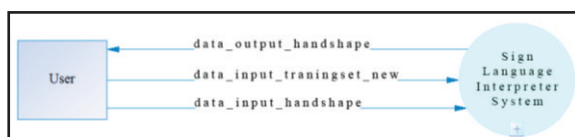


Fig. 4. System Context Diagram

Figure 4 shows that the application receives two inputs, “data\_input\_trainingset\_new” and “data\_input\_handshape”. Both inputs will be processed by the Sign Language Interpreter System. Moreover, the system returns “data\_output\_handshape” output data. Next, the “data\_input\_trainingset\_new” will be saved into a textfile.

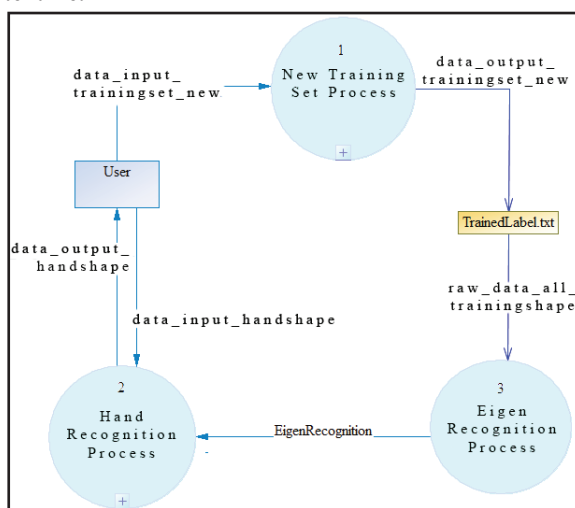


Fig. 5. Application DFD Level 1

Figure 5 shows that the user can input either a “data\_input\_trainingset\_new” to process a new training set data or a “data\_input\_handshape” to receive a corresponding alphanumeric character as the result. The “data\_input\_trainingset\_new” that inserted by user will be processed through “New Training Set Process” module and appended the existing

“TrainedLabel.txt” into a longer list of data. The process is continued through the “EigenRecognition Process” then push a “EigenRecognition” data to the “HandRecognition Process”. On the other hand, the process to translate a “data\_input\_handshape” is done by the “HandRecognition Process” module directly and return a “data\_output\_handshape” as a result.

#### B. Flowchart

The following flowcharts illustrate the process flow that occurred in the application consist of the Application Flowchart, New Training Set Process Flowchart, and Hand Recognition Process Flowchart.

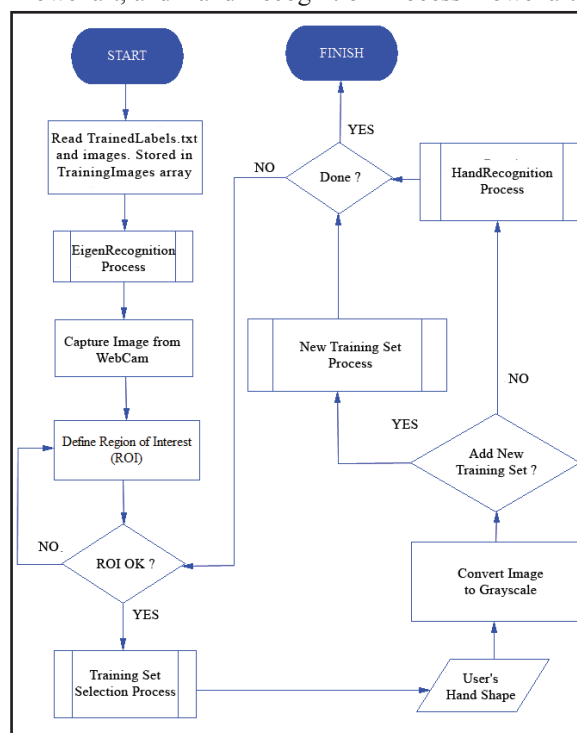


Fig. 6. Application Flowchart

Figure 6 shows that the initial process of this application loads all the training data set in advance from the folder “Huruf” and “Angka” as well as textfile named “TrainedLabels.txt”. As soon as the textfile is loaded, the application proceeds the image training set and stored those images inside a TrainingImages array. The TrainingImages array is used in the EigenRecognition Process subsystem. Furthermore, the application starts to capture images from the computer camera. The user is asked to create a Region of Interest (ROI) or the location of the hand area is located. After that, system runs the “Training Set Selection Process” and ready to receive any BISINDO sign language via webcam installed in the computer within the ROI area. Next, the application converts the image captured into grayscale. The translation process will be done automatically by the Hand Recognition subsystem. However, if the user wants to add the image captured into the training set, the process will be conducted through the “New Training Set Process” subsystem.

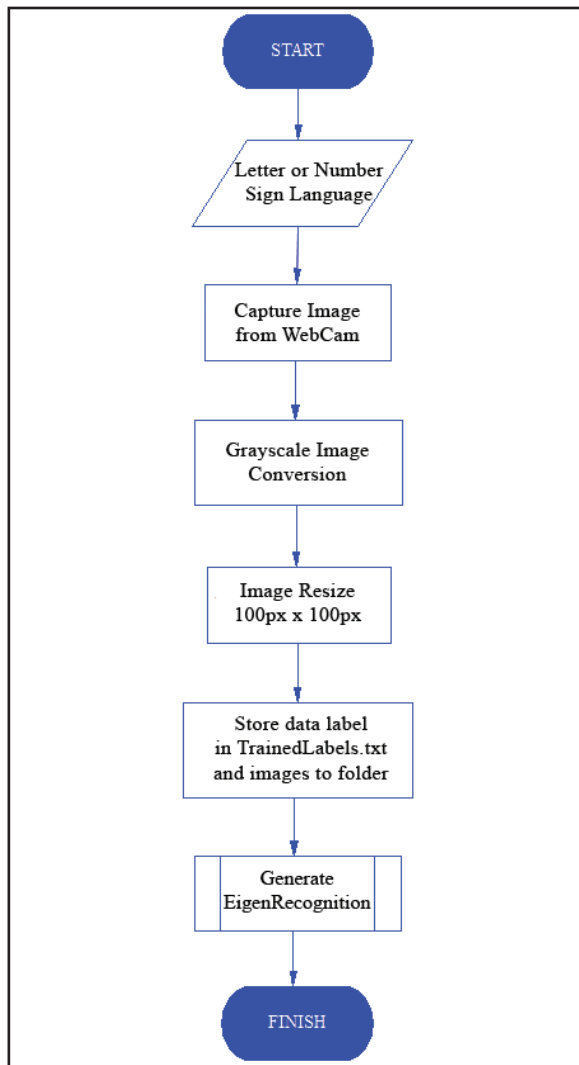


Fig. 7. New Training Set Process Flowchart

The process starts whenever the user sets the ROI area and form a sign language by his hand. After that, the user is prompted to provide a label of the hand in the form of letters or numbers. User only can enter the A-Z letters or 0-9 numbers. The application takes pictures with a computer camera (webcam) within the ROI area that has been specified by the user before. Next, the application converts the image to grayscale. The captured images is reduced to 100 pixel  $\times$  100 pixel so that the size of the application is considered not too large. The resized images will be stored in a folder named "Huruf" or "Angka" within in the application directory. Furthermore, the application adds the new data into a textfile named "TrainedLabels.txt". Once the process completes, the application creates a new EigenRecognition of all existing data.

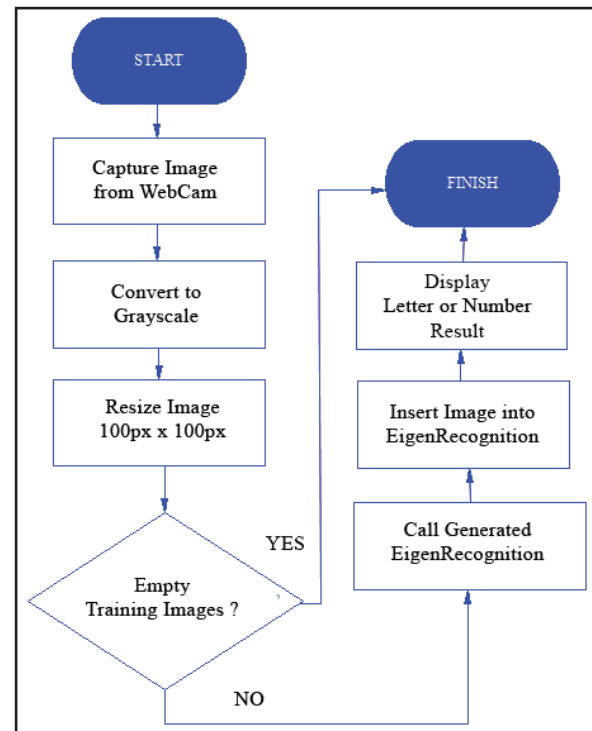


Fig. 8. Hand Recognition Process Flowchart

Hand Recognition process starts when the user determines the ROI area and forms a sign language. The application takes a picture with a webcam within the specified ROI area and converts the image to grayscale. Similar to the previous process, the captured images is reduced to 100 pixel  $\times$  100 pixel. Next, the application ensures that TrainingImages array is not empty. If the array is empty, there are no letters or numbers that can be translated. On the other hand, if the TrainingImages array is not empty, the application will start the translation process. If the user selects the "Letter" option, the application will use "Letter EigenRecognition". On the contrary, if the user selects the "Number", the application will use "Number EigenRecognition". The image that has been scaled will be proceeded into EigenRecognition Process for translation process. The previous process will produce a letter or number. The result will be displayed by the application within the "Translation Result" section.

#### IV. IMPLEMENTATION AND TESTING

##### A. Algorithm and Interface Implementation

Implementation of the algorithm starts when the application loads all letters and numbers training set images stored in training set folders and labeled on textfile named "TrainedLabels.txt". If there is no available training data set, the application displays a warning to add any training set first. On contrary, if the application able to load existing training set data, it displays the number of successfully loaded images.



Each EigenRecognition will be created after the loading process of letters or numbers training set is completely done. The application will create to the parameters. Next, the system will calculate the TermCriteria value based on the existing training set's total number and the value of epsilon ( $\epsilon$ ) 0.001. The  $\epsilon$  value represents the allowed error rate. Smaller  $\epsilon$  value means higher precision rate. EigenRecognition builder requires a training set that loaded beforehand, training set labels, threshold value, and the recent TermCriteria value. This EigenRecognition value is useful to translate the image provided by the user.

The translation process takes a picture from computer's camera and convert it into grayscale. Before translating, the application will check whether there is any EigenRecognition or not and whether there are any new additional training set data then the system need to calculate the new EigenRecognition value or not. Next, the application compares the image obtained from the webcam with the training set inside the EigenRecognition. The EigenRecognition will try to translate the input image with a training set that obtained previously. The result of the process is a corresponding letter or number based on user's BISINDO sign language hand shape inside the ROI area.

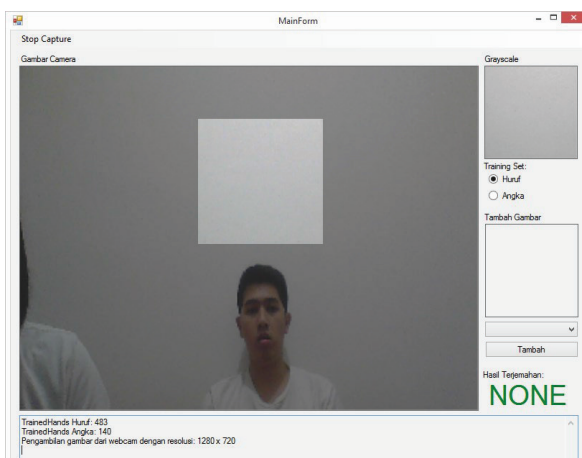


Fig. 9. Interface Application

#### B. Testing with Different Background Colors

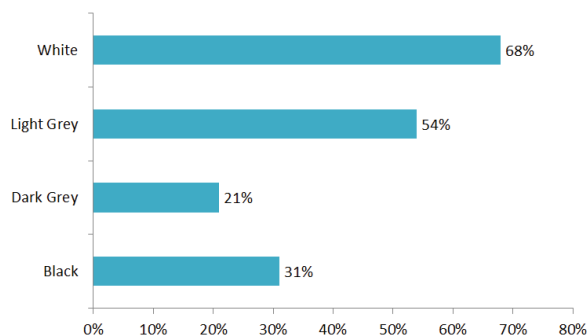


Fig. 10. Various Background Colors Accuracy Rate

As seen in the Figure 10, background color become a significant factor on this implementation. White color background gets the highest accuracy rate

followed by light gray, black, and dark gray. The result seems make sense because in the middle of the process, the received image will be converted into grayscale. According to this experiment results, white color is become the most recommended color to be used as the background color.

The system is considered to deliver higher accuracy rate on a plain background and any color that contrast with the user's skin color. Plain background is recommended because this condition can avoid the system to misunderstand any pattern on the background as a part of user's hand shape. Backgrounds with contrast color from the user's skin color is recommended because the hand and the background color can be easily distinguished once the image is converted to grayscale.

#### C. Testing with Wall and Cloth Background

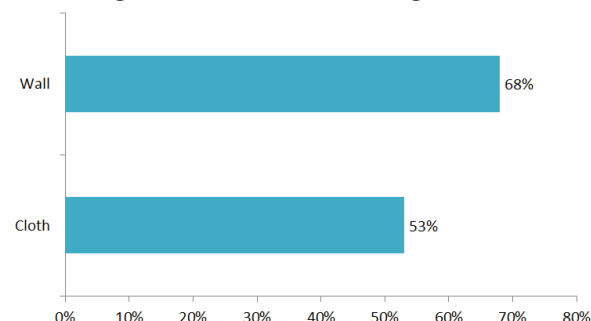


Fig. 11. White Wall and White Cloth Accuracy Rate

The accuracy level in white wall experiment is at 67,65%. Moreover, another trial that employs a white cloth delivers 53,23% accuracy rate. There is around 14.42% differences between these two results. This gap occurs by the user's body indentation that create a slight noise within the input image. As a conclusion, a wall with white color considered as the best background to achieve the highest accuracy rate.

#### V. CONCLUSION AND FUTURE WORKS

A Sign Language Interpreter Application to translate the letters and numbers based on BISINDO sign language system using Principal Component Analysis Algorithm was built successfully in Windows-based desktop environment.

Based on the trials with plain walls with various background colors, white color or any colors that have contrast with the user's skin color considered deliver better accuracy rate. Furthermore, trials with a white wall gives higher accuracy rate rather than plain white cloth as the background. Plain background considered helping the image recognition process to distinguished the user's hand shape within the image that captured from the computer camera. Background with contrast color from user's skin color is recommended because the results of the computer camera captured images will be easily distinguished in grayscale.



In conclusion, the application is able to translate all letters and numbers, except the letter J and R. Applications can not translate the letter J and R because it requires the implementation motion capture methodology. In addition, the application also can not combine letters and numbers simultaneously because there will be several clash possibility in some letters and numbers. The letters and numbers that have higher error rate are letter I with the number 1, letter V and L with number 2, and letter M and N with the number 5.

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# A Comparative Study of Behavior Analysis Sandboxes in Malware Detection

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**Abstract**—Malicious software or malware, has grown rapidly and presented huge information security challenges to a computer system. Many of Anti-Virus (AV) products failed to detect new or unknown malware, since they relied on their malware signature to detect malware. The situation is even made worst with current malware has capability to evade the detection using various code obfuscation techniques. One of the better way to counter this growing evasion capability is analyzing the malware dynamically in a sandbox environment, which provide an isolated environment for analyzing behavior of the malware. This paper presents the comparison of 2 behavior analysis sandboxes for their accuracy in detecting malware using several commonly used machine learning algorithms. Our experiment results show that the overall best performance goes to Random Forest (RF) with a recall (true positive rate) of 96.48%, a precision (positive predictive value) of 98.23%, an accuracy of 95.02%, and the F-Measure is 97.35%. This research shows RF is a better classifier for term frequency classification for malware behavior features while Support Vector Machine (SVM) is suited for behavior features that take the parameters of behaviors into account

**Keywords**—malware detection, malware analysis, dynamic analysis, data mining, classification, machine learning

## I. INTRODUCTION

Malware is now one of the largest information security threats to individual or organization and has continued to increase in terms of volume and sophistication to attack computer systems. Many of the malware are using code obfuscation [1] to evade the conventional signature-based anti-malware system. Thus, it complicates the malware analyst effort in understanding malware characteristics and slows down the process to provide the latest signatures for detecting the new or unknown malware.

The other challenge is the sheer volume of malware samples to be analyzed also explained why the anti-malware system has not been able to cope with the situation. With the growth of various forms of computer systems such as tablets, smart phones and even the latest Internet of Things (IoT) made it even more impossible to win the race against the malware threats. McAfee Lab has predicted that in 2019, there will be more than 75 billions global internet-connected devices and 2/3 of them are IoT [2].

To keep up with latest malware variants as well as to complement the limitation of traditional static malware analysis [3], many malware analysts have utilized automated dynamic malware analysis. In this paper we provide comparison the two

most commonly used malware behavior analysis sandboxes, i.e. Anubis [4] and Cuckoo [5], by extracting behavior features from these sandboxes for analysis using two machine learning engines to evaluate the accuracy in detecting malware. This research also compares the performance of Malheur [6], a specific machine learning engine designed to provide insight to malware behavior features, and various machine learning algorithms using Scikit-Learn.

Following are the organization of the paper: Section II summarizes the related work, Section III discusses our system process design, Section IV and V describe our experiment setup and experiment results respectively, Section VI presents the discussion of our experiment results and VII concludes our research.

## II. RELATED WORKS

**Static analysis.** Since malware source code is generally not available to malware analyst, the most common approach of analyzing malware statically is to disassemble the binary. Various static features such as API call string, system calls and others can be extracted [7], [8]. These unique static features can then be processed to become signature for malware detection, used by most AV products. However, code obfuscation (packers, polymorphic, metamorphic) [1] is common to most malware binaries, which makes static analysis more challenging, if not impossible. Even with the most advance unpacker tools available, there is still limitation to perfectly unpack the binary code [3], [8].

**Dynamic analysis.** To answer the limitation of static analysis, behavior analysis has been proposed and utilized extensively by researchers recently [9], [10]. Behavior analysis, also called dynamic analysis, executes the binary under investigation and performs an analysis during binary execution. Record of system calls and API calls during execution may provide critical insight to determine maliciousness of the binary code. While Rieck et al [9] executed the binary for limited time to extract the behavior features, Bai et al [10] add some input triggering to provide more possible behaviors during the code execution. While Rieck et al [9] and Firdausi et al [11] utilized CWSandbox [12] and Anubis [4] sandboxes respectively in their research, we present comparison analysis of Anubis and Cuckoo [5] sandboxes. CWSandbox, now called ThreatAnalyzer [13], is a commercial malware analysis sandbox, while Anubis is a successor of TTAalyze [14].

**Machine Learning** Rieck et al [9] analyzed extracted API call sequences using CWSandbox on 24 malware families using Malheur [6], machine learning model based on Support Vector Machine (SVM) [15]. Firdausi et al [11] chose to use WEKA [16] with 5 different machine learning algorithms, which include k-Nearest Neighbors (kNN), Naïve Bayes, J48 Decision Tree (DT), SVM, and Multilayer Perceptron Neural Network (MLP) in their research. Firdausi et al managed to use feature selection to increase accuracy percentage by 2-3 % with the impact of having lower accuracy of about 2 % with J48 classifier. Rieck et al used malware instruction set (MIST) [17] format vector model while Firdaus et al used frequency-weight and binary-weight vector model to represent features being evaluated. Tian [18] also used frequency-weight vector model to be used for 5 different classifiers (NB, Instance-Based Learning (IB1), DT, Random Forest (RF) dan SVM) in her framework. Alazab et al [19] also compared accuracy using 5 different classifiers: J48, SVM, KNN, NB, and NN-BackPropagation. In this research, we choose to use the following four classifiers: SVM, DT, KNN and RF, under Scikit-Learn [20] with 10-fold cross validation for more efficient runtime for our classification model.

### III. SYSTEM PROCESS DESIGN

Figure 1 depicts the overview diagram for evaluating two different sandboxes, i.e. Anubis and Cuckoo, in analyzing a collection of binary samples, i.e. malware and benign (not malware) samples. The analysis result reports will be pre-processed through MIST conversion process and feature extraction process before being sent to Malheur and Scikit-Learn. As discussed by Rieck et al [9], it is more efficient in processing time if the input format to Malheur uses MIST format.

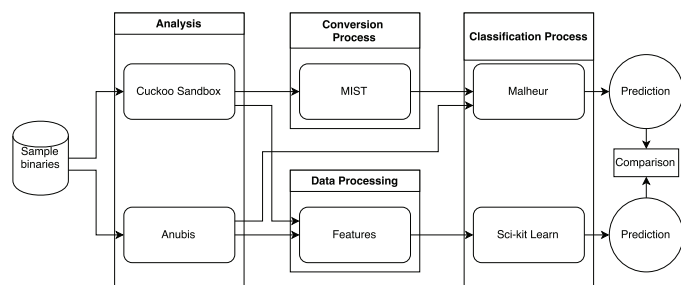


Fig. 1. System Architecture

#### A. Malware Behavior Analysis Sandboxes

The input to each of the malware behavior analysis sandboxes are selected binary samples that include malware binary samples and benign binary samples. The output of each sandbox is a report for each of the binary sample analyzed. In this research, the report format of Anubis used are TXT and XML format, while JSON format is used for Cuckoo Sandbox. Since Malheur accepts either XML (sub-process 4) or MIST format (sub-process 2), MIST is a preferred format - uses a smaller file size and reduces processing time [17]. The required processes can be summarized in the following 4 sub-processes:

- Subproc 1** Cuckoo - Data Processing - Scikit-Learn
- Subproc 2** Cuckoo - MIST - Malheur

- Subproc 3** Anubis - Data Processing - Scikit-Learn
- Subproc 4** Anubis - Malheur

#### B. Data Processing

For sub-process 1 & 3, extracting API calls from sandboxes into databases will be performed. Once the database is populated, frequency-weight vector model is created for each of sandbox databases. For sub-process 2, Cuckoo JSON report will be converted MIST format by using Cuckoo2Mist program.

### IV. EXPERIMENTAL SETUP

#### A. System Setup

Anubis sandbox was chosen since it provides free online submission for behavior analysis of malware samples, while Cuckoo sandbox, an open source behavior analysis sandbox, provides an alternative to Anubis Sandbox. Malheur, a SVM based machine learning engine [15], is available for public use while Scikit-Learn provides free license to use for research purpose. Table I lists hardware and operating systems used in this research and table II summarizes input file formats for each of the machine learning engines.

TABLE I. HARDWARE AND OPERATING SYSTEM SPECIFICATION

	Proxmox	Cuckoo Host	Cuckoo Client
OS	Proxmox Ver. 3.2-4	Ubuntu Server 14.04	Windows XP SP3
CPU	12x Intel(R) Xeon(R) CPU E5-2620 0 @ 2.00GHz (1 Socket)	4 cores	4 cores
RAM	16GB	4GB	1GB
HDD	2x2TB	512GB	20GB
Disk Format	ext4	qcow2	vmdk

TABLE II. INPUT FILE FORMAT FOR MACHINE LEARNING

	Malheur	Scikit-Learn
From Anubis	TXT	CSV
From Cuckoo	MIST	CSV

TXT=Text and CSV=Comma Separated Value

#### B. Datasets

The dataset for this research consist of two types of data set: malware sample dataset and benign dataset. Benign dataset is a collection of non-malicious Win32 binary executable files. Malware dataset, also called Malheur dataset, is provided on the courtesy of Konrad Rieck [9]. The malwares from Malheur dataset are obtained from the anti-malware vendor Sunbelt Software who gathered malware binaries in seven consecutive days in August 2009 [9]. There are 36816 malware binaries and 439 malware families in Malheur dataset. These benign binaries are a combination of native Windows applications, clean 3rd party application, and clean third party application installer which total to 450 binaries. The third party application and installer were obtained from oldapps.com.

#### C. Machine Learning Engines

Two different machine learning engines, i.e. Malheur [6] and Scikit-Learn [20], were used in this research. Malheur is an open source malware dynamic analysis tool, developed by

Konrad Rieck and his team. Canopy version 1.5.2.2785 [21], an integrated analysis environment of Scikit-Learn [20], was used in this research. These engines are installed in the same host, in which Cuckoo sandbox is installed.

## V. EXPERIMENT RESULTS

### A. Datasets

In this research, 20,900 malware reports have been generated, nevertheless there is approximately 10% of the reports that are not successful to be converted into MIST format due to limitation of cuckoo2mist in handling newly added API call in Cuckoo sandbox. Similar to Rieck et al [9], only malware families that have 20 - 300 sample binaries are selected: a total of 58 malware families with 6,114 reports, as shown in table III. Benign samples used in this research are 410 benign binaries, as shown in table IV. The selection of malware and benign binaries is performed based on Anubis' maximum file size of 8 MB per binary file submission and MIST conversion limitation.

TABLE III. DATA SETS OF 58 MALWARE CLASSES.

Malware	#	Malware	#	Malware	#
ZHELATIN	21	Midgare	35	SALITY	62
Stabs	22	FLYSTUDIO	35	VIKING_DLL	74
Geral	23	Bancos	31	FraudLoad	63
Agent2	41	Delf	36	SPYGAMES	79
BHO	27	NetMon	37	Obfuscated	78
LdPinch	24	VAPSUP	37	Zbot	74
WOIKOINER	27	Ardamax	42	Bifrose	85
ROTATOR	27	Mixor	43	EJIK	92
Joiner	29	Black	48	Refroso	102
Inject	27	Bacteraloh	47	AutoRun	88
PcClient	31	Small	46	Tdss	111
Klone	31	PORNDIALER	53	NothingFound	300
Pakes	31	OnLineGames	53	LOOPER	115
DORFDO	34	RBOT	62	Magania	131
Parite	33	Buzus	62	FraudPack	145
Hupigon	144	PODNUHA	172	Poison	156
Agent	300	AutoIt	300	Lipler	248
Patched	300	Swizzor	300	ALLAPLE	300
Basun	300	VB	300	Virut	300
Texel	300				

TABLE IV. DATA SETS OF BENIGN BINARIES

Benign Type	Amount
Windows XP Native Application	319
Third party application	
Messenger	9
Browser	2
File Sharing	4
Audio Utilities	3
Video Utilities	1
CD and DVD Tools	4
Office and Editing	7
File Archiver	8
Misc. Utilities	9
Installer	44
<b>Total</b>	<b>410</b>

### B. Sandbox Reports

Each sandboxes has different report formats: listing 1 and listing 2 show Anubis text and Anubis XML report format respectively. Cuckoo sandbox provides JSON format report as shown in listing 3 while listing 4 shows MIST [17] report, converted from Cuckoo JSON report. The first number of listing 4, 06, indicates category of system calls and the second

number, 08, represents a particular system calls and the last 2 numbers 00000000 0960b59c are the two arguments of the system calls. Since Cuckoo JSON report provides more detailed information than Anubis Text and XML, it has larger file size as a result. Table V shows the comparison of file size of various report format of Anubis and Cuckoo sandboxes.

Listing 1. ANUBIS TEXT REPORTS

```
File Name: [ C:\WINDOWS\system32\rpcss.dll ]
```

Listing 2. SAMPLE ANUBIS XML REPORTS

```
<section_object_created file_name=
"C:\WINDOWS\system32\rpcss.dll" section_name="" />
```

Listing 3. SAMPLE CUCKOO JSON REPORTS

```
{
  "category": "system",
  "status": false,
  "return": "0xc0000135",
  "timestamp": "2015-04-04 09:55:33,284",
  "thread_id": "1448",
  "repeated": 1,
  "api": "LdrGetDllHandle",
  "arguments": [
    {
      "name": "ModuleHandle",
      "value": "0x00000000"
    },
    {
      "name": "FileName",
      "value": "C:\\WINDOWS\\system32\\rpcss.dll"
    }
  ],
  "id": 0
}
```

Listing 4. SAMPLE MIST REPORTS

```
06 08 | 00000000 0960b59c
```

TABLE V. COMPARISON OF FILE SIZE (SAMPLE REPORTS OF CUCKOO AND MIST)

Binary Name	TEXT	XML	MIST	JSON
xxx.Basun.bin	28,7KB	27,4KB	5,18MB	242MB
xxx.NothingFound.bin	73,3KB	77,2KB	2,06MB	99MB
xxx.Texel.bin	12,8KB	11KB	243KB	10,6MB

### C. Classification Results

The data sets were divided into training set and testing set. To limit the possibility of overfitting in this research, 10-fold cross validation was used. To prepare the datasets for the classification process by different machine learning engines, the following processes are performed:

- 1) The datasets for Scikit-Learn: Transformation into frequency-weight vector model from JSON format.
- 2) The datasets for Malheur: Transformation JSON files to datasets of MIST format.
- 3) The datasets for Scikit-Learn: Transformation into frequency-weight vector model from XML format.
- 4) The datasets for Malheur: Text file.

For process 1) and 3), 4 different classifier algorithms, i.e. SVM, DT,  $k$ NN, and RF were applied. For  $k$ NN, parameters tuning was required in order to find which parameters gave better accuracy. There are two types of  $k$ NN classification weights: uniform and distance. Uniform value is obtained from



simple majority vote of the  $k$ NN, while distance weights value is calculated based on distance between neighbors and query point. Using  $k$ NN as a classifier, Anubis datasets achieved 94% of accuracy while Cuckoo datasets achieved 92% of accuracy. For Anubis datasets, uniform weights and distance weights have the same accuracy for all  $k$  in  $k$ NN. For Cuckoo datasets, uniform weights provide a higher accuracy than distance weights. Table VI shows the comparison of classification results on  $k$ NN classifier using uniform and distance weights for Anubis and Cuckoo datasets. For Anubis datasets, uniform weight and distance weight perform equally well and the accuracy did not increase further beyond  $k = 3$ . On the other hand, for Cuckoo datasets, the accuracy peaked at the accuracy of 94% with the  $k = 5$  and for larger  $k$  ( $k > 5$ ) that the accuracy stayed unchanged.

TABLE VI.  $k$ NN PERFORMANCE COMPARISON (ANUBIS VS CUCKOO)

Parameters	1-NN		3-NN		5-NN		7-NN		9-NN	
	A	C	A	C	A	C	A	C	A	C
Distance	93	90	94	89	94	90	94	90	94	90
Uniform	93	90	94	90	94	92	94	92	94	92

A=Anubis and C=Cuckoo; Numbers are in percentages

1) *Malheur Result*: From 6.524 reports, the author splits the data into training and testing with ratio 60% and 40% respectively. Malheur classification results contains precision, recall, and F-measure values were summarized in table VII and figure 2.

TABLE VII. MALHEUR CLASSIFICATION RESULT

	Precision	Recall	F-Measure
Anubis	100%	94.8%	97.3%
Cuckoo	100%	77.1%	87.1%

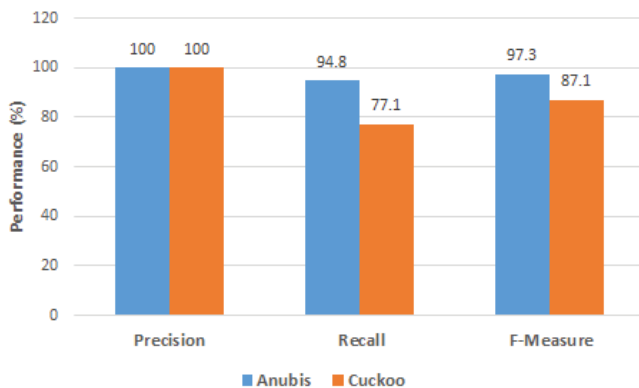


Fig. 2. Performance Comparison analysis based on Anubis and Cuckoo Data Sets

2) *Scikit-Learn Result*: Using the same number of reports, i.e. 6.524 reports, as used in Malheur are used in Scikit-Learn. To provide a more accurate way for predicting result based on given training data, 10-fold cross validation is used. The average lead time for processing using Scikit-Learn is shown in table VIII.

3) *Confusion Matrix*: Table IX compares confusion matrices of each classifier based on frequency-weight on Anubis Sandbox and Cuckoo Sandbox.

TABLE VIII. LEAD TIME COMPARISON (ANUBIS VS CUCKOO)

Classifier	Anubis	Cuckoo
SVM	36.09	215.10
Decision Tree	2.86	16.05
Nearest Neighbor	5.61	22.30
Random Forest	3.52	13.98

All numbers are in seconds

TABLE IX. CONFUSION MATRIX COMPARISON (ANUBIS VS CUCKOO)

Classifier	TP		TN		FP		FN	
	A	C	A	C	A	C	A	C
SVM	2418	2439	39	1	12	2	141	168
Decision Tree	2361	2343	92	43	69	98	88	126
Nearest Neighbor	2390	2405	67	24	40	36	113	145
Random Forest	2378	2387	33	93	63	43	136	87

A=Anubis and C=Cuckoo; TP=True Positive, TN=True Negative, FP=False Positive, FN=False Negative

Table X shows performance metrics comparison of each classifier based on the frequency-weight on Anubis and Cuckoo. Figure 3 presents a column chart comparing accuracy of each classifier for Anubis data sets and Cuckoo data sets. Finally figure 4 compares factors that contribute to confusion matrix for both Anubis and Cuckoo reports.

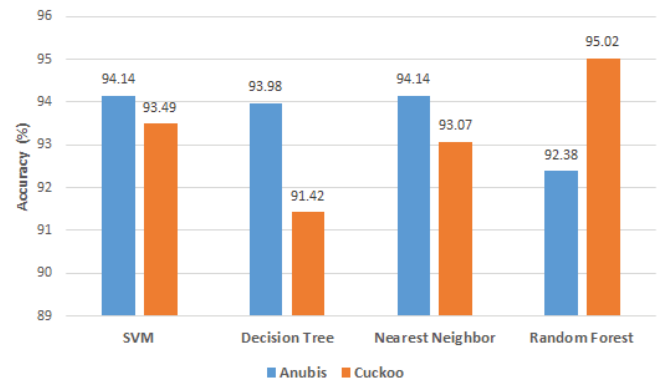


Fig. 3. Classifier Accuracy Comparison (Anubis vs Cuckoo)

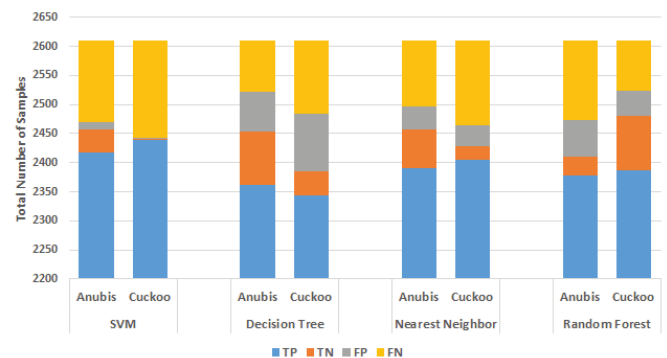


Fig. 4. Classifier Comparison (Anubis vs Cuckoo)

## VI. DISCUSSION

Table VII shows the result of Malheur classification, in which classification of Cuckoo dataset did not perform as well as Anubis dataset. One reason is due to Cuckoo2MIST conversion only supported 91 API calls out of 130 API calls



TABLE X. PERFORMANCE COMPARISON (ANUBIS VS CUCKOO)

Classifier	TPR		FPR		PPV		ACC		F-1	
	A	C	A	C	A	C	A	C	A	C
SVM	94.49	93.56	23.53	66.67	99.51	99.92	<b>94.14</b>	93.49	96.93	96.63
Decision Tree	96.41	94.90	42.86	69.50	97.16	95.99	93.98	91.42	96.78	95.44
Nearest Neighbor	95.49	94.31	37.38	60.00	98.35	98.53	<b>94.14</b>	93.07	96.90	96.37
Random Forest	94.59	96.48	65.63	31.62	97.42	98.23	92.38	<b>95.02</b>	95.98	<b>97.35</b>

A=Anubis and C=Cuckoo; Numbers are in percentages

supported by cuckoo. Both Anubis text data sets and Cuckoo MIST data sets have high precision score which indicated precise predicting relevant data, but Cuckoo MIST data sets have lower recall than Anubis text data sets, this indicates that Cuckoo MIST data sets was not as effective as Anubis text data sets.

It is obvious from table VIII, SVM classifier took the longest average time to compute, and it needed about 6 times longer for computing Cuckoo datasets than for Anubis datasets. For the same classifier SVM, Cuckoo datasets show better performance, with the F-measure of 96.93%, than Anubis data sets. On the other hand, the best classifier for Cuckoo datasets was random forest which yield 97.35% F-measure score. While Random Forest is the classifier with the lowest result using Anubis datasets while Decision Tree classifier is the classifier with the lowest result for Cuckoo datasets. Table X shows the detail of the performance comparison on Anubis and Cuckoo datasets. Similarly, as shown in figure 3, the accuracy also exhibits the same characteristics as F-measure for both Anubis and Cuckoo datasets.

Looking at the table IX and figure 4, True Positive (TP) values for SVM are the highest both Anubis and Cuckoo which show that the prediction of detected malware is high. However, the average of True Negative (TN) for SVM classifier is quite low, which mean the accuracy of binary detection as a benign is low. False positive (FP), in which benign binary is predicted as malware binary, is quite low, for both DT and RRF classifier. On the other hand, False Negative (FN), in which malware binary is predicted as benign binary, is quite large for SVM classifier and Nearest Neighbor.

Comparing table VII and table X on F-measure, Malheur performed much better using Anubis datasets than Cuckoo datasets, while RF classifier performed better than using Cuckoo datasets than using Anubis datasets. Overall, F-measure using RF classifier on Cuckoo datasets is slightly better (0.05%) than Malheur on Anubis datasets.

## VII. CONCLUSION

In conclusion, this research has compared between 2 sandboxes with 2 different classification tools and different classifier algorithms for alternative malware detection. The analysis shows that Malheur is a good machine learning engine, however it is more optimized toward MIST format. It relied on the accuracy of mapping the observed behavior features to MIST format, resulting a lower performance when used with Cuckoo data sets. RF classifier yielded slightly better in our research using Cuckoo datasets. Nevertheless, Malheur required more update behavior feature mapping to MIST format to support newer API calls supported by Cuckoo.

In addition, JSON format, a standard reporting of Cuckoo sandbox, requires higher storage needs even tough the report provides a more detail reports compared to Anubis XML reports. The F-measure for Malheur is 97.3% using Anubis datasets while F-measure for RF yielded 97.35% using Cuckoo datasets. It can be seen that RF is a better classifier for term frequency classification while SVM is suited for API calls that takes the parameters of call sequence into account. To increase the TN rate, we plan to increase the number of benign binaries and develop Cuckoo mapping function for the newer Cuckoo API to increase the accuracy in detecting malware binaries.

## ACKNOWLEDGMENT

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# Identification of Object Shapes on Two Dimensional Digital Image Using Normalized Cross Correlation

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**Abstract**— Digital image recognition is one of the common research topic in Computer Science. Image pattern recognition is used in several applications for example in object identification. This research using a simple method to recognized the shape of object. There are some of object shapes like circle, square, and triangle. The object shapes are the basic shapes of many object things in human life. To recognize the shape, this research using template matching method. Template matching method is process based on the searching of similarities between input image object and image object template. Therefore the purpose of this research is to design and develop a two dimensional image shape identification system which is supported with various condition of image database. The method is using template matching method with NCC (Normalized Cross Correlation) formula. The result of the experiment with various image data is 82.9% accuracy.

**Keyword**—Image processing, two dimensional image, normalized cross correlation, template matching

## I. INTRODUCTION

Identification of object need a complex method and various of database of the object to develop the identification system. To reduce the variety of the database, the identification of the object shapes classify the object based on the shape. Mathematic science has several shape of object like circle, triangle and square. The purpose of this research is to develop a system for identifying the object shape. The identification methods use two dimensional digital image of object shape. The method that used in this research is template matching method which has been developed on other research like on [3] [4]. The image processing is also used as preprocessing on the system to increase the accuracy of the identification.

Template matching is used as the identification method; this method is very simple but it similar to the process of human brain recognizes the pattern [5]. The previous researches about the template matching show that the method is appropriate for simple problem to identification object [3] [5]. On the [3] the accuracy of finger print identification is high and easy to be implemented on the system. The previous research on [4] also using template matching to identify the vehicle number produce a high accuracy. The template matching method compares the databases to the input data. The image input is compared per pixels to the image on databases. Some of the research purpose that using template matching has developed various methods to increase the accuracy, one of the common

and simple method is Normalized Cross Correlation (NCC) [4].

Digital image with RGB format pixel has a big number of pixel data and it makes the template matching process needs high processing time and memory. Based on this problem the digital image processing is needed to reduce the processing time of template matching. This research also using the greyscale method is to reduce the input pixel of digital image.

This research set up various condition of experiment to testing the method. The experiment data that used in this research is collected on digital image. The accuracy of the method is got from the experiment on various sample data.

## II. LITERATURE REVIEW

Image is a collection of colors that has a pattern and abstract shape [6]. Digital image is an image obtained from digital devices such as digital cameras, scanners, fingerprint, webcam, and CCTV (closed circuit television) [7]. Digital image consist of many pixels which every pixel has some color and x, y coordinate. The pattern of the digital image is get from several pixels. The pattern can be used to identify the digital image.

### A. Image Processing

Image processing is a technique to make the image simpler or even more complex for the analyses step. The understanding of image processing is a process which receives input an image and makes an edited image [6]. Beside, image processing is a processing an image to make better quality, the aim is to make an easy interpretable for human or computer [3].

### B. Template Matching

Template matching process describes how human brain recognizes the shape and pattern. Meanwhile according to Bahri, template matching process compare and counted the area of the image that match to the template for getting the result of recognizing process [5].

In this study using NCC (Normalized Cross Correlation) which had been used before by Leksono (2011) for the template matching method. This NCC Formula has high level accuracy [3]. The following NCC formula [3]:

$$NCC = \frac{\sum_{i,j=0}^{i-1,j-1} T_{ij} I_{ij}}{\sum_{i,j=0}^{i-1,j-1} (T_{ij})^2} \quad (1)$$

Description:

$NCC$  : Normalized Cross Correlation

$T_{i,j}$  : Binary value from pixel template

$I_{i,j}$  : Binary value from inputted image pixel

$i, j$  : Value of image pixel( $i \times j$ )

### C. Object identification

Identification is a process to find and give the identity for some object. Many objects are used as template data to identify image object in identification process. The identification object is a process to recognize some object thought many analysis using high accuracy information and description. The identification system is used in this research to recognize two dimensional of object on digital image.

### D. Two Dimensional Figure

Two-dimensional image consist of line or curve. Two-dimensional image can also be describe as flat design that has two dimension whose are length and width, but it do not have high or thickness.

## III. METHOD AND SYSTEM DESIGN

The developed system is described using a flow chart system.

### A. Process Flow System

In Figure 2 shows how the process flow in the image identification system.

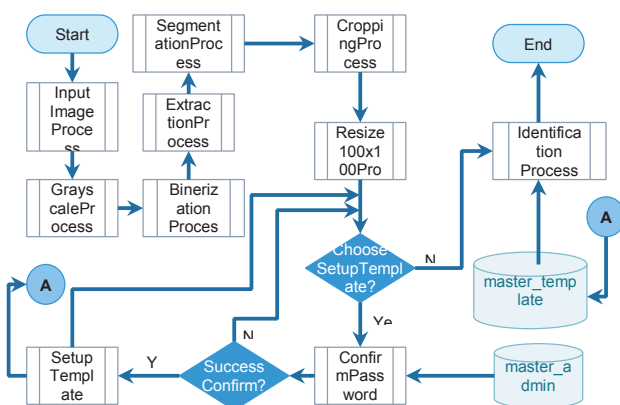


Figure 2 Flowchart Identification System

The initial process is inserting images into the application by the user, and then the next step is the grayscale, binarization, and extraction process, segmentation, cropping and resizing process. Once the resizing process, the user can choose to go directly to the identification or setup template. If the user selects the setup template menu, then before entering into the setup template process user must confirm password. If the confirmation password is correct then it will go into the setup template process.

### 1) Input Image

The input images accept several of formats of digital image. The formats are JPG, PNG, and GIF. The selected image will be displayed in the interface system after the user selects an image.

### 2) Grayscale Process

This process aims to process the input colored image into a gray image.

### 3) Binarization Process

This process aims to process images that gray grayscale image to black and white.

### 4) Extraction Process

This process aims to process binarization image in black and white by make the edge of the image smaller only by using one pixel.

### 5) Segmentation Process

The aim of this process is an image extraction process to obtain the location of the point of the object.

### 6) Cropping Process

This process aims to separate the image object with the background.

### 7) Resize 100x100 Process

This process aims to simplify the image of a large size into smaller size of 100 x 100 pixels, so that the identification process can be done more quickly.

### 8) Setup Template

This process aims to set a data template in the database of the inserts of new data, update data and delete the data.

### 9) Identification Using Template Matching Method

This process aims at checking compatibility of data input image with the image template using template matching methods.

## IV. IMPLEMENTATION AND EXPERIMENTS

The experiment of the research is using various type of object shape. The purpose of the experiment is to know how suitable the method to identify the object based on the shape. The data is produced by drawing the image of shape object using Photoshop Application. The image data is on various conditions. On the first experiment we use the rotated image, the rotate scale start on 5 degree until 180 degree by increase 5 degree for each rotate scale. To prove the method is suitable on many conditions image, we also used various image scale of template image.

Testing the identification type of two-dimensional figure system using image master data templates created manually through Photoshop Application to obtain images square shape, rectangle, triangle and circle. Image size master data template used the half size of the background, background size of 300 x 300 pixels and the background color is white and the absence of noise in the picture.

### A. Testing Using Rotated Inputted Image

The purpose of this test is to determine the degree of slope that still fit on the master image and the influence of an object on the slope of accuracy in recognizing the object.

TABLE I  
ROTATION TEST RESULTS

Data Input	Master Data				Information
	Square	Rectangular	Circle	Triangle	
Square 5°	16%	1%	7%	3%	TRUE
Square 10°	11%	1%	7%	3%	TRUE
Square 15°	8%	0%	7%	3%	TRUE
Square 20°	6%	3%	7%	2%	FALSE
Square 25°	6%	3%	7%	2%	FALSE
Square 30°	7%	3%	6%	3%	TRUE
Square 35°	5%	2%	3%	3%	TRUE
Square 40°	7%	2%	3%	4%	TRUE
Square 45°	6%	2%	0%	3%	TRUE
Square 50°	6%	2%	3%	3%	TRUE
Square 55°	7%	2%	4%	3%	TRUE
Square 60°	7%	2%	6%	3%	TRUE
Square 65°	8%	3%	5%	3%	TRUE
Square 70°	8%	3%	7%	3%	TRUE
Square 75°	8%	0%	6%	3%	TRUE
Square 80°	10%	1%	7%	3%	TRUE
Square 85°	10%	1%	7%	3%	TRUE
Square 90°	100%	7%	14%	14%	TRUE
Square 95°	19%	1%	8%	4%	TRUE
Square 100°	11%	1%	7%	3%	TRUE
Square 105°	8%	0%	7%	3%	TRUE
Square 110°	6%	3%	7%	2%	FALSE
Square 115°	6%	3%	6%	3%	FALSE
Square 120°	7%	3%	6%	3%	TRUE
Square 125°	5%	2%	3%	3%	TRUE
Square 130°	7%	2%	3%	4%	TRUE
Square 140°	6%	2%	3%	3%	TRUE
Square 145°	7%	2%	4%	3%	TRUE
Square 150°	7%	2%	6%	3%	TRUE
Square 155°	8%	3%	5%	3%	TRUE
Square 160°	8%	3%	5%	3%	TRUE
Square 165°	8%	0%	6%	3%	TRUE
Square 170°	10%	1%	7%	3%	TRUE
Square 175°	19%	1%	8%	3%	TRUE
Square 180°	100%	7%	14%	14%	TRUE

The rotation of Image object that has a pixel size that is the same length and width and has a number of side more than four, for example, the square has a fairly high degree of accuracy due to changes in each pixel is not too big, so that the rotation of any object can still be identified with the right. Square accuracy rate of 88.8% accuracy.

### B. Testing Inputted Image with Changing Threshold Value

The purpose of this test is to record the effect of the threshold value to the degree of accuracy using template matching methods.

TABLE II  
RESULTS OF TESTING CUSTOM THRESHOLDING VALUE

Threshold	Master Data Rectangular Size 178px X 92px				
	Data Input				Master Data
	Rectangular 150 x75 Fill	Rectangular 5°	Rectangular 15°	Rectangular 25°	
25	-	-	-	-	-
50	-	-	-	-	-
75	-	-	-	-	-
100	40%	-	-	-	-
125	40%	2%	2%	-	-
150	40%	13%	4%	2%	100%
175	40%	9%	4%	3%	100%
200	40%	11%	4%	3%	100%
225	40%	11%	4%	4%	35%
250	40%	12%	5%	3%	74%

The thresholds are used to adjust the brightness contrast of the image object. Threshold values may affect the accuracy of matches on the input image with the image of the master template. The effect of changes in threshold value on the average accuracy rate is 3% and a threshold value which has the highest degree of accuracy is 200. control the

### C. Testing Image Input with Comparing Various Types of Master Data Settings

The purpose of this test is to record the effect of the large number of master image data on the level of accuracy.

TABLE III  
RESULTS OF TESTING WITH MANY TYPES OF MASTER DATA





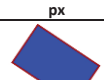


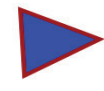
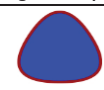
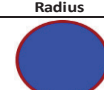

Data Input	Master Data				Information
	Template 1	Template 2	Template 3	Template 4	
 Square 128x128 px	Square	Rectangular	Triangle	Triangle 90°	TRUE
	66%	17%	17%	17%	
 Square 128x128 px 63°	Square 65°	Square 60°	Square 70°	Square 55°	TRUE
	58%	43%	24%	19%	
 Square 100x100 px with radius	Square	Rectangular	Rectangular 90°	Triangle	TRUE
	67%	18%	18%	17%	
 Rectangular 200x125 px	Rectangular	Square	Triangle 90°	Circle	TRUE
	32%	21%	21%	8%	
 Rectangular 200x125 px 33°	Square 50°	Rectangular 25°	Triangle 30°	Square 80°	FALSE
	12%	12%	9%	9%	
 Rectangular 200x100 px with radius	Rectangular	Square	Triangle 90°	Rectangular 5°	TRUE
	33%	18%	18%	14%	

TABLE III  
RESULTS OF TESTING WITH VARIOUS TYPES OF MASTER DATA (CONTINUE)







Data Input	Master Data				Information
	Template 1	Template 2	Template 3	Template 4	
 Triangle 83x83 px	Triangle	Triangle 5°	Square	Triangle 125°	TRUE
	40%	16%	15%	14%	
 Triangle 83x83 px 87°	Triangle 85°	Triangle 90°	Square 85°	Triangle 80°	TRUE
	34%	15%	15%	12%	
 Triangle 120x120 Radius	Square	Square 85°	Circle	Square 10°	FALSE
	25%	14%	13%	11%	
 Circle 125x125 px	Circle	Square	Square 85°	Square 10°	TRUE
	77%	27%	14%	11%	
 Circle 32x32 px	Square 10°	Square 80°	Square 85°	Circle	FALSE
	16%	16%	16%	13%	

A large number of image data master templates can affect the accuracy of the object because the object input compatibility compared with the type or condition of the first master template image does not have a great match, it will be a continuous comparison with the same type but different conditions. So the increasing number of existing master template picture makes the selected matching more suitable. The test results can be concluded that the 72.7% rate of data compatibility with template master 108.

#### D. Testing Hand Drawn Image Objects

The purpose of this test is to record the level of accuracy and the ability to recognize an object identification system using a hand sketch image.

TABLE IV  
RESULT OF TESTING HAND DRAWING IMAGE OBJECTS

Data Input	Master Data				Information
	Template 1	Template 2	Template 3	Template 4	
 Rectangular Ambang 50	Rectangular 175°	Square	Rectangular 170°	Square 65°	TRUE
	30%	15%	13%	12%	
 Triangle Ambang 50	Triangle 120°	Triangle 110°	Triangle 105°	Triangle 125°	TRUE
	27%	14%	10%	10%	
 Circle Ambang 50	Circle	Square	Square 85°	Square 10°	TRUE
	71%	28%	13%	12%	
 Square Ambang 75	Square 85°	Square	Triangle 175°	Square 80°	TRUE
	46%	20%	15%	15%	

The object images obtained in real time through the camera image processing to be done right, so as to obtain results that object to avoid the noise. The object images obtained from

hand drawing does not have a neat line and size are not clear, with the many of master template image data, then the object can be identified with a fairly high degree of accuracy. Total percentage match with the input object image object data master template image at 100%.

## V. CONCLUSIONS AND SUGGESTIONS

### A. Conclusion

The conclusion of this study is to successfully design and develop the system of identification of the type of two-dimensional figure from digital image with a template matching method (NCC) by measuring the level of accuracy of identification suitability and produce results that correspond to the inputted image. The success of the system can be seen from the test results match the accuracy of object image object image inputted with a data template by using template matching 82.9%. A fairly high degree of accuracy of this method is affected by several factors such as the large number of data types and conditions of the object master image, the difference between the input image pixel size with master image, and the addition of the appropriate image processing.

### B. Suggestion

Some suggestions that can be used as a performance improvement of image identification systems form is as follows.

- 1) The system can be added several image processing that can increase the level of accuracy of the template matching method, such as adding a filtering process to remove noise in the image and the object.
- 2) The system can recognize objects more than one object in the image so that the quality of the identification system can be improved by knowing more complex objects with added edge detection method.
- 3) The system can recognize objects in real time so that the identification process can be processed more quickly without having to import images and can identify the real objects that exist around, by using additional webcam device.

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# **E-learning and Education Technology**

# A New Stance of Learning Based On Cloud Computing Characteristics to Solve Education Problems

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**Abstract**— Cloud computing has arisen become one of new technology that offers many advantages with its own characteristic for services. This paper discussed about using cloud computing for learning process. We start the discussed with the advantages of cloud computing for education. Based on the concept and theory we proposed a learning model based on cloud computing environment, then figured out what kind cloud architecture fit with this model, and we found that role of government is very important when implements cloud computing for educational system, it gives more power to ensure the system will be success. We also discussed about the impact of this new cloud educational system for users and stakeholders that can change the way of learning.

**Keywords**—*learning, cloud computing; model; architecture; impact*

## I. INTRODUCTION

At present cloud computing is one of the newest information and communication technology development based on the internet connection. It allows information technology and systems to be delivered and used externally over the Internet. It is a new technology for enabling convenient to share a pooling of configurable computing resources, the technology includes networks, servers, storage, applications, and services. It can be rapidly provisioned and released with minimal management effort or service provider interaction.

The convenient makes this technology become recently trend in information technology (IT) field that moves computing and data away from desktop and portable PCs into large data centers that centralized at other place based on internet, it refers the services will through internet as well as actual cloud infrastructures. It means the hardware and systems software in the data centers provide these services via internet [1][2].

Cloud computing has come out as a new innovation of Information Communication and Technology (ICT) with its characters. The advantages of cloud computing are sharing

infrastructures and applications across all the world, make ICT investment more efficient and effective, and it is believed can immensely reduce IT investments.

For educational, it has been widely used in education (cloud education), especially when the advantage can share ICT infrastructure and applications, it makes educational resources is more effective and efficient. It will help narrow down the gap education quality in different areas within a nation. [3].

Cloud education may yield new learning scenarios where ubiquity, advanced online tools and collaboration come together to create innovative opportunities for education. But on the other hand, cloud computing brings new risks when compared to the conventional IT model such as security, performance, or interoperability that now have to be considered [4].

In this study, we discussed how cloud computing can accelerate to increase education quality. To find the answer, we start the discussed from the advantages cloud computing for learning, the impact of cloud computing environment for learning's users such students, teachers, and also for school and government, parents, society and so on as stakeholders, even understanding the culture changed and the new way of learning. At the end, we discussed about the future challenge of cloud computing to take in educational system.

With all of this, we will find out how the new perspective and the new stance of cloud environment can increase quality education and also help solve education problems.

We organized this paper as follows. Section 1 explains the background of writing this paper. In section 2, elaborates the new feature of cloud computing and cloud computing for education. Then in section 3, presents a net stance cloud computing for education, such of architecture model of learning and learning model based on cloud computing environment. Section 4, discusses the impact the system for users, stakeholders, and environment. Last, section 5 will provide conclusion comments of this study.

## II. CLOUD COMPUTING FOR LEARNING

### A. New Feature of Cloud Computing

Cloud computing integrates massive systematic resources and provide computing resources for users by providing services and they can access information as they need by any equipment anywhere. Cloud computing also uses shared infrastructure, even if more IT resources are added, the management cost will not change significantly, and this reason has made cloud computing become a hot trend of IT structure currently.

Therefore cloud computing shows us the advantages as the new features of excellence service characteristics [5].

*Virtualization*, it makes users get services from anywhere and anytime by using all kinds of terminals and devices, the resources requested is from "cloud" but not fixed and shaped entity because the applications are executed at somewhere else. So users do not need to know and worry about the location, users just need the devices such notebook and mobile phone to realize what be needed.

*High reliability*, the "cloud" measurement applies such as multi-copies data fault-tolerant and computing node double replacement to guarantee high reliability of service, using cloud computing is more reliable than using local computer.

*Versatility*, cloud computing is not directed against particular application, with support of "cloud", you can make tens of thousands of applications, also can support different applications at the same time.

*High expandability*, the scale of "cloud" can be adjusted dynamically to meet the needs of increased scale of applications and users.

*Service on demand*, the "cloud" is just like a big pool of resources, you can buy what you want and the "cloud" can be provided as a serviced or billed just like water, electricity and gas.

*Extremely cheap*, we can build "cloud" by using extremely cheap node because of the special fault-tolerant measures of cloud. The automatic and centered management allow lots of enterprises be free from the high cost of data center, the versatility of cloud helps the utilization ratio of resources increase much higher than traditional system.

*Data and information sharing*, cloud computing as a tool for sharing data and information for resources that make more efficient and effective in many aspects, it also has wider access services across country as there is supporting equipment.

To integrate computation and storage resources as learning services, cloud computing has been evolving as a key computing platform for resources' sharing that includes infrastructures, software, applications, and business processes.

*Accessibility and availability*. Cloud computing is based on internet, it will be easy to access at anytime and anywhere to get data and information as needed.

A further benefit is that availability for education services may be higher with less downtime due to the superior resources and skills available to cloud providers. Users

increasingly depend on online services for learning and assessment strategy should allow the best possible availability

*Economic*, cloud computing is significant for cost reduction, it can be available at a fraction of the cost that traditional IT services cost, upfront capital expenditures eliminated, and reduced IT administrative burden.

Cloud computing will also reduce investment for ICT in undeveloped areas. With cloud computing, infrastructure are shared across a wide area, makes it easier for users to get the data and information as needed, while not reduce the quality of services provided.

*End user satisfaction*. For end users, apart from better availability, there are other clear benefits of cloud-based services, particularly evident with the range and variety of new applications being provided, and it can also keep applications up to date.

As we know, cloud computing provides safe, fast and convenient data storage and network computing services based on the internet, so it will based on open standards and services. The applications and principles of cloud computing technology in the educational promoted the new coming of era that be called cloud education.

### B. Cloud Education

There is many difference between traditional computing and cloud computing as shows at Table 1 [6].

**Table 1.** Comparison Traditional Computing and Cloud Computing

Model	Traditional Computing	Cloud Computing
Acquisition	<ul style="list-style-type: none"> <li>• Buy Assets</li> <li>• Build Technical Architecture</li> </ul>	<ul style="list-style-type: none"> <li>• Buy Service</li> <li>• Architecture Included</li> </ul>
Business	<ul style="list-style-type: none"> <li>• Pay for Assets</li> <li>• Administrative Over Head</li> </ul>	<ul style="list-style-type: none"> <li>• Pay for use</li> <li>• Reduce admin function</li> </ul>
Access	<ul style="list-style-type: none"> <li>• Internal Networks</li> <li>• Corporate Desktops</li> </ul>	<ul style="list-style-type: none"> <li>• Over the internet</li> <li>• Any device</li> </ul>
Technical	<ul style="list-style-type: none"> <li>• Single Tenant, Non Shared</li> <li>• Static</li> </ul>	<ul style="list-style-type: none"> <li>• Multi-tenant, scalable, elastic</li> <li>• Dynamic</li> </ul>
Delivery	<ul style="list-style-type: none"> <li>• Costly, lengthy deployments</li> <li>• Land and Expand Staffing</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce deployment tune</li> <li>• Fast ROI</li> </ul>

To develop good quality of education, resources are needed. Educational resources are such as qualified teachers, teaching materials, teaching environment and financial supports. To acceleration our efforts to get good education, resources must be managed and provided in effective ways.

Cloud computing can be used to manage these resources with its benefits, shown in table 2.

**Table 2.** Benefit of Cloud Computing for Educational Resources

Education Resources	Benefits
Institution	<ul style="list-style-type: none"> <li>• Optimizing resource allocation</li> <li>• Decreasing the needed for in-house IT staff</li> <li>• Short implementation process</li> </ul>
Teacher and Student	<ul style="list-style-type: none"> <li>• To raises computing resource accessibility and availability, even in underserved districts</li> <li>• Adds mobility</li> </ul>



Administrator	<ul style="list-style-type: none"> <li>• Standardizing applications and processes</li> <li>• Provisioning software, resources and management of data</li> <li>• Lightens the burden of software version control</li> </ul>
Module, books and curriculum	<ul style="list-style-type: none"> <li>• Increasing availability and integrity of data, applications and research/learning materials.</li> <li>• Making delivery schedule of assignment instructions, study materials, syllabi or software.</li> <li>• Large capacity</li> </ul>
Infrastructure and technology	<ul style="list-style-type: none"> <li>• Based on internet</li> <li>• Bringing greater virtualization</li> <li>• To Amplifies application &amp; computing performance</li> <li>• To reduces client application and system resource footprint</li> <li>• Improving server and data storage capacity</li> <li>• To raises server utilization and software licenses, reducing purchasing requirements</li> </ul>
User and Institution	<ul style="list-style-type: none"> <li>• Cutting resource management costs and infrastructure cost (hardware, application) including power and cooling</li> </ul>

The major purpose of cloud computing for education is providing a safe, stable and easy to expand cloud computing platform. The ease to put the courses, needing large amount of resources computer in the platform for educational institutions and allows students to learn independently outside the classroom, set the learning schedule by themselves, and perform self-study.

### C. E-learning with Cloud

e-Learning is an internet based learning process, using internet technology to design, implement, select, manage, support and extend learning, which will not replace traditional education methods, but will be greatly improve efficiency of education as e-learning has a lot of advantages like flexibility, diversity, measurement, opening and so on.

With cloud technology, e-learning will have many advantages. Mendez [7] illustrates that in traditional web-based learning mode, system construction and maintenance are located inside the educational institutions or enterprises, which led to a lot of problems, such as significant investment is needed but without capital gains from them, which leads to a lack of development potential.

In contrast, cloud-based e-learning model introduces scale efficacy mechanism, i.e. construction of e-learning system is entrusted to cloud computing suppliers, which can make service providers and users to achieve a win-win situation.

The cloud-based environment supports creation of new generation of e-learning systems, able to run on a wide range of hardware devices, while storing data insides the cloud. For cost, it will be more efficient, many of existing e-learning systems are not dynamically scalable and hard to extend, because integration with other e-learning systems is very expensive. Cloud computing will solve kinds of problems.

## III. A NEW STANCE OF LEARNING BASED ON CLOUD COMPUTING

### A. Basic Principles of Cloud Education

Cloud computing constructs a free and extensive space, when applied for teaching, so we must ensure learners' autonomy and improve the effectiveness of learning.

Therefore, in the process of construction, we should pay attention to the reasonable construction of the environment of education. We should follow the following basic principles, i.e. [8]:

- *Learner-Centered*, learners-centered is the core principle of cloud computing environment, before educational construction. We should analyze learners' requirements; determine the appropriate course content, teaching recourses, and design appropriate teaching activities.
- *The effectiveness of teaching resources*, in the teaching of cloud computing, most of the teaching resources on the cloud. For all kinds of those resources, we need careful for screening, try to choose some stable network resources, and prevent some web links lapse because of long time linking. At the same time, teaching resources should be timely updated to continually meet the learners' requirement.
- *The rationality of navigation settings*, no matter about teaching resources, or reference resources after teaching, all should be rendered in the appropriate location. Each resource module structure should be unified, clearly navigated and easy for learners to quickly locate and browse, to prevent them
- *Collaborative and sharing e-Learning*, collaborative and sharing is also the core concept of cloud computing environment. The collaboration between departments, the interaction between teachers and students and the experiences exchanging between the parents, all fully reflect this principle.

### B. Hybrid Cloud Educational System by Government Supervision and Responsible

There are three cloud educational system (CES), namely: (i) *centralized cloud educational system*, in this system, link among many school data centers become scatter but close with large enterprise cloud data centers; (ii) *distributed cloud educational system*, many school data centers are directly connected with each other, but not directly with large enterprise data centers; and (iii) *hybrid cloud educational system*, school data centers and many large enterprises cloud data centers highly interrelated and directly connected, one school can share information resources with others and make use of many services from enterprises [9].

In this study, researchers proposed the concept of *hybrid cloud educational system by government controlling*. With this concept, a government will develop the main central architecture of learning model and resources supported, but still give a space to school and a teacher to create their own learning style as long as fit with government policy, regulation, and goals.

### C. Cloud Educational System Architecture

The concept of *hybrid cloud educational system by government controlling* give a specific character in architecture model, shows at figure 1. Because government has role for all the system, from develop system, maintenance resources, readiness of users and environment, policy and regulation also evaluation.

Layer C6, *user interface layer*, is the entry-point into learning in cloud. It provides interface function and interface interaction, including Web UIs and client software. These layers also represent users and stakeholders of learning model such as government, school, teacher, student and parents.

Layer C5, *multi access* this layer responsible for managing access to cloud education services and related to: type of devices and presentation model. This study is adopted multichannel access [10] concept that allows a variety of services model can be access all services through various devices (such as: mobile phones, smartphones, computers, and so on) and variety of presentation model (such as: mobile applications, desktop applications, and so on). The goal of this concept to increase the availability of service model on Cloud Education until users able to consume its service without any constrained [11].

Layer C4, *application program interface layer* can guarantee model's scalability. Because of the diversity of the existing application system, some applications system cannot satisfy all the needs of customers, but the model must provide the interface can be extended for the feature.

Layer C3, *education middleware layer* is the core layer, because it is the basic business platform. This layer is different from existing, and all information attached to it on different computing node including ordinary file and database. So, all application systems on the middleware layer have the feature: distributed, and fault tolerance and high expansibility.

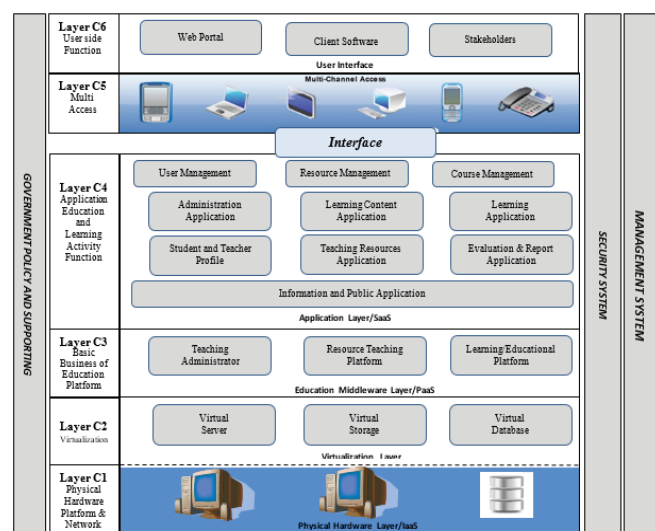


Fig. 1. Cloud Education Architecture [12]

Layer C2, *virtualization layer* with the feature [13]: dynamic configuration, distributed deployment, learning process measurement realizes the five characteristics of cloud computing. The goal of virtualization layer is to break completely information islands based on existing regional

through the distributed technology and virtualization technology.

This layer also consists of three parts: virtual servers, virtual storages, and virtual databases. Virtual servers are the logic units for physical server, these virtual servers can provide computing on demand, high availability and data recovery according to computation resources. Virtual storages will be the abstract form of storage hardware, and the way to separate the storage hardware by virtual storage realizes the function: automatic copy, failure role rate. Virtual Databases provide queries for data set with Web services. Virtual databases are not in the traditional relational database, but high available storage engines, to ensure that eventual consistency as the prerequisite, extended system availability and expansibility.

Layer C1, *physical hardware layer* is a basic platform in model, including servers, storage equipment, and network equipment are centralized by government, so this layer mostly under government control and maintenance with all potential for distributing services with computing characteristics and scalable.

*Management system* mainly watchers physical condition, virtualization software, hardware and software, open API. Management system can enhance the safety of the software platform.

*Security system* includes identity authentication and authorization, single point login, virtualization software and hardware access control and audit, the education middleware and open API access control.

*Government policy and supporting*, the strategy for developing countries to catch up the gap quality education from developed countries, the implementation of online teaching system based on cloud education must be mainly coordinated by government, because the government has power and many resources to success this program.

#### D. Learning Model

As we see at figure 2, shows us three section in the model, i.e. main or core business; (ii) publication business; and (iii) supporting learning business.

*Main or Core Business*, this is a section of learning process services. This section as a bridge for learning process interaction between teachers, students and school also government. It provides the stages of learning process services such input, process, output and evaluation of learning process.

*Publication Business*, this section is very important as information center for users such schools, teachers, students and parent also society to know progress of learning process as needed.

*Supporting Learning Business*, this section contents for learning supporting application, such discussion forum, inbox, sharing knowledge, information feedback or government policy feedback, etc.

Notice for this model is full supporting from government for mainly infrastructure, policy maker and institution who responsible for successful program guarantee.

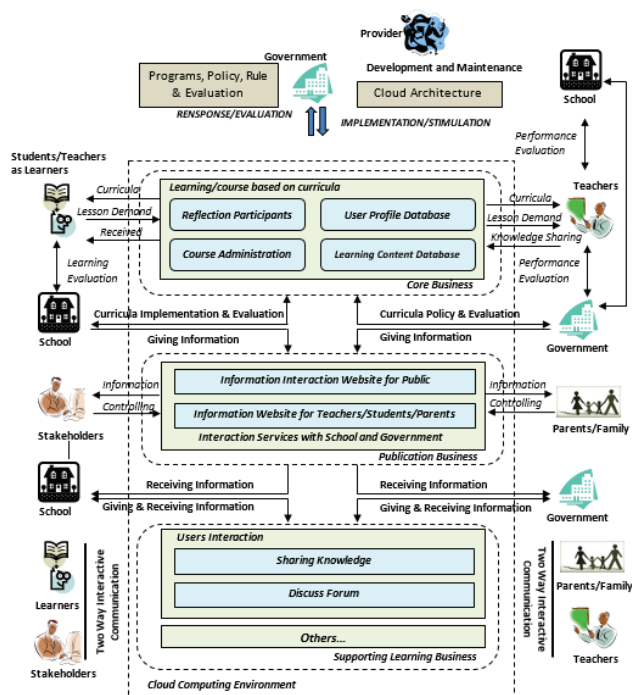


Fig. 1. Learning Model Based on Cloud [12]

This model also fit with all level of education from early childhood until university, even this model based on distance learning, but still open for face to face learning. All can be fit with all level of education, needed and environment of users and stakeholders.

#### IV. DISCUSSED THE IMPACT OF LEARNING BASED ON CLOUD COMPUTING ENVIRONMENT

##### A. Environment Changed

The model and cloud architecture that propose has impact with educational environment.

*Centralized education by government*, government has more power to control education matter, running and evaluation education program and give the best policy for solving problem based on valid centralized data and information.

*Centralized educational resources*, cloud computing has advantage for sharing virtual infrastructures. Government builds a main cloud computing infrastructures and develop serviced centralized in the center, while others as end users such as schools, teachers, pupils, parents and the community simply use the application as services with any simplicity at the level of a single web.

Easy and serviced centered with flexibility time and place are making the learning process become desired. The more ease when government makes a learning templates for end users, it make easier to use application in the learning

process, as well as learning material replacement, system interaction, system evaluation, and so on.

*Autonomy support for learning*, cloud computing technology has yield the new way of teaching, such give more autonomy support for teaching, but not autonomy suppression. Feeling autonomous is not the same as feeling independent of others, autonomously initiated actions can be initiated either independently or in response to a request of significant others. The need for autonomy which it finds where the origin of the inherent desire people has to be causal agent, to have volition, and act accordance to their own selves senses.

*Flexibility combined of virtual and face to face class room*, cloud education will be moved the place for learning to virtual class mostly, so learners can do others many good things for their selves and educational resources will be more effective and efficient to ensure give a good quality of education service and widely services for users.

As we know, still there are some events cannot replace face to face learning or directly meeting between teacher and user, school and teacher, school and student, and so on. Education institution under government governance should manage it with properly of those meeting to achieve learning goal. For example examination, advisory, practical and so on.

##### B. Users Impact

*Government supporting and responsible*, government can use their influences and power such as funding, development supporting infrastructure, socialization and publishing, human resource training and policy also to guarantee all the system will be running like a planning based on good evaluation.

*School as central of education services*, to manage education resources become more effective and efficient for ensure quality assurance of education.

Besides helping government policy and program, school also have a duty to control learning process between teachers and students also develop information system for stakeholders for accountability.

*Acceleration teacher quality*, a teacher has a task to fill up the content in online teaching system, evaluate learning process, learning process report, and also using this system for upgrading of teaching quality and increasing mutuality of teacher mate relationship for knowledge shared.

It shows there is a connection between teachers and several indicators such digital content, skills and teachers usage. This system will help teachers to increase their capability.

For teachers have feel autonomous is when they don't bind by tight schedule for teaching and evaluation, otherwise they also have more times and activities for increasing their capability and knowledge for their professionalism without leaving responsibility.

*Student as central learning*, learners-centered is the core principle of cloud education construction. Before implement the educational construction, we should take analysis of learners' requirements; determine the appropriate course content, teaching recourses, and design appropriate teaching activities. The technology gives all educational stakeholder flexibility of time and place to accessibility, especially for



students, they can arrange their own study planning with their capability and their own supporting.

For students have feel autonomous is crucial to experience their engagement in learning as a self-chosen act that reflects their own authentic needs and values. In other words, teachers and students who experience autonomy in their willingness to engage in learning, experience this willingness as unpressured.

*Parent attention*, good education for student should be there is cooperation between school, teachers and parents. This cooperation will make a student feels more comfortable, openness, happiness, and the important thing is a student feeling about care form others.

Using cloud computing will make easier for parents to determine treatments for their children in learning process. Obviously with this ease parents will be more active for understanding, helping the learning.

*Control of society*, because of the technology based on internet system and ease of use of cloud computing for end users, then society will easily has accessed to know about learning process their children at school. In this era, community participation is very important for education, not just only the government, because a good education when education is fully supported by sincerely and attention of community, the result will be much better.

## V. CONCLUSION

From the discussed, this educational learning system based on cloud computing environment will become great solution for education problems, such as less educational resources, limitation education funding, limitation of education infrastructures, and difficulty of managing learning serviced.

The model and cloud architecture of a new educational system based on cloud computing shows us that government's role has important placed to the system, it shows at learning model and cloud architecture that proposed by researchers. Role of government not only to establish and maintain main infrastructure but also keep all the educational resources well, and supports it with policies and rules for the success of the system.

Learning based on cloud computing initiates the establishment of cooperation between stakeholders and users for the success of the learning process is carried out, in order to improve the quality of education.

The educational system based on cloud under government governance will give more advantage for the success of this program and fit with characteristic of cloud computing itself. Government has power and authorized to ensure this program running well and prepare all supporting matter and maintenance it. Users and stakeholders also have safety feeling to use the system because of the guarantee from Governance and this will increase trust of the system.

Developing countries can use this strategy to catch their gap about education quality with developed countries by using cloud computing advantages.

## ACKNOWLEDGMENT

This paper dedicates for developing countries as an input and idea sharing for acceleration strategy to increase education quality with cloud computing technology.

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# Ability evaluation of learners in the collaborative e-learning recommendation environments

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**Abstract**—In the traditional e-learning recommendation systems, the individual ability of learners is applied to complete the evaluation of learners' learning outcomes. Moreover, the collaborative ability of learners is often used to assess the collaborative performance of learners in the collaborative learning. However, it has not been deeply considered how to combine the individual ability estimation of learners with collaborative ability evaluation of learners in the collaborative e-learning recommendation environments. In this research, an ability evaluation model which can solve the above problem is proposed to better promote the learners' learning. The model applies the maximum likelihood estimation to estimate the individual ability of learners, and two types of indexes which include the collaborative performance and the peers' assessment are selected for the collaborative ability evaluation of learners. The research results show that the proposed model cannot only effectively estimate the individual ability of learners, but also better evaluate the collaborative ability of learners which will reflect the collaborative performance of learner. Meanwhile, compared with the individual learning, the results also indicate that the collaborative learning is more beneficial to the learning of learners to some extent.

**Index Terms**—E-learning; ability evaluation; recommendation system; collaborative learning

## I. INTRODUCTION

In the past few decades, traditional classroom education has been unable to meet the requirements of learners because of the rapid spread of information on a global scale [1]. As a new method of knowledge sharing, e-learning is gradually changing the learners' understanding for learning so as to make our learning process more convenient and simpler. Because the e-learning can provide the learners with learning opportunities at anytime and anywhere, it becomes extremely attractive for learners [2]. Meanwhile, the collaborative learning, which serves as an important part of e-learning, has been widely researched by many researchers.

Since the learning ability of every other is different, it is often considered as a very important role to assess the learning effects of learners in the learning process. Since traditional e-learning recommendation systems support the one-way knowledge transmission, it leads to independent learning among learners and makes learners not receive the timing learning assistance. The researchers usually use the individual ability of learners as an evaluation factor of learning outcomes in e-learning recommendation systems [3].

Meanwhile, the collaborative learning is defined as a learning activity which learners can work in the group or team to effectively achieve their learning goals [4]. In the collaborative learning, the learners can communicate with each other to share their knowledge which they have obtained. The collaborative interaction often happens among learners and between teachers and learners, which is served as a key factor in the learning process. Since good collaborative learning depends on good collaborative mechanism and good collaborative process evaluation mechanism, the collaborative ability of learners which is associated with the collaborative interaction is usually considered as an evaluation index in the collaborative learning environment [5].

However, the previous researchers don't realize that synchronously considering the individual ability estimation and the collaborative ability evaluation of learners will be able to better enhance their learning effectiveness in the learning. Besides, including the collaborative learning in an e-learning recommendation system has not been looked into adequately owing to the complexity of interaction in the collaborative learning. Hence, an ability evaluation model is proposed to estimate the individual ability of learners and evaluate the collaborative ability of learners at the same time in the collaborative e-learning recommendation environments in this paper. First of all, the collaborative e-learning recommendation environments are supplied to motivate the communication among learners so that they can have a convenient learning place, and it can also recommend suitable learning coursewares to them. Secondly, the maximum likelihood estimation [6] is applied to estimate the individual ability of learners for the following learning. Finally, two types of indexes including the collaboration level and the evaluation level are used to represent the learners' collaboration. Compared to the single ability evaluation method existed previously, the ability evaluation model in the paper can better guarantee the learning results of the learners.

The rest of this paper is organized as follows: Section II describes the design of the ability assessment model in the collaborative e-learning recommendation environments. And the implementation of the proposed model is presented in Section III, while Section IV reviews and analyzes the testing results. Finally, we give the conclusions and future works in



## Section V.

## II. MODEL DESIGNING

This section presents the ability evaluation model in the collaborative e-learning recommendation environments. Firstly, the overview of the proposed model is described in Section A. Besides, Section B depicts the estimation of learners' individual ability in the process of learning. And the evaluation of learners' collaborative ability is then described in Section C.

## A. Model architecture

The architecture of the proposed ability evaluation model, which includes the collaborative e-learning recommendation environments, the module of learners' individual learning estimation and the module of learners' collaborative learning evaluation, is shown as Fig. 1 [3]. In the collaborative e-learning recommendation environments, the learners can choose one courseware from the list of recommended coursewares and then start to learn it. And the learners can communicate with each other to share the knowledge they have obtained through the collaborative learning platform. In the process of courseware learning, the collaboration level of learners would be evaluated with the help of the module of collaborative learning evaluation. And the evaluation result of collaboration level can be feedback to them at regular intervals. After the learners finish the learning of the recommended courseware, the module of individual ability estimation can

estimate the individual ability of learners for the following learning. Meanwhile, the evaluation level from the learners' peers would be evaluated through the module of collaborative ability evaluation and the result can be feedback to them after they start to learn the new one.

## B. The estimation of learners' individual ability

In the existed individual ability estimation systems, there are two methods including the maximum likelihood estimation (MLE) and the Bayesian estimation, which are used to estimate the individual ability of learners [7]. In this model, the method used is the maximum likelihood estimation (MLE) because it is very easy to implement and the result accuracy which it produces also meets the requirements. The step for estimating the individual ability of learners is illustrated in Fig. 2 [7]. After the learners finish the recommended courseware, they need to answer some predesigned questions including the identity of the courseware learning. Then, the difficulty parameters of coursewares can be taken out in order to assess the individual ability of learners.

In the maximum likelihood estimation method used in the model, the likelihood function of learner's individual ability is illustrated as follows:

$$L(u_1, u_2, \dots, u_n | \theta_k) = \prod_{j=1}^n P_j(\theta_k)^{u_j} Q_j(\theta_k)^{(1-u_j)} \quad (1)$$

$$P_j(\theta_k) = \frac{1}{1 + e^{-D(\theta_k - b_j)}} \quad (2)$$

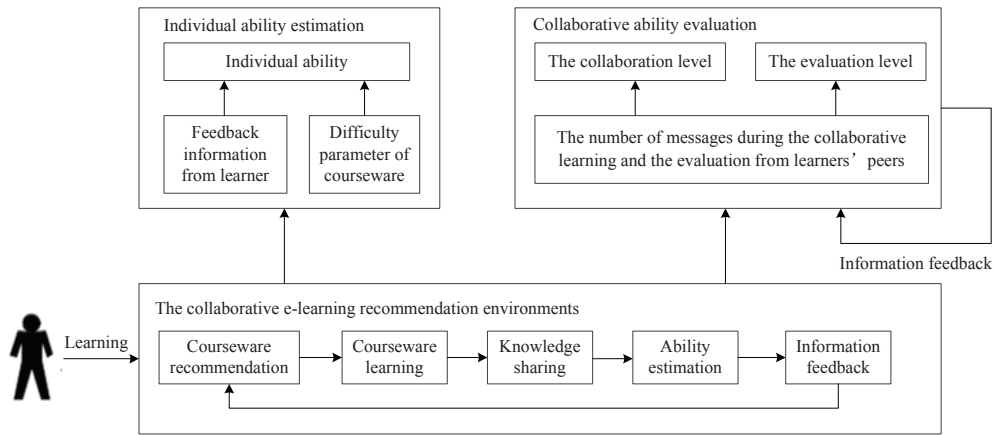


Fig. 1. The model architecture

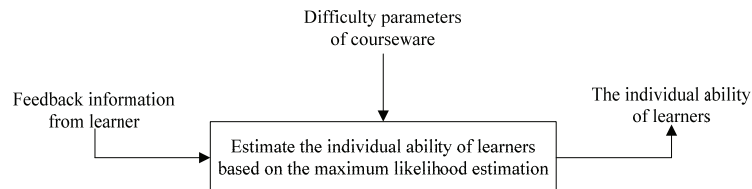


Fig. 2. The steps for estimating the individual ability of learners

$$Q_j(\theta_k) = 1 - P_j(\theta_k) \quad (3)$$

where  $u_j$  represents the answer of the  $k$ th learner about identity of the  $j$ th courseware learning.  $P_j(\theta_k)$  denotes the probability that the  $k$ th learner can completely understand the  $j$ th courseware at a level less than the ability level  $\theta_k$ , and  $Q_j(\theta_k)$  is the probability that the  $k$ th learner can not completely understand the  $j$ th courseware.  $b_j$  is the difficulty parameter of the  $j$ th courseware, while  $D$  is a constant 1.702.

To compute the accurate numerical value of learner's individual ability, the maximum value of (1) needs to be computed by using the Newton-Raphson (N-R) method [8], which is usually employed to solve the solution of nonlinear questions. The formula of N-R method is shown in (4), (5) and (6) below,

$$\theta_{t+1} = \theta_t - \frac{g(\theta_t)}{g'(\theta_t)} \quad (4)$$

$$g(\theta_t) = D \sum_{j=1}^n (u_j - P_j(\theta_k)) \quad (5)$$

$$g'(\theta_t) = -D^2 \sum_{j=1}^n P_j(\theta_k) Q_j(\theta_k) \quad (6)$$

Variable  $\theta_k$  ranges generally between -2.0 and +2.0. The learners with individual ability of -2.0 will be regarded as having the poorest individual ability, while those who with +2.0 having the greatest individual ability.

### C. The evaluation of learners' collaborative ability

In the model, the interaction frequency between the learners and the evaluations from the learners' peers will be regarded as the indicators of learners' collaborative ability evaluation. The indicator Collaboration\_level is applied to represent the interaction frequency between learners, while Evaluation\_level is used as an expression of the evaluations from the learners' peers.

1) *The indicator Collaboration\_level*: Since the researchers have shown that the interaction frequency between learners is closely linked to the collaborative initiative of learners, the Collaboration\_level will be used as an expression of learners' collaborative ability [4]. In order to better assess the indicator Collaboration\_level, two additional indicators, which includes the Level\_ask and Level\_answer, are introduced in the model [9].

The additional indicator Level\_ask is an expression of the frequency of learners' asking the question in the collaborative learning. The formula of this indicator is shown in (7) below,

$$Level\_ask = \frac{N_{thrd}}{\sqrt{(\frac{1}{n}) * \sum_n (N_{thrd} - \sum_n \frac{n * N_{thrd}}{N_{thrd}})}} \quad (7)$$

where  $n$  is the number of learners, and  $N_{thrd}$  is the number of questions asked by the learners in the process of collaborative learning.

And another additional indicator Level\_answer is applied to show the frequency of learners answering the questions, which other learners ask in the collaborative learning. The value of Level\_answer is updated by using the (8) below,

$$Level\_answer = \frac{N_{msg}}{\sqrt{(\frac{1}{n}) * \sum_n (N_{msg} - \sum_n \frac{n * N_{msg}}{N_{msg}})}} \quad (8)$$

where  $n$  is the number of learners, and  $N_{msg}$  expresses the number of answering the questions which other learners ask.

Finally, the value of the Collaboration\_level will be computed as shown in (9) below,

$$Collaboration\_level = \omega * Level\_ask + (1 - \omega) * Level\_answer \quad (9)$$

where  $\omega$  is an adjustable value in the range of 0 to 1. In our model, the Collaboration\_level is divided into five levels from "very poor" to "very good" according to the calculated value of (9). The five levels are used to quantify the indicator, where -2 is "very poor", -1 indicates "poor", 0 represents "medium", 1 indicates "good" and 2 is "very good". Since the two additional indicators can be updated in real time in the collaborative learning based on some data records, the indicator Collaboration\_level can also be computed in real time. In the collaborative learning of learners, some feedback rules are applied to feedback the Collaboration\_level to them in order to give them a better understanding of collaborative learning and promote their better participation in the following collaborative learning.

2) *The indicator Evaluation\_level*: In the collaborative learning, only using the Collaboration\_level to evaluate the collaborative ability of learners appears somewhat one-sided because collaborative learning is a team work. Then, the collaborative ability of learners will be evaluated from another point of view by applying the indicator Evaluation\_level [10]. Since the value of Evaluation\_level keeps pace with the acknowledgement of learners' peers, the indicator will be applied to get a more comprehensive understanding for the collaborative ability of learners.

After the learners finish the recommended courseware, they are required to answer some questions including the evaluation about their peers. The value of the Evaluation\_level is computed by using (10) below,

$$Evaluation\_level = \frac{(n-1) * V_{eva}}{\sum_{n-1} V_{eva}} \quad (10)$$

where  $n-1$  is the number of learners except the target learner in the collaborative learning, and  $V_{eva}$  is the evaluation value which the learner's peers give the learner.

The value of Evaluation\_level is divided into five levels from "very low" to "very high" which follow the 5-point Likert scale. There is a scale where 2 indicates "very high", 1 denotes "high", 0 is the expression of "medium", -1 means "low" and -2 represents "very low". After the learner starts to learn a new

courseware, the result of Evaluation\_level will be feedback to him/her so that he/she can know the evaluation given by other learners for collaborative learning.

### III. MODEL IMPLEMENTATION

Based on the model described above, the implementation of the proposed model will be shown below by applying the MyEclipse software. Meanwhile, the data produced in the collaborative learning of learners are stored in a database created by the MySQL server.

When the learners login into the system, the learning interface will be displayed for learners by selecting the option in the drop-down bar, which displays in the main interface. In the learning interface, there are two sub-interfaces including the courseware recommendation interface and the courseware learning interface by the multiple tabs. Fig. 3 shows the layout of courseware recommendation interface in which learners can look at the recommended coursewares in the specified courseware category based on their current individual ability. Then learners can input the courseware name that they select in the specified text field in order to view detailed courseware content in the courseware learning interface illustrated in Fig. 4.

In the courseware learning process of the learners, they can create the collaborative learning interface, which is revealed in Fig. 5 through the option in the drop-down bar in the main interface so that they can freely communicate with each other to share the learning experiences. In addition to learning

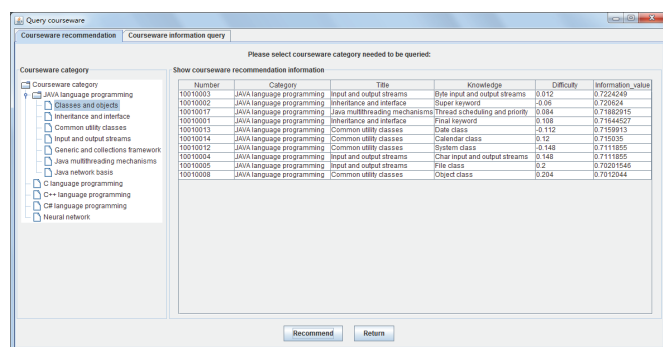


Fig. 3. The courseware recommendation interface

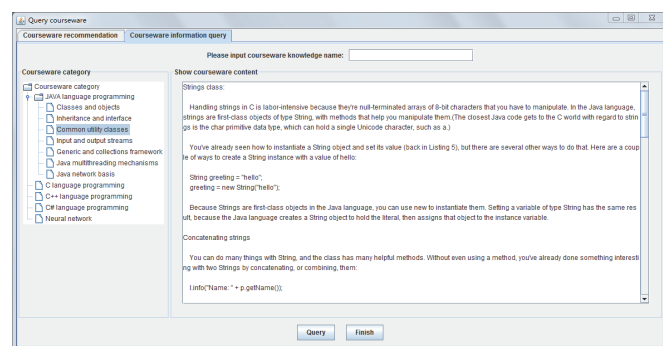


Fig. 4. The courseware learning interface

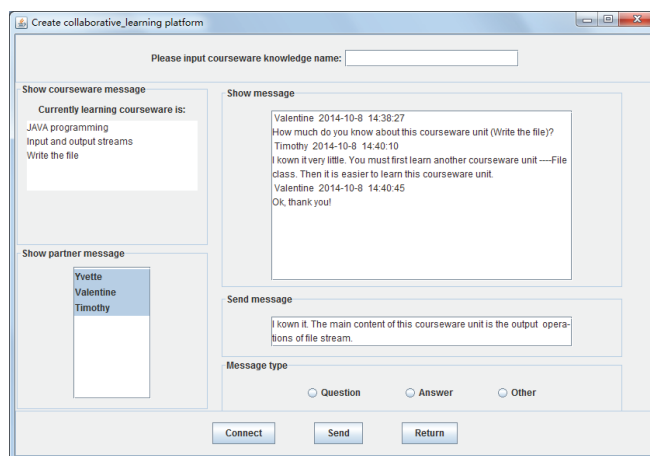


Fig. 5. The collaborative learning interface

collaboratively, learner can receive some feedback information according to the value of the Collaboration\_level in the collaborative learning process of learners and get other feedback information based on the value of the Evaluation\_level after learners start to learn another one. Besides, learners need to answer some predesigned questions through the information feedback interface shown in Fig. 6 for following courseware learning after finishing the recommended courseware learning.

### IV. THE EXPERIMENTAL RESULTS AND ANALYSIS

In order to verify the validity of the proposed model, there is an experiment inviting 67 college students who are about to study the predesigned coursewares. Meanwhile, among the 67 college students, there are 22 of them who are served as the control group to be involved in individual learning in order to test the module of learners' individual ability estimation, while the remaining students are served as the treatment group to participate in collaborative learning so as to test the whole model [11].

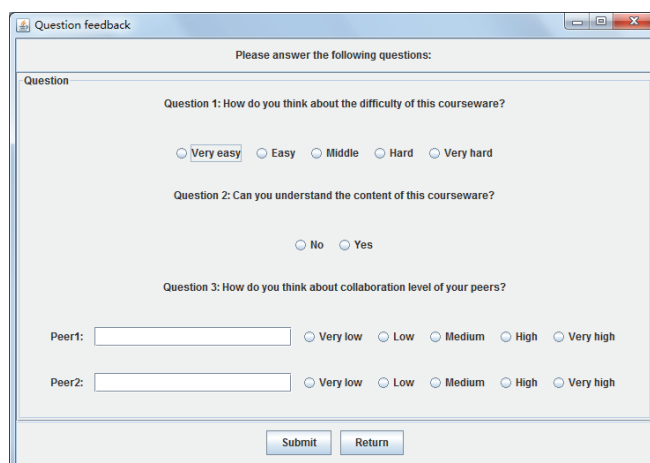


Fig. 6. The information feedback interface

### A. The verification of learners' individual ability

In the module of individual ability estimation, the individual ability of learners can be estimated based on the feedback of learners and the difficulty parameters of learned coursewares. Fig. 7 presents the adjustment process of learner A's individual ability in the control group. While the adjustment process of learner B's individual ability in the treatment group is illustrated in Fig. 8. It can be seen from the two figures that the individual ability of learners will be increased when they can completely understand the content of recommended coursewares. On the contrary, it will be decreased. So the proposed model can effectively estimate the individual ability of learners. Besides, Table I shows the final average individual ability of all learners in the control group and treatment group after they have finished the learning tasks. The experiment results imply that the collaborative learning has some advantages

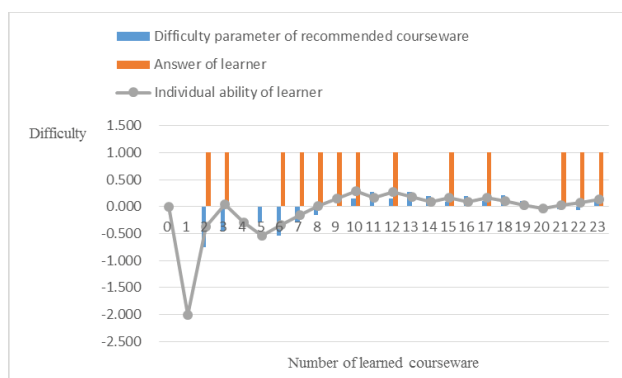


Fig. 7. The adjustment process of learner A's individual ability

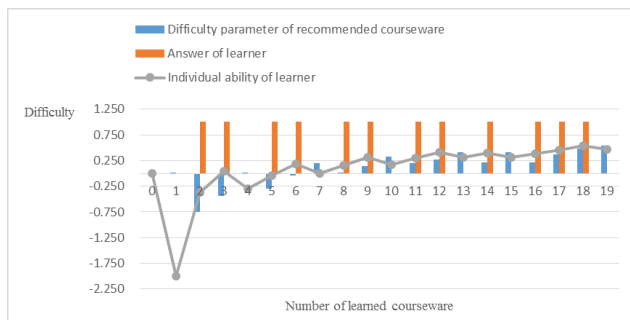


Fig. 8. The adjustment process of learner B's individual ability

TABLE I  
THE FINAL AVERAGE INDIVIDUAL ABILITY OF ALL LEARNERS

Learning mode	Comparison item		
	Number of learners	Average individual ability	Deviation
Individual learning in control group	22	0.519	0.0608
Collaborative learning in treatment group	45	0.730	0.0358

over the individual one in enhancing learning of learners because the collaborative learning can provide learners with the function of information sharing to enhance their learning about recommended coursewares.

### B. The verification of learners' collaborative ability

In the module of collaborative ability evaluation, the collaborative ability of learners can be evaluated in the collaborative learning process of learners. In the experiment, the learners who are arranged to test the whole model are divided into three groups. After all learners has finished the learning tasks, there are 1392 records about the Collaboration\_level and 887 records about the Evaluation\_level in the database. Fig. 9 and Fig. 10 show the collaborative ability evaluation of learners in the collaborative learning. Fig. 9 and Fig. 10 can be analyzed as follows:

1. The Collaboration\_level of learners mainly concentrates on -1, 0 and 1. It indicates that learners are very actively involved in the collaborative learning. Meanwhile, it implies that the effectiveness of learners' Collaboration\_level is better.
2. The value of learners' Evaluation\_level is largely -2 and 2. It indicates that the effectiveness of learners' Evaluation\_level is not ideal because it may be influenced by the subjective evaluation of learners.

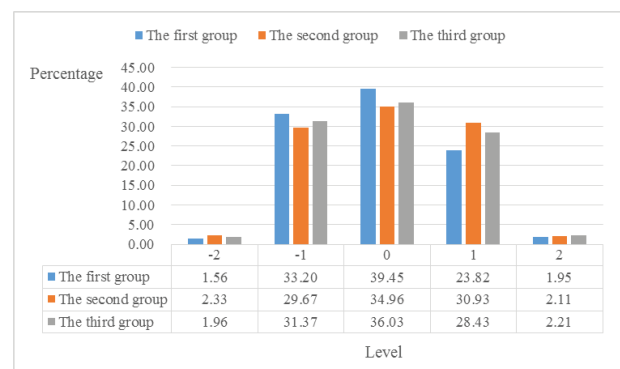


Fig. 9. The evaluation of learners' collaborative ability-Collaboration\_level

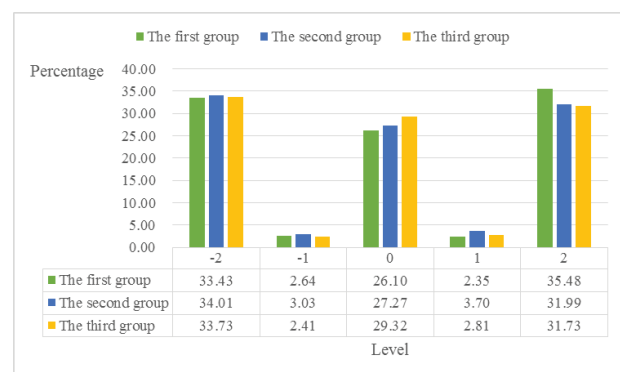


Fig. 10. The evaluation of learners' collaborative ability-Evaluation\_level

### C. The verification of satisfaction degree

In the experiment, the predesigned questionnaire answered by learners after they have finished the learning tasks is applied to evaluate the learners' satisfaction degree for the proposed model. The three predesigned questions and the learners' responses about them are listed in Table II. Question 1 is used to investigate the learners' satisfaction degree about the module of learners' individual learning estimation. Meanwhile, the learners' satisfaction degree about the module of learners' collaborative learning evaluation is investigated by Question 2. Besides, Question 3 is applied to determine whether the proposed model can better promote the learners' learning. Experimental results indicate that the learners' satisfaction degree about the proposed model is very high.

### V. CONCLUSIONS AND FUTURE WORK

Based on the experiment conducted, it can be concluded that the proposed model can successfully achieve the function, which it can synchronously estimate the individual ability of learners and evaluate the collaborative ability of learners. Besides, it can show that compared with the individual learning, the collaborative learning will be more conducive to the learning of learners from one aspect.

However, there is a problem that the indicator Evaluation\_level of collaborative ability evaluation, which may be easily affected by the learners' subjective feeling, results in the inaccurate evaluation results. So the prospective work is to establish some better evaluation indicators to more effectively reflect the collaboration of learners in the collaborative learning.

### ACKNOWLEDGMENT

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TABLE II  
THE LEARNERS' SATISFACTION DEGREE AFTER LEARNING

Question 1: Are you satisfied with the individual ability estimation mechanism provided by the proposed model in the learning process?					
Answer:	Very unsatisfactory	Unsatisfactory	Moderate	Satisfactory	Very satisfactory
Learner choices	2 (2.99%)	9 (13.43%)	20 (29.85%)	21 (31.34%)	15 (22.39%)
Question 2: Are you satisfied with the collaborative ability evaluation mechanism provided by the proposed model in the learning process?					
Answer:	Very unsatisfactory	Unsatisfactory	Moderate	Satisfactory	Very satisfactory
Learner choices	0 (0%)	8 (17.78%)	13 (28.89%)	14 (31.11%)	10 (22.22%)
Question 3: Can the proposed model better promote your learning about the recommended courseware in the collaborative e-learning recommendation environments?					
Answer:	Not at all	No	Not sure	Yes, but a little	Yes, absolutely
Learner choices	1 (2.22%)	5 (11.11%)	6 (13.33%)	17 (37.78%)	16 (35.56%)



# The Evaluation of User Acceptance of an E-Learning Application of Kolintang Musical Instruments

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**Abstract**— In earliest days, Kolintang instruments were usually played in the ancestor worshipping rituals and other traditional ceremonies due to its close relationship with the traditional belief of Minahasa's (a regency in North Sulawesi) natives and as their culture. Nowadays, the use of the Kolintang widely spreads not only nationwide but also in overseas for various performances. In light of this, an e-learning application of Kolintang musical instruments was thus developed to provide assistance for the novice users to learn the instruments as well as to enrich the experiences of advance users to play with others using various controllers on Windows or Android operating system. Assessing the quality and efficiency of learning objects of this application is considered important. Hence, an evaluation framework is developed to measure learning goal alignment, presentation design, interaction usability, and accessibility of the e-learning application. The findings revealed the knowledge and experience of the participants after using the application have significantly improved from fair to good. These participants also considered the presentation design of this application to be high. The interaction usability of the Kolintang application was found to be ease of use by most participants (77.3%). This application also enables the participants to learn Kolintang at their own convenience and and time regardless their knowledge, skills, and experiences in playing the Kolintang instruments. Therefore, the acceptance and use of this application are considerably high by most participants because of its easiness, clarity, and coherence of the materials presented in the application.

**Keywords**— *E-learning, Kolintang, Multimedia, North Sulawesi*

## I. INTRODUCTION

Kolintang, also known as Indonesian xylophones, is the traditional musical instruments originated from Minahasa, a regency in North Sulawesi. Not only nationwide popular have Kolintang instruments been played in overseas for various occasions like weddings and official ceremonies. These instruments consist of five different instruments, namely bass, cello, tenor, alto, and melody that must be played together.

As the culture heritage of Minahasa, it is important to preserve the knowledge and skills in playing the Kolintang instruments. Unfortunately, it can be challenging to be able to play these instruments due to different techniques and

tools used for each instrument. Hence, there was an e-learning application of Kolintang instruments developed to ease the learning process for users with limited knowledge, skills, and experiences in playing the instruments [1]. This application provides basic steps of learning each instrument.

In order to measure the quality of content and information provided in the e-learning application of Kolintang as well as measure the acceptance and use of the application, Wikarsa *et al.* thus developed an evaluation framework that was derived from the Unified Theory of Acceptance and Use of Technology (UTAUT). This particular framework assessed the performance expectancy, effort expectancy, social influence, and facilitating conditions [1]. Each of these variables was also moderated by age, gender, and experience. The findings revealed that there was a significant improvement made by the users after using this application. However, it was also notable that this evaluation framework was very complex to use due to its inter-related variables and indicators which could be overwhelming when it was applied to analyze the use behavior of a larger and wider range of participants.

There is an opportunity to develop a more simplified evaluation framework that can carefully measure the learning process in the e-learning application of Kolintang in terms of learning goal alignment, presentation design, interaction usability, and accessibility. There are two indicators used to measure the learning goal alignment such as previous knowledge and experiences and post knowledge and experiences. For the presentation design, it will assess the structure and visualization.

The participants of this study are students at University of De La Salle Manado, Indonesia. This university already has a student activity club that provides facilities and practices for students to play Kolintang. This club is under the mentoring of the appointed lecturer who has the knowledge, skills, and experiences with the Kolintang instruments. In addition, this student activity club has taken parts in local Kolintang competitions for several years. In addition, there is an increasing interest in Kolintang by other students at this university.

## II. RESEARCH QUESTION AND OBJECTIVES

The formulated research question is “how to develop an evaluation framework that can measure the learning process experienced by users in the e-learning application of Kolintang with a multimedia-assisted environment?”. In this regard, the research objectives are as follows:

1. To develop a more simplified evaluation framework that can carefully measure the learning process in the e-learning application of Kolintang in terms of learning goal alignment, presentation design, interaction usability, and accessibility.
2. To further promote learning interest and experiences in playing the Kolintang instruments by engaging both novice and advance users in a multimedia-assisted environment.

## III. RELATED WORK

The following contains the specifications of the e-learning application of Kolintang musical instruments [1] [2]:

1. To provide assistance for the novice users to learn the instruments by outlining instructions in the application.
2. For advanced users, there are more options provided in terms of operating systems, controllers, types of instruments, and others.
3. Users can play together simultaneously online where they are also able to see and hear the plays of others online.
4. To provide features like the history of Kolintang, type of Kolintang instruments, lyrics, video demo of playing Kolintang instruments, chatting, and setting.

Figure above depicts the interaction between users and the application where each user type is given options to choose from as explained in the specification requirements. Meanwhile, the interfaces of the e-learning application of Kolintang musical instruments can be seen below [1].



Figure 2. Main Menu

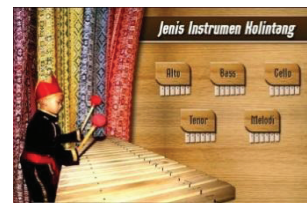


Figure 3. Instrument Selections



Figure 4. Song Selections

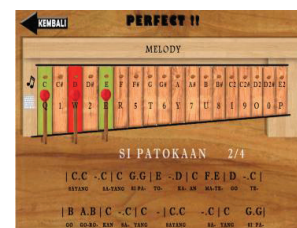


Figure 5. Melody Kolintang

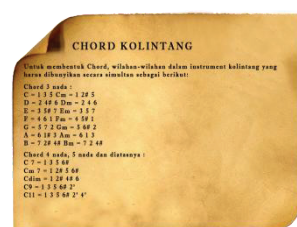


Figure 6. Chords of Kolintang

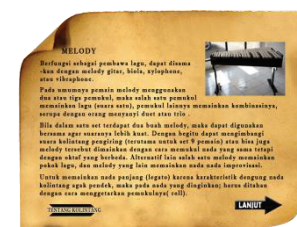


Figure 7. About Melody Kolintang

## IV. RESEARCH METHOD

### A. Research Sample

The participants in this research were 75 students who were selected randomly from the five faculties at University of De La Salle Manado. These participants were asked to fill in the questionnaires online.

### B. Variables and Measurement

Criteria used for assessing the quality and efficiency of the e-learning application of Kolintang are learning goal alignment, presentation design, interaction usability, and accessibility.

Table 1. Definition of Criteria Used in the Evaluation Framework

<b>Learning goal alignment</b>	The design of application content must meet the learning goals in relation to learner's activities by paying close attention to learner's specificity and perception.
<b>Presentation design</b>	Suitability, visibility, audiology, coherence, image display, colors and graphical elements related to the learning goals.
<b>Interaction usability</b>	The ease of use, clarity, and learn-ability of the materials presented in the application.
<b>Accessibility</b>	Ability to access the content of the application by the individual's choice of pace and time.

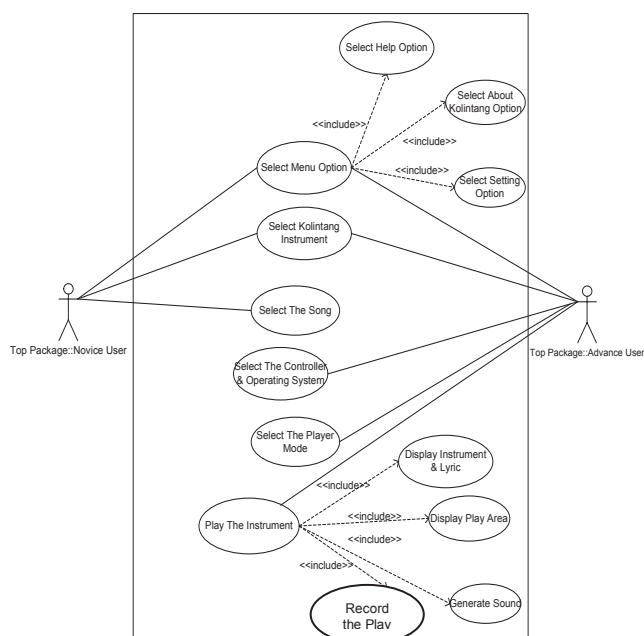


Figure 1. Use Case Diagram for the E-Learning Application of Kolintang Instruments

Data processing was conducted on this research comes from the participants' answers to questions. Research participants are asked to select the response closest to their opinion that ranges from 'very good' to 'poor' with a neural category in the middle using the Likert scale. Each question and answer is given alternate scores respectively as follows:

Table 2. Scoring

Score	Strength of Agreement
1	Very good
2	Good
3	Moderate
4	Fair
5	Poor

As these options are ordered, the codes will be entered into SPSS 20. This study will also use Cronbach's Alpha to determine internal consistency of the instrument. It is regarded as "a function of the number of test items and the average inter-correlation among the items" [3] [4]. The following table will enlist the range values of Cronbach's Alpha [5].

Table 3. Cronbach's Alpha [5]

Cronbach's Alpha	Internal Consistency
$a \geq 0.9$	Excellent
$0.7 \leq a < 0.9$	Good
$0.6 \leq a < 0.7$	Acceptable
$0.5 \leq a < 0.6$	Poor
$< 0.5$	Unacceptable

The formula of Cronbach's Alpha is [6]

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}} \quad (1)$$

$\alpha$  : alpha

$N$  : the number of items

$\bar{c}$  : the average inter-item covariance among the items

$\bar{v}$  : the average variance

Data analysis uses descriptive statistics that consist of mean and percentage to provide a simple summary of the data gathered from the sample as well as the observations that have been made for this research [7].

### C. Evaluation Framework

The evaluation framework is developed to identify and measure the uptake and use of this e-learning application of Kolintang by the selected sample for this research as shown below.

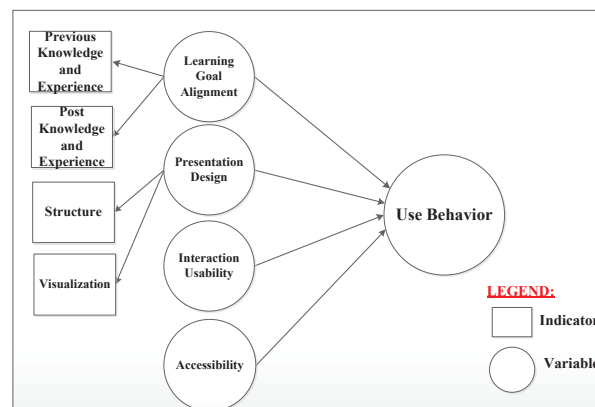


Figure 8. The Evaluation Framework

It is important to identify and analyze the previous knowledge and experience of users in playing Kolintang. Later, it will assess whether there is any improvement in knowledge and experience after the use of the e-learning application. For the presentation design, it will analyze the structure of the materials presented along with the application of multimedia elements related to the learning goals. The interaction usability basically measures the ease of use and clarity of the materials. The accessibility refers to users' perceptions of the resources and support available to use the application.

## V. ANALYSIS AND DISCUSSION

Assessing the quality of the materials provided in this application was considered important to ensure ease of learning process for users. There are 75 students who were selected randomly from the five faculties at the University of De La Salle Manado. There were 40 male participants and 35 female participants whose age ranging from 18-23 years old.

Figure 9. Research Participants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	40	53.3	53.3	53.3
	Female	35	46.7	46.7	100.0
	Total	75	100.0	100.0	

It was found that there are only several participants who have some knowledge and experience in playing the Kolintang instruments (20%) and they are mostly by the male students as shown in the figure below. These skillful participants are members of the Kolintang student activity club. They are regularly trained to play the instruments by the appointed lecturer who teaches them various techniques of plays on different Kolintang instruments. Meanwhile, other participants basically practice on their own whenever they have free time from their studies. It also found that none of the participants have ever tried any Kolintang software.

		Knowledge and Experience				Total
		Good	Moderate	Fair	Poor	
Gender	Male	2	8	13	17	40
	Female	4	1	16	14	35
Total		6	9	29	31	75

Figure 10. Knowledge and Experience of the Participants

The participants were asked to fill in the online questionnaires before and after the use of the e-learning application of Kolintang. The internal consistency of the instrument using the Cronbach's Alpha was 0.79.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.790	.656	23

Figure 11. Reliability Analysis Using Cronbach's Alpha

The findings revealed that there was a significant improvement in the knowledge and experience of the participants after using the application from 'fair' to 'good'. In other words, experience has direct effects on meeting the performance expectancy of this application.

	Previous Knowledge and Experience	%	Current Knowledge and Experience	%	P Value
Very good	0	0	16	21.3	
Good	6	8	7	9.3	
Moderate	9	12	38	50.7	
Fair	29	38.7	14	18.7	
Poor	31	41.3	0	0	
Total	75	100	75	100	0.00 **

Figure 12. Knowledge and Experience

#### Note:

\*\* Significant value 99% ( $\alpha=0.01\%$ )

Mean for the previous knowledge and experience = 4.13

Mean for the current knowledge and experience = 2.67

In terms of the presentation design of the e-learning application, the findings showed that the materials presented were coherent with its structures and visualization using appropriate multimedia elements like text, images, animations, sounds, and video related to the learning goals as shown in the following figure. Most participants considered the presentation design of this application to be high as shown in Fig.12.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Very good	42	56.0	56.0	56.0
Good	30	40.0	40.0	96.0
Moderate	3	4.0	4.0	100.0
Total	75	100.0	100.0	

Figure 13. Presentation Design of The E-Learning Application

The interaction usability of the Kolintang application was found to be ease of use by most participants (77.3%). Instructions delivered in this application were carefully designed by identifying and analyzing the sequence of learning required for achieving the instructional goals.

However, there are some improvements that can be made by adding voice instructions to narrate the learning materials.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Good	58	77.3	77.3	77.3
Moderate	17	22.7	22.7	100.0
Total	75	100.0	100.0	

Figure 14. Interaction Usability

This application also enables the participants to learn Kolintang at their own pace and time as shown in the figure below. Both novice and advanced users can access the contents accordingly to their knowledge and experience in playing the Kolintang instruments. Novice users can learn and practice by following the instructions at their own convenience. On the other hand, those students who are in the Kolintang student activity club (advanced users) can further enhance their techniques of playing by selecting the advance mode in the application. The appointed lecturer for this club can use the application to demonstrate his teaching face-to-face.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Very good	23	30.7	30.7	30.7
Good	42	56.0	56.0	86.7
Moderate	9	12.0	12.0	98.7
Fair	1	1.3	1.3	100.0
Total	75	100.0	100.0	

Figure 15. Accessibility

Based on the test results above, it can be concluded that the uptake and use of this e-learning application are considerably high as it promotes learning interest and further improve the efficiency of learning process without being limited by physical constraints.

## VI. CONCLUSIONS AND RECOMMENDATIONS

### A. Conclusions

The following conclusions were presented with reference to the research questions:

1. The new evaluation framework is proven to be more simplified comparing to the previous framework by omitting unnecessary variables and indicator to measure the uptake and use of the e-learning application of Kolintang.
2. This framework is able to analyze the learning process in the e-learning application of Kolintang by addressing diverse goals that engage learners to experience the learning process at their own convenience.
3. This application has successfully blended self-paced e-learning and face-to-face learning to improve knowledge and performance of users.
4. The learning goal alignment, presentation design, interaction usability, and accessibility of the e-learning



application help improve the knowledge and experience of users by providing easy and clear instructions on the contents in a multimedia-assisted environment.

### B. Recommendations

The following recommendations are made for further research in this particular area of interest:

1. It is highly recommended to add more octaves to each instrument in order to produce a wider and better range of sound.
2. For advance users, they can perform a live Kolintang musical performance to a wider range of audience through the Internet connection.
3. For the next development of this e-learning application, it can automatically translate notes into respective sounds based on the selected instruments.
4. It is better to provide the contents and instructions in multi-languages.
5. To add an option for voice instructions that can narrate the content and learning process in the application.

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# Development of Integrated Knowledge-based Information System as A New Media for Managing Wind Tunnel Test Activities in ILST

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**Abstract**—Wind tunnel test consists of several complicated activities which are to be managed properly. A knowledge-based information system for this purpose was proposed to improve efficiencies and performance level of the test execution in Indonesian Low Speed Tunnel. Benefits of the system were explored, which, in turn, proved its significancies for better test management practices in the future.

**Keyword**—wind tunnel, wind tunnel test, information system, information technology project management.

## I. INTRODUCTION

Wind tunnel test is a series of engineering activities mainly aimed at measuring and acquiring aerodynamic characteristics of a modeled object, such as aircraft or building, as one part of design phase in the manufacturing proses of the real object. The test itself is conducted by a test team in a so-called wind tunnel, a tunnel-like facility in which the object is located, equipped with measuring instrumentations and exposed through the blown wind to simulate the real situation, e.g. the flight situation for the aircraft model. Wind tunnel test is categorized as an experimental method with relatively low cost, low risk and high accuracy. In the aircraft industry, these advantages are exploited to validate the result from the theoretical method with lower cost and lower risk but higher inaccuracy, such as computational fluid dynamics (CFD). This validation process is done before the real flight test with higher cost, higher risk and higher accuracy is carried out.

One of outstanding wind tunnel facilities in Indonesia is Indonesian Low Speed Tunnel (ILST). Located in Serpong, Tangerang Selatan, Banten, ILST has been serving various wind tunnel tests since 1987 under the management of Laboratory of Aero Gas-dynamics and Vibration, which is a part of Agency for Assessment and Application of Technology. Supported by modern test instrumentations and experienced test teams comprising well-trained human resources, ILST is rigorously sustaining each test activities to achieve a successful execution. Nevertheless, complexities involved in such activities increase especially as markets demand more in services, and technology advances require adaptations and changes in the way of organizing the test. Among available answers to these challenges, information

system would be a potential candidate to consider. Information system has been proven useful in improving efficiencies, providing competitive advantages, promoting adaptabilities to changes, increasing productivities, and reducing operational costs. Consisting of people, hardware, software, data and network as five basic resources, information system can also be flexibly built and configured accordingly.

This study proposed a knowledge-based information system as a new media for managing the activities comprising the wind tunnel test in ILST. Referring modern techniques in information technology project management, the sequence of activities in a typical wind tunnel test in ILST was firstly analyzed to elicit the requirement. The information system aspects were then explored to construct the conceptual design based on the requirement. The implementation of test execution scheduler as the first priority subsystem was carried out subsequently. Finally, the benefits of the information system were reconsidered to evaluate the contributions to the test management practices.

## II. WIND TUNNEL TEST ACTIVITIES

As shown in Fig. 1, a typical wind tunnel test in ILST is conducted in three phases, i.e., the pre-test, the main test and the post-test phase.

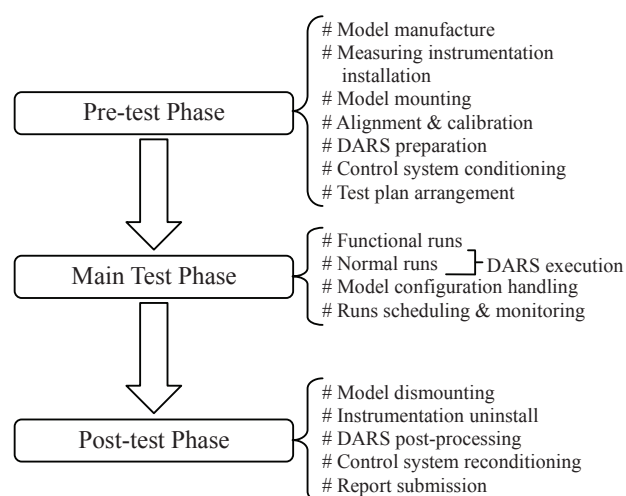


Fig. 1. Activities in a typical wind tunnel test in ILST

### A. Pre-test Phase

This phase technically starts from client requests to test the modeled objects. Depending on this request, the model may be manufactured internally or subcontracted to the external third parties. When the model is ready to use, it is equipped with measuring instrumentations and then set or mounted on the support system in the test section of the wind tunnel. Subsequent processes, such as instrumentation calibrations or model alignments, may take place prior to the main test phase. Meanwhile, the preparation for data acquisition and reduction system (DARS), and the conditioning of wind tunnel control system occurs parallelly. The test plan is arranged to order the model configuration to be tested, based on client requests and model handling considerations. The pre-test phase is the most important phase which determine the success of the test. Thus, preparations in a thorough manner are required.

### B. Main Test Phase

This phase starts from several functional tests to confirm the readiness of all parts of the wind tunnel. Here, the wind is blown in various speeds while the attitude of the model is varied to check the safety aspects. Afterward, the normal tests, i.e. the tests in which the data detected or sensed by instrumentations is formally measured and processed in a wind-on condition, are conducted according to the test plan. One test is usually carried out based on a specific model configuration, i.e. flap deflection is set to zero degree or landing gear is set off for aircraft model, and called *run*. Thus, one wind tunnel test consists of a number of runs with various configurations, which are scheduled and monitored during the main test phase. Transition from one run to the next one involves configuration change in model parts, which is handled by model handling personnel.

### C. Post-test Phase

This phase finalizes the wind tunnel test, where the model is dismounted from the support system and all measuring instrumentations are removed. The DARS execute so-called post-processing of all data acquired during the main test phase and produce the result in the formats according to the client request. The wind tunnel control system is then reconditioned to prepare for the next test. The leader of the test team write and submit the test report to the client.

## III. INFORMATION SYSTEM DESIGN

Figure 2 shows the conceptual design of the information system to manage the wind tunnel test activities in ILST based on the description given in the previous section. The information system is distributed into three domains according to the sequence of activities to enable the execution of multiple different tests in different phases without interfering each other. Though, they are all integrated in one network platform to allow any domain access others for reference or retrieval purposes. Each domain server may work as a centralized database server or functionalities provider to any surrounding client computer or workstation. Yet, considering the load balance between the server and the clients, it is also possible to provide the certain functionalities in the client sides.

### A. Pre-test Domain

Four clients, i.e. (1) model design and manufacture, (2) calibration, (3) control system conditioning, and (4) test plan, are essential in organizing the activities in the pre-test phase. The first client handles the model to be manufactured, which may be firstly designed based on the similar historical data for

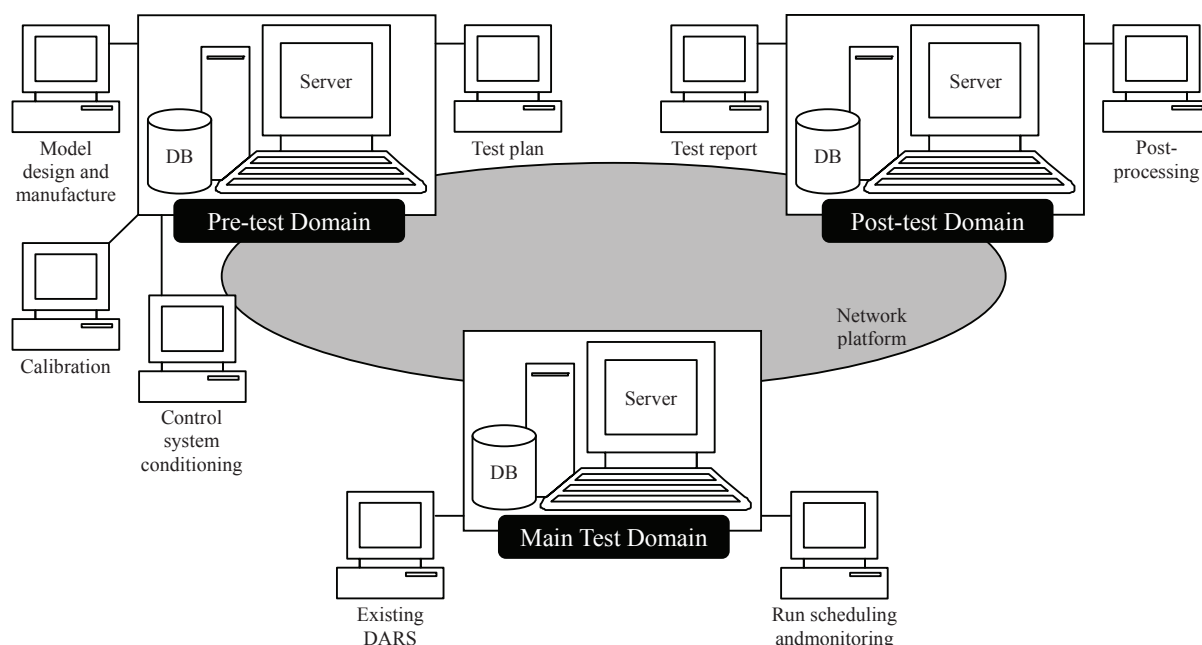


Fig. 2. Conceptual design of proposed information system

previous model ever used and saved in the database of the pre-test domain server. To realize such kind of retrieval, this client is equipped with knowledge-based functionalities to recognize the desired data which fit the similarities. The second client serves as calibrators as well as manager of calibration data of measuring instrumentations to be used in the main test phase. The third client confirms the availabilities of wind tunnel control sub-systems, such as fan driver and compressor. The fourth client is used to arrange the order of runs to be executed, and also to pick up the necessary data processing modules from the available libraries.

### B. Main Test Domain

Two clients, i.e. (1) existing DARS, and (2) run scheduling and monitoring, are connected to the server, which functions as the central processor of test data and also as the database server for resulted data. Here, the server collects the model geometry data, the calibration data and the information on the modules to be used from the pre-test domain server. The resulted data saved in this server may be transferred to the post-test domain for further correction purposes. The first client is the gate to compile and to embed the main processing programs. This client handles standard processing modules as well as user-defined ones. The second client is used to display the current status of the run being executed and other related information. Recently, such information attracts stakeholders' attention who want to know the test status in a real-time condition. This client requires access to the pre-test domain to get the information about the test plan to be applied.

### C. Post-test Domain

Two clients, i.e. (1) test report, and (2) post-processing, are linked to the server in this domain. The first client is used as a repository of reports on the test and other related documents ever created so far. These documents are useful especially when a new test needs references to the similar past tests. Such referencing can be realized by introducing knowledge-based functionalities, same as the case for the model design and manufacture client discussed previously. The second client is provided to, if necessary, re-process the data resulted from the main test phase with additional correction or different methods of calculation. Such re-processing often occurs especially to crosscheck the validity of the resulted data with several methods.

## IV. IMPLEMENTATION

The conceptual design discussed in the previous section is implemented gradually according to the priority scale defined for each component in the domains. One of highly prioritized subsystems is the run scheduling and monitoring client, due to the urgent need for a real-time 'watchdog' functionality in the wind tunnel test. For the time being, this subsystem was implemented in a stand-alone personal computer based system with moderate specifications, while the software was designed in a form of window-based graphical user interface, as shown in Fig. 3. This software is fully functional and used in actual wind tunnel tests, though, further revisions and modifications are still in progress.

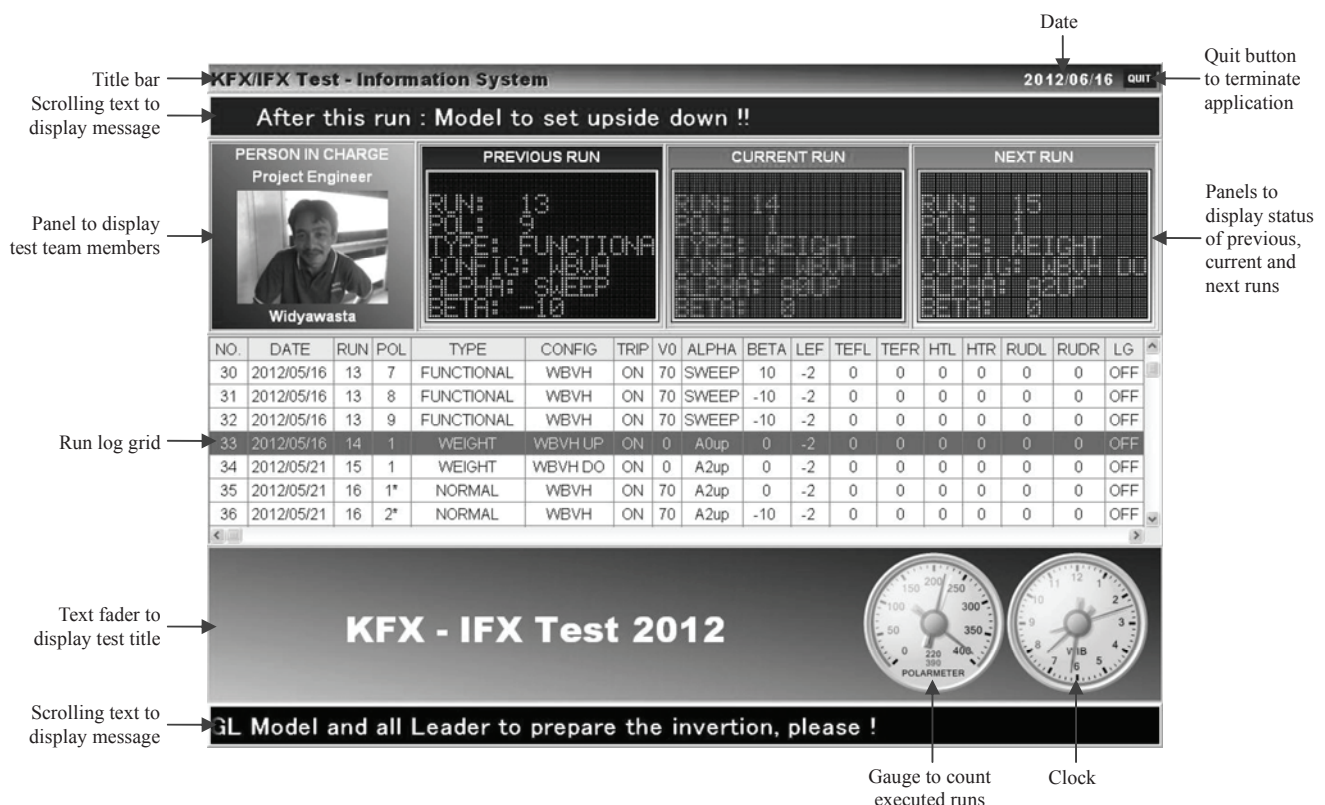


Fig. 3. Implementation of run scheduling and monitoring subsystem

## V. BENEFITS CONSIDERATION

Table 1 shows comparative benefits in managing wind tunnel tests with and without proposed information system, viewed from several key aspects. The level of significance shows how significant the information system in specific aspect items. The higher this level, the more important the information system to build for the corresponding items.

Table 1. Comparative benefits of proposed information system

No	Aspect	Without Information System	With Information System	Level of Significance
1	Model preparation # Geometry data update # Data integrity	Manual input Distributed	Auto-update Centralized	High Moderate
2	Calibration # Coefficients update # Database access	Manual input Ask operator	Auto-update Access to server	High Moderate
3	Tunnel control system # Maintenance # Failure detect/repair	Manual check Manual	Auto-alert Semi-auto	High Moderate
4	Test planning # Test plan creation # Reference to past test	Manual Manual search	Auto-creation Access to server	Moderate High
5	Run monitoring # Real-time info. # Model handling info. # Operator awareness	No Manual check Self-assisted	Yes Real-time System-assisted	Very high High Moderate
6	Post-processing # Algo. traceability (Versioning) # Data format variety	Manual comparison Limited	Auto-comparison On demand	High Moderate
7	Test report # Reference to past test	Manual search	Access to server	High

As shown in the table, level of significancies for run monitoring aspect is relatively high than other aspects, which shows the importance of the subsystem directly related to this aspect. This is also the main reason why the implementation of the run scheduling and monitoring subsystem is highly prioritized and carried out first.

## VI. CONCLUSION

An integrated knowledge-based information system for managing wind tunnel test activities in ILST was proposed. Using the cycles of analysis → design → implementation iteratively, the necessary requirement was elicited to subsequently translated to a conceptual design, and gradually implemented in operational system. Benefits evaluation shows the significancies of the proposed information system to better management practices in the future.

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# Efforts to Improve Productivity and Grade Coffee Beans Indonesia Through Counseling Website

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**Abstract**— Coffee beans have been appointed a strategic and staple commodity of Indonesia, because of its ability to move public economy and encourage development in various areas. The problem faced by Indonesia at this time is the decline in the volume of coffee beans export, while coffee beans trade heavily relies on that market. Indonesian government seeks to provide support for coffee growers through counseling, so that they can produce coffee beans with standardized productivity and quality. This study aims to plan the concept of agricultural counseling website that focuses on improving the quality of coffee beans. This website will be used by the government as a centralized information channel intended for plantation counselors in various regions in Indonesia, so that the agricultural counseling would have clear guidelines and benefits the coffee planters.

**Keywords**—coffee, grade, counseling, website, Indonesia

## I. INTRODUCTION

Coffee is one of crops with evenly spread plantations in Indonesia. This plant produces commodities which is its seeds, both the raw and processed into ingredients for drinks. This plant belongs to the genus *Coffea* which has thousands of species in it. Two of the thousands of species of coffee plants are the most desirable are Arabica and Robusta. Both of these species are spreading evenly in Indonesia because it is supported by the appropriate topography. The Investment Coordinating Board noted that upto 2015, there are 354 cities / districts that have been cultivating coffee plants with the total area of 1.246.810 hectares[3][8]. 96% of the area is managed through the estate of the people, while the remaining 4% through private estates and government (PTP Nusantara)[1]. This composition suggests that the coffee commodity acts as a driver of the economy of the people and encourage development in the regions in Indonesia. The role of commodity of coffee beans is reliable nationwide, so the government set coffee as a strategic commodity. With the such status, the handling of the coffee commodity will become a priority over other general commodities.

Indonesia has one of the highest export volume to the 3rd in the world in 2012, but unfortunately this position is taken over by Colombia in 2013. Since that year the volume of production and export of coffee beans in Indonesia continues to decline until this year[13]. A decrease in production volume and exports is a significant problem for the coffee business in

Indonesia, because 69% of the yield used to meet the foreign demands and the rest for domestic needs. The government set the quality standard that is used for export activities, but the problem is that more than 65% of Indonesian coffee beans are included in the category of quality VI and above or classified as low quality that it is suspended from being exported [9]. Problems of the production and the export of coffee beans is influenced by the composition of Indonesian coffee plants that are largely managed through civil plantations. Civil plantations are managed only through simple technology, with limited technology, productivity, capital, knowledge and organization.

One of the efforts done by the Indonesian government in improving the productivity and quality of coffee beans is counseling. These activities provide access to the coffee planters to improve their ability to access market information, technology, capital and other resources, so that they can seek the improvement of the quality of the coffee beans. The problems in agricultural counseling include: (1) differences in perception of the meaning of agricultural counseling, either at central level or at regional level, (2) agricultural counseling done with the approach, work systems and methods that are not participatory, (3) agricultural counseling organized by various institutions with tasks and functions that are not standardized, so it does not find its goal (4) the low performance of agricultural counseling because the coaching of functional positions at the district / city is not implemented properly, (5) the legislation has not set out clearly concerning agricultural counseling, so it cannot be applied as a guide, (6) there is no guarantee of protection for farmers concerning the negative impacts of the application of recommended technology, (7) the absence of operational costs and (8) changes in the strategic environment that has far-reaching impacts on the agricultural counseling activities[5].

## II. LITERATURE REVIEW

### A. Indonesian Coffee

Indonesian coffee cultivation was started by Dutch Force Commander Adrian Van Ommen who brought the coffee plant seedlings from Malabar to Batavia (Jakarta) in the 17th century. This plant was developed in the area in East Jakarta, Pondok Kopi, using Kedaung private land. The first generation of the coffee plants died due to natural disasters that hit the



area. Furthermore, Henricus Zwaardcroon imported coffee plant cuttings from Malabar to Java, which eventually became ancestors going back to all the coffee plant in Indonesia[15]. Indonesian natural conditions qualify for the coffee plants to grow well, ranging from: (1) altitude, (2) precipitation and land, (3) the plant material and growing environment[2]. These conditions assisted the expansion of cultivation areas so that they are not only concentrated in Java, but also reach out to other islands such as Sumatra, Kalimantan, Sulawesi, Bali, Flores and Papua.

Productivity is the ratio between the output and the input, which is a benchmark stating how well the resources are organized and utilized to achieve optimal results[12]. In 2010 the productivity of Indonesia's coffee plantations is 779 Kg/Ha, in 2011 702 Kg/Ha, in 2012 745 Kg/Ha, in 2013 amounted to 739Kg/Ha and 2014 amounted to 741 Kg/Ha. Coffee plantation productivity growth at a vulnerable time is 0.27% 2013-2014. The highest productivity in 2014 was dominated by the North Sumatra Province of (1061 Kg/Ha), West Sumatra (940Kg/Ha), Riau (903Kg/Ha), Lampung (883 Kg/Ha) and West Java (855 Kg/Ha); while Southeast Sulawesi province occupies the highest position based on productivity growth by 26% in 2013-2014[10]. In the Performance Report of the Directorate General of Plantation in 2013, there is an explanation of the general strategy of plantation development in 2010-2014, known as the Seven Revitalization Resonance. It was an effort to reach the target, to realize the vision, mission and objectives and to implement policies estate development during the period of 2010-2014. Development strategy refers to the seven components consisting of: (1) the revitalization of land, (2) the revitalization of seed, (3) the revitalization of infrastructure and facilities, (4) the revitalization of human resources, (5) the revitalization of financing farmers, (6) institutional revitalization of farmers and (7) the revitalization of technology and downstream[7].

In response to the ICO Resolution 407 on the low quality coffee trade ban, the government issued a regulation on the export through Permendag No.41/M-DAG/PER/9/2009 which is technically described through SNI 01-2907-2008. Classification of coffee beans based on the type of coffee, processing, quality, size, number pieces of seeds and further identifications in each region. Based on the type, coffee is categorized into two types, robusta and arabica. By processing coffee is categorized into dry and wet processing. Coffee beans with dry processing categorized in small and large sizes, whereas the wet processing coffee beans are categorized into large, medium and small. Based on the number of pieces of seeds, divided into peaberry (single seed) and polyembryoni (double seed). Coffee beans must fulfill the general and specific quality requirements before it is sent as an export commodity. The general requirements requires coffee beans free of live insects, seeds stink or smell of mold; has a maximum water content of 12.5% and 0.5% maximum impurity content. In determining the classification of the quality of coffee beans, the flaw value system that consists of 6 levels of quality (quality Robusta coffee special 4 is divided into 4a and 4b) is used. This technique is done by adding up the value of the damage or dirt in the sample of 300 grams[4].

TABLE I. GROUPING THE GRADE OF ROBUSTA AND ARABICA GRADE

Grade	Amount of defect value
Grade 1	Maximum 11*
Grade 2	12 to 25
Grade 3	26 to 44
Grade 4a	45 to 60
Grade 4b	61 to 80
Grade 5	81 to 150
Grade 6	151 to 225

<sup>a</sup>. For peaberry dan polyembrio coffee beans

Source : Standar Nasional Indonesia 01-2907-2008

TABLE II. DETERMINATION OF THE AMOUNT OF VALUE DEFECTS IN COFFEE BEANS

Defect	Defect Value
1 black beans coffee	1
1 particular black bean coffee	½
1 cracked black bean coffee	½
1 bunch coffee bean	1
1 brown bean coffee	¼
1 large coffee seed coat	1
1 medium coffee seed coat	½
1 small coffee seed coat	1/5
1 seed crusted horn	½
1 large-size leather horn	½
1 medium-size leather horn	1/5
1 small-size leather horn	1/10
1 seed broke	1/5
1 immature seed	1/5
1 seed hollow one	1/10
1 seed perforated more than one	1/5
1 seed spotted	1/10
1 branch / rock / soil large-size	5
1 branch / rock / soil medium-size	2
1 branch / rock / soil medium-size	1

Source : Standar Nasional Indonesia 01-2907-2008

### B. Agricultural Counseling

Agricultural counseling has been implemented since before Indonesia's independence and has become an integral part of agricultural development efforts. Matters relating to agricultural counseling activities are regulated in Law no. 16 Year 2006 on the Counseling System of Agriculture, Fisheries and Forestry. Counseling is defined as a learning process for the main parties and businesses so that they are willing and able to help, organize themselves in accessing markets, technology, capital and other resources. Counseling's goals include improving productivity, business efficiency, revenue, welfare, as well as awareness in environment conservation.

There are six major aspects in counseling activities are regulated by law, namely: (1) institutional, (2) counselor, (3) implementation, (4) infrastructure, (5) financing, and (6) the development and supervision[14].

The approach used in the early days of agricultural counseling is top-down, which forced farmers in these activities, and regularly forced to accept a particular technology. This approach is less relevant in the present condition, so a new approach which aims at raising awareness of farmers to manage their farming properly is applied. Conception of counseling that is applied in the future need to accommodate the aspirations, expectations, needs, potentials, and involves the role of farmers and other plantation businesses in a participatory manner based on the principles of empowerment. Through this, it is expected for the agricultural counseling to be able to perform its function as follows: (1) facilitate the learning process for the main actors and businesses, (2) seek access to resources, technologies and resources, (3) improve the ability of leadership, managerial, and entrepreneurship, (4) help develop the organization so competitive, productive, good managing and sustainable development, (5) support the analysis and problem solving, as well as to respond to the opportunities and challenges, (6) develop awareness of the preservation of environmental functions and institutionalize the values advanced culture and modern development in a sustainable manner[5].

Until now, the implementation of agricultural counseling still faces problems both theoretically and technically, for example: (1) differences in perception of the meaning of agricultural counseling, (2) the approach used not in accordance with the new paradigm of participatory development, (3) implementation at district / city carried out by various institutions with tasks and functions are different or not standardized, (4) development of functional position of counselor is not carried out properly, (5) the legislation has not set out clearly about the activities of law that can not be used as guidelines, (6) the agricultural counseling does not guarantee protection for farmers, (7) the absence of support for operational costs, and (8) changes in the strategic environment that directly affect agricultural counseling systems as a whole (globalization, decentralization, policy, etc)[5].

### C. Information Website

Website is a means of data storage and information based on specific topics. Websites is in the form of a collection of pages that display the data as text, images, animation, sound, video or a combination of them. Judging from the permanence of the content, websites are divided into two types: static and dynamic. Content in fixed and static websites are rarely updated information; whereas the dynamic website information is renewable [11]. There are four main stages that are used to build websites, namely: (1) Requirements: This stage is the beginning of the project design of the website and the basis to strengthen the subsequent processes. A project website design starts with determining the scope of the problem, the rules, the gap, the budget, the formation of the team, the role of the user, as well as the timeline, (2) Design Needs: this stage is an attempt to build defining in detail about the purpose, usefulness, aesthetic value and design ideas related, (3)

Designing the Solution: every aspect of the previous stages will be analyzed in order to generate design ideas as solutions to meet the needs of each related aspects, (4) Creating the website: this stage is an attempt to implement the ideas that have been built in the previous stages, consisting of activity coding, building, testing and evaluating the website as a whole[6].

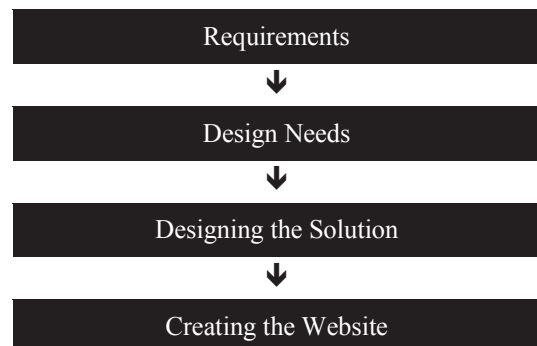


Fig. 1. Methodology Process

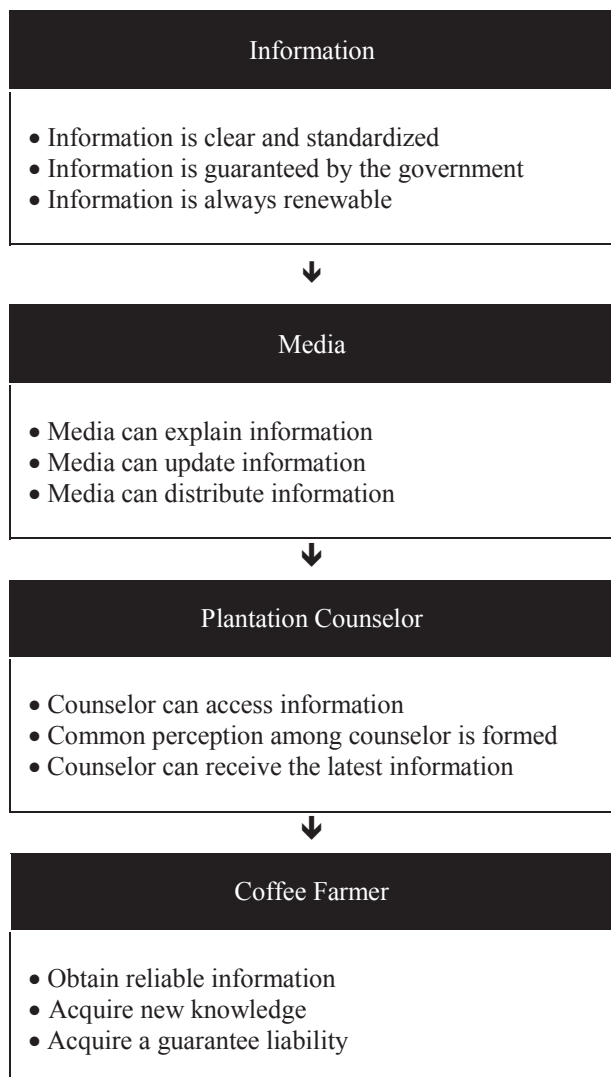
## III. RESULT AND DISCUSSION

The main problem of the coffee commodity in Indonesia is the low productivity and quality of the coffee beans. The problem appears because most of the coffee crop in Indonesia traditionally managed through people's plantations. Plantation of this type has a weakness in the mastery of technology, processing plants, lack of capital and lack of knowledge and lack of organizing efforts by farmers. The coffee planters need to gain access to information in order to improve the quality of business management plantation and produce good quality coffee beans. Farmers who have not gained access to information concerning efforts to increase productivity and quality will tend to do the traditional plantation management that is based on hereditary tradition, although it will not always be able to face changes in the present and in the future.

One of the government's efforts to overcome these problems is through education to improve the ability of traditional farmers in managing the coffee plant. In its journey, the implementation of agricultural counseling is likely to face problems related to differences in perception due to the absence of clear guidelines. These differences need to be addressed so that all parties have a consistent perception of the counseling on the estates, so that their operations can be run in an integrated manner. Media as a source of information on agricultural counseling guidelines are clear and reliable is required, so that all parties have a clear guide in carrying out agricultural counseling.

Another issue that appears is the spread of coffee plantations in various islands in Indonesia. Distribution of information will be hampered by space, time and cost constraints. An effective and efficient media is needed to manage and deliver information on an ongoing basis, one of them through the internet. Forms of media that use the Internet is a website. This media is designed as an counseling facility into a centralized government information channel, so that all

counselors obtain clear and reliable information. This website is not to be accessed by the coffee planters but by plantations. Through this media information can be submitted on an ongoing basis to the agricultural counseling workers in various regions in Indonesia.



The main concept of this website is to provide information that can help the organization of counseling. Through the website it is expected to process the transfer of information from the government run more effectively and efficiently, thereby creating an integrated outreach activities, can achieve its mission, as well as assist coffee growers to improve productivity and quality of coffee beans. Based on an analysis of existing needs, the website will be designed with the following five features:

#### A. Basic Introduction

This feature guides the user to know the six basic aspects of counseling according to the law. The information on this feature is provided by government agencies as authorities.



Fig. 2. Basic Information features

#### B. Counseling Material

This feature will be a page that displays a list of agricultural counseling materials. This material can be downloaded by counselors and distributed to coffee planters at the time of counseling activities in the field.

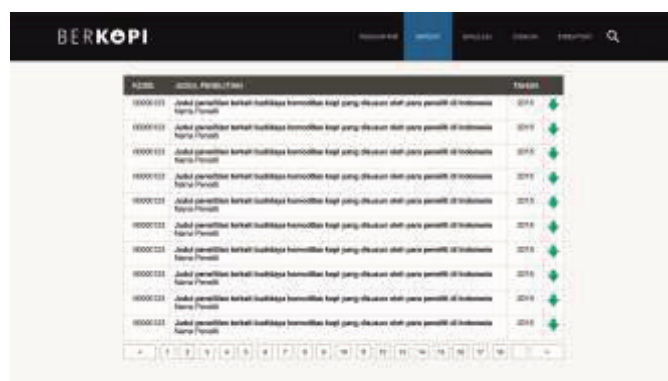


Fig. 3. Information Material features

#### C. Grading Simulation

This feature shows step by step process of classification quality coffee beans. This feature helps the counselor to simulate the same thing in the field. Thus the coffee planters will get an overview of the overall process to improve the quality of coffee.

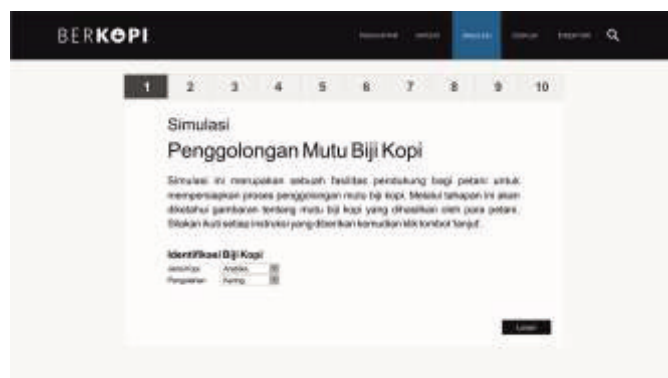


Fig. 4. Grading Simulation features

#### D. Discussion Forum

This feature is in the form of a virtual discussion space contains a list of topics the problems created by the user. This feature connects the various parties concerned in order to discuss the problems that occur in a certain area, so finding solutions in accordance with certain conditions.

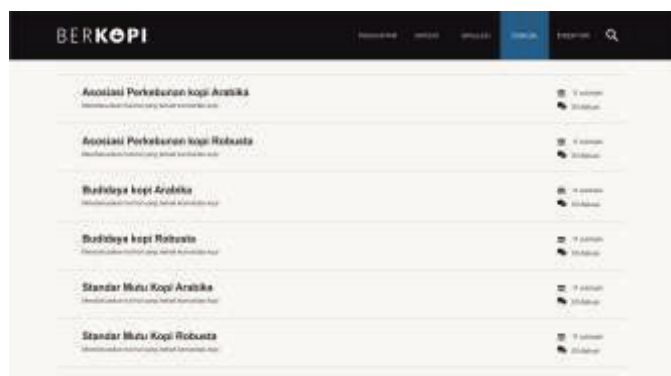


Fig. 5. Discussion Forum features

#### E. Information Directory

This feature contains a list of location-based information classified. Users simply select a specific point on the map, then you will see a variety of relevant information based on location, such as information on the institutional, program, plantations and so on.

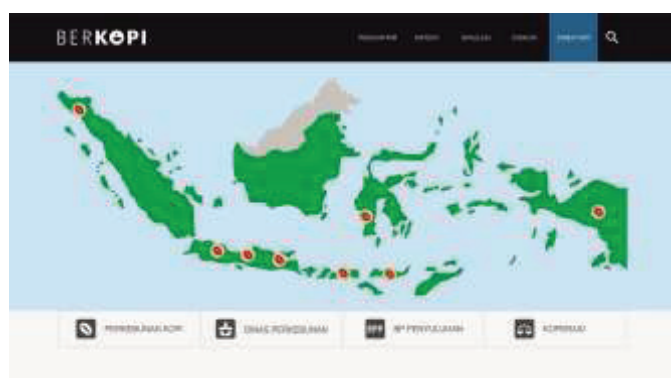


Fig. 6. Information Directory features

### IV. CONCLUSION

The website becomes an alternative media to convey information to each region in various islands in Indonesia without being limited by time and space. Counselors can access information on the development of productivity and quality of Indonesian coffee using a device that has been provided by the government in each district through the District Internet Service Center and Mobile District Internet Service Center. Website becomes a forum for the management of information on improving productivity and quality of coffee need to involve all stakeholders in coffee to provide a more detailed picture of the problems. Any opinions coming from these circles can be suggestions of website development more effective and efficient, because it represents the real field conditions. Counseling website becomes the means to be

developed not only in the area of the coffee, but also can be applied to other fields.

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# Self Directed Learning Media for Public Speaking Practice Towards People with Social Phobia Condition

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**Abstract**—This study analyze the theory of self-directed learning for people with social phobia using interactive media. Comparing between medias of earlier research and the possibility of learning public speaking using self-dedicated learning method. This study also describes how to train social anxiety using cognitive behavior therapy (CBT) and the cause of social anxiety with different types of listener reactions.

**Keywords**—public speaking; self directed learning media; social phobia

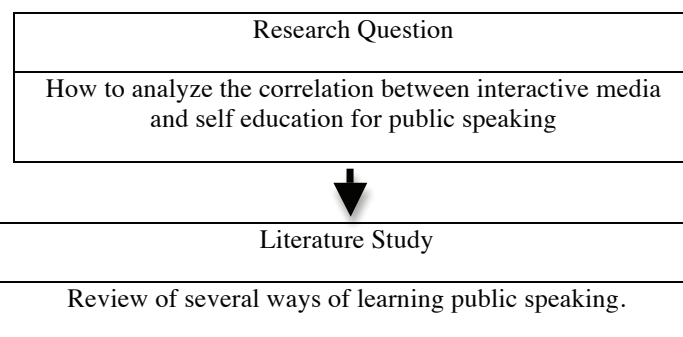
## I. INTRODUCTION

The ability to speak in front of public has become a skill that needs to be learned by each individual person. In this generation not just an adult but also children are intended to have the courage to talk in public. Schools uses public speaking as one of its ways to pursue students to learn by presenting the final product of a project in front of the class whether it is individual or in group. The importance of learning public speaking is to allow a person speak upon their thoughts in front of a group of people without having cold feet or frozen tongue but showing more confidence with a good pace and flow of speaking. in psychology, there are several types of human having difficulty to speak due to the psychological issues which is called as social anxiety. Social anxiety is a social phobia that is prevalent and occasionally debilitating personal problem even in normal populations. Equal with the increase awareness of the phenomenon that grows literature on its causes and treatments, showing as social anxiety, shyness, dating anxiety, heterosexual-social anxiety, stage fright, speech anxiety, communication apprehension, reticence, and embarrassment (Schlenker, 1982). The main problem of learning public speaking is to have lots of courage, confidence, and will of learning, to leave once comfort zone.

Usually people who has a social phobia problem has a strong fear to perform in social situations that fears them to act in a way of humiliating or embarrassing and eventually people would judge them negatively (Pertaub, 2002). This seeks them to avoid any contact with a social encounters when and wherever possible. People with this condition would have limited career choices and avenues for promotions that are near to them, resulting personal distress, frustration and depression.

The focus of this study is to provide virtual audience for public speaking practice. The purpose is to provide the a real effect and sensation of a speaker standing in front of an audience. The responses of people is derived by the behavior of the audience not mattering whether its virtual or real. (Pertaub, 2002). Resulting the greater the negative audience response provokes greater anxiety towards the speaker. By using virtual as a media to perform a different dimension as sessional as the real audience, could trigger the anxiety and would be very effective to train and exercise public speaking. With the help of speech recognition that could correct the vocabulary and pronunciation within words to even give a better result in the end.

There are three different fields concluded in this studies from the early researches: interactive media, public speaking, and self education. These information are then analyzed to achieve a new type of analysis to support in building a tool for practicing public speaking that would be a solution for self educate.



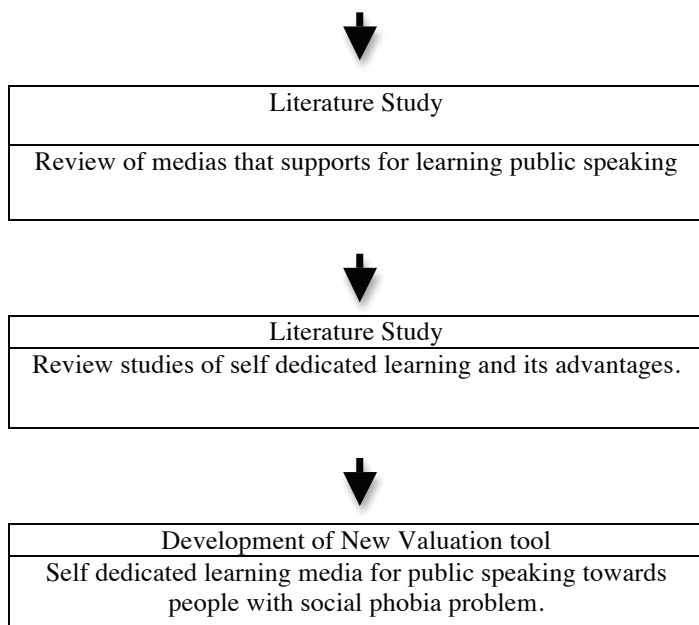


Fig. 1. Literature review flow.

## II. ANALITICAL REVIEW IN ENDURING SOCIAL PHOBIA

Treatment to endure social phobia is by going through cognitive behavior therapy (CBT) which combines the two types of therapy, exposure and cognitive. It addresses negative patterns and distortions towards how people look upon the world and their self. As the name suggests, this involves two main components: (a) **Cognitive therapy**: Examines how negative thoughts, or *cognitions*, contribute to anxiety. (b) **Behavior therapy**: Examines how you behave and react in situations that trigger anxiety.

The main premise of cognitive behavioral therapy is in the thoughts that effects the way how people feel. In other words, it's determines how people feel not the situation they are in.

To conceder CBT as a good way to cure social anxiety, despite in the demonstration efficacy of CBT, less than 50% of people with social phobia receive psychological treatment for it. The other reason for people not to take the CBT is because they are ashamed to do so. Furthermore, many people that took CBT do not receive effective treatment, which is caused by the mental health practitioners, difficulty with disseminating CBT. Apart from it, CBT has other limitations, including high cost and lot of time usage, both that prevents many people to avoid a suitable treatments

### A. Thought Challenging in Cognitive Behavioral Therapy

Though challenging or also known as cognitive restructuring is a process that challenges the negative thinking patterns which contribute to the anxiety by replacing it with positive and realistic thoughts. This kind of method involves three steps:

#### a. Identifying the negative thoughts.

By having anxiety disorders, the situations perceived are as more dangerous than it really are. This thoughts are irrational that leads to fear. The solution is to ask to our self what types of thoughts that make the people to start feeling anxious.

#### b. Challenging the negative thoughts.

Challenging the negative thoughts is to evaluate the anxiety that provoke thoughts. This is to question the evidence for the frightening thoughts, analyzing unhelpful beliefs, and testing out the reality of negative predictions. Strategies for challenging negative thoughts include conducting experiments, weighing the pros and cons of worrying or avoiding the things that are feared, and determining the realistic chances for the anxious will actually happen.

#### c. Replacing negative thoughts with realistic thoughts.

After identifying the irrational predictions and negative distortions from the anxious thoughts, its is possible to replace them with new positive and accurate thoughts. This method needs to be handled with a partner that has positive minds to help figure out which is best to be done.

## III. INTERACTIVE MEDIA AND PUBLIC SPEAKING

Media today are a tool for entertaining people with its amazing feature by constructing images, video, and audio into something enjoyable. Media are also known for its ability to help people learning through educational game or even an interactive media that could respond to human error. There are some researches about interactive media that can help practicing public speaking.

### A. Telephone

A related study by Carlbring in the research of treatment of social phobia: randomized trial of internet-delivered cognitive-behavioral therapy with telephone support, that focused on improving treatment adherence by adding short weekly telephone calls. This study controls randomize trial to 9 weeks internet based self help program plus weekly phone calls was compared with waiting list control group. Resulting that the treatments was affective in treating social phobia and in improving adherence. Further more, the improvement was maintained after 1 year of time. There has been limitation to this study, the authors administered the clinical interview over telephone and the assessment was only based on self-report measures. Then the participants are the volunteers that intended and interested to an Internet based self-help program,

which occurred a biased selection method. Finally there was no inclusion of comparison towards face-to-face treatment.

### B. Internet Based

In the matter of internet treatment for social phobia, according to Glasgow and Rosen[8] there are two groups classification. (a) Internet-based self-help programs with therapist contact using phone, e-mail, or infrequent meetings and (b) Internet-based self-help programs without therapist contact in which the entire treatment is delivered over the Internet. Andersson[2] came to conclusion that a controlled randomized study in which an Internet-based self-help program with therapist contact via e-mail combined with two group exposure sessions was more effective in treating social phobia than was a waiting-list control. Then the limitation to this study is the uncertainty over which treatment component was responsible for the outcomes given that the self-help procedure was combined with two in vivo exposure sessions. There is one report of an internet based self help program for treatment of fear of public speaking which is called Talk to Me. This program uses video of real audiences that simulates social situation using actors. One of its main features is the continuous assessment of the progress of the user. It presents the progress treatments according to the user whether their ready, it is to achieve suitable evolution and avoiding the therapeutic failures. In Botella's study resulted that Talk to Me could be an effective therapy for treating fear public speaking. The aim of its work is to offer controlled data about the efficacy of Talk to Me by comparing it with the same program applied face to face by a therapist and a waiting-list control group.

### C. Real-time Recognition

A real-time recognition is a media that generates emotion towards the user using the media. To give a persuasive communication, the non verbal clues a speaker conveys require special attention (Thomas, 2011). Usually an untrained speakers conveys require special attention which often come across presenting a bland and lifeless communication. Precisely analyzing voice is difficult for humans. By using emotion detector could enable system to recognize accurately and even enables more objective assessment of public speaking skills. Applications that are potential for analyze including speech coaching and presentation skill practice. This application could be modified according to the use or occasion that the user are going through, then the computer would analyze using the speaking style.

## IV. SELF DIRECTED LEARNING FOR PUBLIC SPEAKING

People with phobia towards crowd can cause several effects to their future, limited working environment, socialized that cause loneliness, unmarried, and even death due to depression. The need of learning public speaking has occurred a compulsory skill to own although just a little bit. The problem to the phobia is people are to shy and dragged by

their anxiety toward negative thought that makes them unconsciously decides not to learn public speaking. The humiliation that can't be bare by them holds them down. Self-directed learning method is the solution to this problem.

Towle[6] in her article describes why we self directed learning is needed. She describes knowledge develops from time to time and university can support student only until they graduate. With this method of learning there are several particular advantages that other people couldn't give but our self. Confidence, question asking and reflection, openness and risk taking, uncertainty and surprise all encounters in our self that develops the eager to learn and it makes learning much more effective.

## V. CONCLUSION

There are ways to learn public speaking for those who have social phobia problem. These days technology has developed and theories have evolved significantly helping it to be easier to understand. By practicing and knowing the anxiety of our self towards the fear that unconsciously drive us towards the wrong decision, could eventually fix the habit and reprogram into a more positive attitude and decision. In the olden times, mirror is used as a media to practice public speaking in order to have audience and to see how our body gesture shows. As it is described before, that what matters toward how we would speak depends on the reaction of the audience, how enthusiastic the listener want to hear the speaker positively. Social anxiety can be cured by taking the cognitive behavior therapy (CBT) that consist of steps that replacing negative thoughts into some positive thoughts. Giving courage and self-confidence in every step and sedition. An interactive media is one of the solutions that accurate in deliberating the concept of close to real feature. For example virtual reality is a media that could create a new type of dimension that could give the close to real effect towards the user, which is needed in learning public speaking.

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# An Overview; Learning Through Social Media

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**Abstract—** Indonesia education index contributed 0.584 to the human development index. In 2011, Indonesia's Human Development Index fell from rank 108 to 124 from the previous year. Several studies have shown that the decline of student interest in learning has greatly contributed to the declining quality of university graduates in Indonesia. With the changing times and cultures, youngsters in Indonesia are no longer interested in learning through traditional means. They are known as Generation "Y", a group of active and dynamic people who use the media to enhance their learning achievement. Proliferation of digital product innovation is believed to arouse their interest in learning that makes them willing to share and learn more active and meaningful. Therefore, social media perhaps can be use as the right choice to develop their knowledge.

**Keywords—** Learning, Social Media, Social Networking Sites, Students.

## I. INTRODUCTION

Recently, discussion that occurred in various media showed the decreased of Indonesian Human Development Index (HDI). Quoting from Susanto [1], Indonesia's Human Development Index (HDI) dropped from position 108 (169 countries in 2010) to position 124 (187 countries in 2011). Ministry of Education and Culture (Kemendikbud) said that the education index in Indonesia made a major contribution, reaching 0.584 on the Indonesia Human Development Index (HDI) in 2011 [2]. Based on these data, it can be concluded that to improve the HDI, we should be able to increase the main contributors to HDI (education sector). Improving the quality of education in Indonesia can be done through increasing students' interest in learning. This paper will describe about the characteristics mapping from social media vs traditional model of learning. Some articles claim that today's student learning achievement has decreased [3] A sri. There are several factors that led to the decrease of interest in learning. First is the interest in reading. Nuryanti also said the same thing, namely the decline in student achievement due to lack of interest in learning [4].

They (students) are fed up with the same model of learning they have acquired since elementary school. This is reinforced by the Widjaja [5], which says people born between 1980 and 1995 known as the generation "Y" which were used to the instant case and did not like the routine work.

Today, various forms of digital innovation have driven the changes and developments in almost all fields. One that directly related to digital innovation is the Communications and Information Technology or commonly known as ICT. The development of information and communication technology which is rapid, make the researchers refer to this phenomenon as a revolution. This development is characterized by the emergence of innovations in information and communication technology. One of them is the internet technology.

Currently, the Internet is a necessity for almost everyone. This is because many people can access the internet and find all information around the world quickly and easily. Nowadays, the Internet not only serves as a means of communication, business, or entertainment, but it has been used in education. The rapid growth in Internet usage around the world has become a new phenomenon that occurred in recent years. With the presence of internet, business activities can be developed easier, as well as in the field of education. The Internet has had an important role which includes research and learning.

The development of the internet has not stopped. Recently, a new version of the web known as Web 2.0 appeared, which provide convenience and compelling feature. This further aroused the enthusiasm of young people, so they are willing to spend time with their applications on the internet. What is interesting is the emergence of Web 2.0 applications are known as social media like Wikipedia, YouTube, Friendster, Facebook, blogs, twitter, online games, etc. So far social media has been used in the field of marketing that focuses on imaging and promotion.

Social media is a bunch of internet-based application built on the ideology and the Web 2.0 technology. The operations require the exchange of content created by users. Overall, Web 2.0 provides an important role in changing the flow of

communication between the users. It is believed that social media is one tool that is easy to use by the college in providing lessons and serves as a good communication tool between students and faculty, as well as the academic staff.

As quoted from an article by Bloomberg Business weekly edition of 14 September 2009 which states that higher education has been transformed by the internet revolution and became the new model of higher education in this century does not have to put the students and faculty in a room together [6]. These conditions attracted many researchers to think critically about the application of social networking as a new trend in learning. Furthermore, Hamid, Chang, and Kurnia study the literature related to the use of social technologies. Then they classified the literature into four basic activities, which include: content creation, sharing, interacting, social and collaborative [7]. The results of the study from Hamid, Chang and Kurnia suggest that wikis and social networking were ranked highest in the social group and collaborative content [7]. This suggests that social networks allow individuals to build relationships with the other people who have the same concern and interest. So the social networking technology can be built as an active sense for the community. However, can the social networking sites increase student interest in learning and achievement?

## II. LITERATURE REVIEW

Social networking sites are not new to modern society. If seen, almost every day people doing social activities through the use of information technology which becomes cheaper and easier to use. Social media begins with the advent of digital innovation that continues to evolve, so that people feel dependent on digital technology and digital innovation, which in turn is used to conduct business and social activities.

Social media is known today, it can be said as technology and online activities such as text, images, audio, and video that are used to share opinions, insights and experiences. As Edwards said, social media can be divided into social media networks (eg Facebook, MySpace, and LinkedIn), wikis (eg Wikipedia), multimedia sharing sites (eg YouTube and Flickr), bookmarking sites (eg Del.icio. U.S. and Digg), virtual worlds (eg, Second Life), and rating sites (eg, Yelp) that allow people to interact with each other and share information about products and brands [8]. More details can be seen in the landscape of social media on the fig. 1.

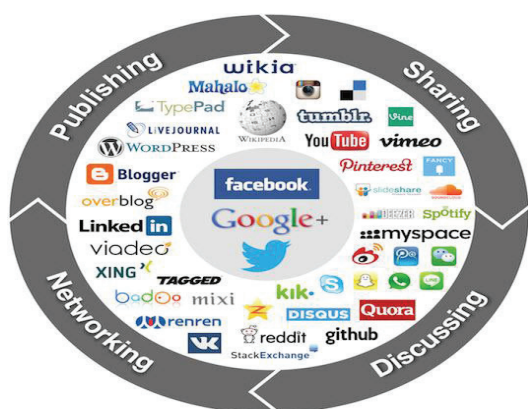


Fig. 1. Social Media Landscape 2013 [9]

Social media influencers represent a new type of independent third party endorser who shapes audience attitudes through blogs, tweets, and the use of other social media. Some scholars appear to view Social media influencers as competing or possibly hostile voices [10]. Four out of five internet users visit a social network site on a monthly basis, with Facebook and Twitter propelling much growth in the industry. Six out of seven US internet users are now viewing online video content in a month [11].

Judging from the number of applications, social media like Wikipedia, blogs, and youtube are a medium that is used to share. It can be used as a medium to manage and share knowledge that is known as knowledge management. This is in line with that Dalkir said [12]. He said that knowledge management is a strategic combination of equipment and techniques that each variety for a structured knowledge acquisition from experts [12].

According to Blaschke, the active use of social media can increase learner engagement levels (student–student, student–instructor and student–content) and promote the development of cognitive and meta-cognitive learning skills, such as reflection, critical thinking, construction of knowledge and understanding of one’s individual learning process [13].

## III. RESEARCH METHODOLOGY

This study aimed at finding the information needs and seeking behavior of student learning in Bina Nusantara University and proposing a comprehensive and well integrated learning model through social media to improving student learning and achievement. Flow chart presented in fig. 2 shows the research methodology of the study.

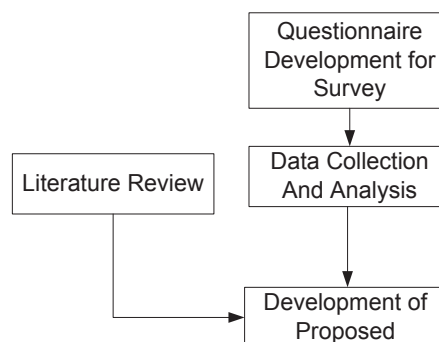


Fig. 2. Research Methodology

## IV. DISCUSSION AND RESULT

### A. Users of Social Networking Sites

In nature, person serves as an individual and social being that is required to communicate with the others. Consciously, humans as social beings will continue to learn from the environment to develop themselves. Digital innovation, especially around early 2000, started to develop blogs and wikis, which makes humans easier to carry out human nature as social beings.

As it happens today, in their daily life, those who are using social media seems to have an unwritten obligation to always report the condition as a way to change their status on Blackberry Messenger, Facebook, yahoo messenger, or social media such as check-in using Foursquare application. In addition to changing the status, those who are using social media often upload a new profile picture on Facebook or just scrolling timeline on Twitter to follow the "hot" conversation. It seems that people become more concerned for the variety and always want to know the things that happened in the life of the social environment.

Based on Yeagle's [14], the numbers of users who use social networking applications on five of the most popular, where there are the greatest number of users on Facebook (901 million users), followed in second is Twitter (555 million), third is Google+ (one application from Google) by the number of users reached 170 million, followed by Linked In with 150 million users, and the fifth is Pinterest (11.7 million users). Keep in mind that the number of users in social networking in the world reached 1.788 billion. Referring to the landscape of social networking sites are illustrated in Fig. 1 above, one can imagine how many users of social networking sites in the world entirely. It is not described here, because the numbers of users on social networking sites were under the order of five.

Social media nowadays mostly are used for business and friendship. If there are any social media that are used for learning it is limited for sharing and discussion only. Based on it, hereby the characteristics of learning and social media are mapped on the table below. With the goal to get the connection between learning and social media characteristics so the right research model can be made.

### B. Characteristics of Learning

When learners' knowledge of their own learning experiences is enriched and enhanced through well-supported dialogue, the private aspects of learning experiences and the shared language for talking about learning are built together. Through this process learners' characteristics for effective learning can be developed [15]. Watkins believed there are some components that are shaping the characteristics of learning, the table below describes about the characteristics of learning from each components.

TABLE I. CHARACTERISTICS OF LEARNING

Components	Characteristic
Institution and environment	Create connection, Learning organization
Content	Adjusted with needs and the level of comprehension
Lecturer	Sharing knowledge, learning source partner
Students	Cognitive pattern, Result oriented, problem centered, Dialogue.

<sup>a</sup> Watkins, et. al. [15]

### C. Characteristic of Social Media

Compared to traditional media, social media enables two-way conversations rather than one-

directional transmissions or distributions of information to an audience [16]. While traditional channels, such as television, radio, newspaper, and magazine, only deliver a linear communication mechanism, the Internet provides a non-linear or two-way communication environment [20]. Web 2.0 enhances the conversation and making it a central theme of social media. Whereas participation, interactivity, conversationality is rooted in communicational aspect of interactivity. The characteristics of social media from different authors are described in the table below.

TABLE II. CHARACTERISTICS OF SOCIAL MEDIA

Characteristic	Author
Participation, openness, conversation, community, connectedness	Mayfield, 2008 [16]
Sharing, engaging	Drury, 2008 [17]
Facilitate participative culture	Russo, 2008 [18]
Active, engaging, interaction	Burgoon, 2000 [19]
Two-way communication environment	Rowley, 2004 [20]

### D. Data Analysis

The basic research was done by simple random sampling method by distributing hardcopy questionnaires to 300 students who met at Anggrek campus in Bina Nusantara University from June 1, 2012 until June 2, 2012. See the table below to see the results of data analysis.

TABLE III. SEMESTER DISTRIBUTION AND SEMESTER MAJORS

Description	%
Students:	
• Semester 2	35 %
• Semester 4	43 %
• Semester 6	16 %
• Etc.	6 %
Majors:	
• Accounting	4 %
• Language	8 %
• Management	9 %
• Marketing Communication	6 %
• Hospitality	11 %
• Information Systems	21 %
• Computer Science	30 %
• Etc.	11 %
The use of IT in Learning:	
• Fully IT Solution	53 %
• Half of IT	32 %
• IT as supporting tools	14 %
• Don't use of IT	1 %
User internet activity	
• Check and send email	100 %
• Connected with social networking sites	78 %
• Download audio and video	40 %
• Use of e-library	7 %
• Use of wikipedia	87 %
Activity in e-learning (BINUS Maya)	
• Stepped in course materials via the provided link	7 %
• Download material	71 %
• Doing tasks	100 %
• Discussion forum with lectures	8 %
• Discussion forum between students	48 %

## Become of member of social networking sites

• Facebook	98 %
• Twitter	67 %
• LinkedIn	48 %
• Google+	12 %
• Pinterest	6 %
• Blog	12 %
• Wiki	87 %
• Youtube	84 %

Based on the analysis of these data, we conclude that the majority of respondents in Bina Nusantara University as a member of social networking sites (98%) and the majority of their activities on the Internet are used to access social networking sites by 78%. Based on the analysis, the learning materials can easily be delivered to the students by using social media, because the majority activities of students use the social media rather than e-library. So the opportunities to gain and share knowledge, solve problems by discussing, and engaging in collective of learning process are easier to do through social media. They can share the material, as well as a discussion (the majority of their activities on the e-learning portal (BINUSmaya) are used for downloading the content and discussion forums). The social networking site appears to help in building academic groups to achieve better learning than the traditional communication and academic approach..

### E. Learning Model

Indonesian people, who enter the school at the age of today, are those born between 1980 and the present. According to Widjaja, those who are in the age range of the generation known as the "Y" [5]. A lot of people say that the generation "Y" is a casual generation, a generation that want to do the same thing with their whole life and the generation that does not like routine activities. They are very dynamic. The characteristics of the generation "Y", among others are: (1) easier to accept change, because of the open minded and willingness to learn every high novelty. (2) have more confidence to perform in front of the forum and express their opinions. (3) always connected online via computer, laptop, smart phone or other electronic media to work or communicate with others. (4) do not like things too detailed and considered work café over a cup of coffee was a regular thing. (5) have incredible spirit to an idea and innovation [5].

Based on the things mentioned above, especially with the nature of the underlying generation "Y", then needed a medium that can be used freely and openly to accommodate all of the ideas, interests and ultimately to improve their capabilities in the field of academics. It takes influencers in the social media world. Influencers are individuals or organizations that have the power to change perceptions, attitudes and behavior of the people around their social network [5]. Widaja said that the characteristics of influencers in social media are an individual or organization is known to have the credibility on a particular topic and then the attitude and imitated his word, trustworthy and inspires people around their social network [5]. From that context it can be seen that in the end, everyone will become influencers in social media. It is believed that the interests of generation "Y" are to express themselves.

Therefore, using social media as learning tools is the right tools to give students from generation "Y" a media to express themselves, and not only that, it also make them engage in the learning process. As it shows in the matrix that social media and learning has some characteristics that are able to complement each other, then the educational institution can use social media as the portal to provide a channel where students, lecturer, and the content of learning can interact with each other using the social media. The characteristics of learning and social media are shown in the characteristics matrix below.

TABLE IV. SOCIAL MEDIA VS LEARNING CHARACTERISTICS MATRIX

CL \ CS		PT	OP	CV	CM	CT	SH	EG	FP	AC	IT	TW
IE	CC	✓		✓	✓	✓			✓			
	LO	✓		✓	✓	✓			✓			
CO	AN		✓						✓			
	LC								✓			
LE	SK	✓	✓	✓		✓	✓	✓		✓	✓	✓
	LS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ST	CP	✓						✓			✓	
	RO	✓	✓					✓			✓	
	PC	✓			✓		✓	✓			✓	
	DG		✓	✓		✓	✓	✓	✓	✓	✓	✓

#### LEGEND

IE: institutions and environment	
CO: Content	
LE: Lecturer	
ST: Students	
CL: Characteristics of Learning	CS: Characteristics of Social Media
CC: Create Connection	PT: Participation
LO: Learning Organization	OP: Openness
AN: Adjusted with needs	CV: Conversation
LC: Level of Comprehension	CM: Community
SK: Sharing Knowledge	CT: Connectedness
LS: Learning Source Partner	SH: Sharing
CP: Cognitive Pattern	EG: Engaging
RO: Result Oriented	FP: Facilitate Participating Culture
PC: Problem Centered	AC: Active
DG: Dialogue	IT: Interaction
	TW: Two Way Communication Environment

The academic environment has the same model, i.e. education by teaching through a physical classroom and lectures manage the delivery of knowledge. On the other hand, students are individuals who attend classes with varying degrees of self-preparation, social and intellectual, which directly affects the acquisition of knowledge and feedback. Although it is assumed that faculty and students have a strong and consistent for the absence, exchange ideas, share knowledge and expand understanding, but still have different absorption. Accordingly, the social networking site appears to assist in building academic groups to achieve better academic learning and communication.

And come from some research, the experts suggest that [1] [21][22][23];

- (1) Students in personal have to achieve basic competencies which are needed to access the application on the social networking. They open an account, post photos, videos, audios, exchange messages, and establish groups that



have similar interests. The most important thing is they are people who would rather share with others. This makes them easier to read and used as a materials in the discussion.

- (2) The importance of technology efforts to support students with an introduction to the wireless connection, fully supported by the laboratory, and ongoing training programs.
- (3) Currently, the Internet as a technology that offers a variety of training and communication implications enables students to engage in learning that is easier than face-to-face and online environments. This causes the group to solve communication problems and projects, and actively participate in discussions untrammelled with time.
- (4) The lack of social networks, it is only in the level of privacy and security issues.

## V. CONCLUSIONS

Students already use information technology in their daily lives in learning, communicating, and running their activities as social beings. Their daily activities cannot be separated by information technology; nearly every day they are checking emails, downloading songs and movies, and getting task of finding material on the internet and find a solution tasks over the internet. Social media allow students to discuss and find materials on the Internet as a material for discussion and share. The downside is a critical thinking and the positive used of social media. They must be directed and given the knowledge of social media that are merely social goals into academic and social goals. This will cause them to devote more time and skills to communicate and learn in a better way. It is believed that community in social media offers an opportunity to gain and share knowledge, solve problems by discussing, engaging in collective learning process, and other academic activities. Not only for students, as it shows in the matrix that social media and learning has some characteristics that are intertwine and able to harmonize each other, then it is possible that the educational institution can use social media as the portal to provide a channel where students, lecturer, and the content of learning can interact and engage with each other using the social media.

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# DESIGNING ANIMATION LEARNING MEDIA BASED MANAGAMENET LEARNING SYSTEM FOR VOCATIONAL ANIMATION MAJOR

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## ABSTRACT

*Animation industry has a big potency to give significantly contribution for economic in Indonesia. However develop animation industry in Indonesia constrained by lack of human resources who has appropriate competence with industry needs. School as an institution who create human resources has problems, lack professional teachers who competence in animation section, lack of productivity class hours, lack media instructional to support teaching and learning activities, and curriculum and material course is not up to date.*

*In consequence we need a media instructional with LMS based. Success indicator for this design program is availability a LMS instructional system that has been filled with content that developed into a more complex and complete with SKKNI based as a learning for online Media Instructional course.*

**Keywords:** *Animation, LMS, SKKNI, Learning Media*

## 1. BACKGROUND

Animation industry is sub-sector of creative industries that are believed can contribute to Indonesia economy significantly. Seem quoted from President Joko Widodo speech in Kompas 100 CEO Forum at Four Season Hotel Jakarta, Friday (07/11/2014) morning, said that the creative industry has a huge potential. Some creative industries he mentioned is animation, games, movies, fashion, culture, dance, and music

The history of animation in Indonesia was started in the 70s, but only really widespread in 1980-1990, when some private television stations in Indonesia began to establish. Unfortunately, the rate of develop animation industry in Indonesia constrained by international financial crisis in 2000s, until now only a few of small animation studio and animation freelancers are left and still able to survive.

Development of animation industry in Indonesia is comparatively very slow. Animation studios generally are not very long, the main problem is because the absence of infrastructure that not adequet one of them is lack of educated human resources in animation section (Grand Book Develop Animation Strategy Technology Section. Instructional institution has a important role to produce human resources. Education can be either formal education and non-formal education .One of form formal education in Indonesia is a vocational high school called SMK. Vocational high school is high school that oriented to prepare worker in middle level, for fulfill business or industries world. Regulation of the Minister of National Education no. 22 in 2006 on the Content Standards for elementary and secondary education units explains that, “vocational education aims

to improve intelligence, knowledge, personality, noble character, and skill learner to independent live and follow further education with vocational program”. Can work effectively, efficiently, develop expertise and skills, learners must has high stamina, Master expertise, basic knowledge and technology, has high work ethic and can communicate appropriate with work requirement and ability to develop themselves.

Based on the type of field work, vocational education programs are grouped into 6 groups: Agriculture, forestry groups, technology and industry, business and management, public welfare, tourism, arts and crafts. SMK in arts and crafts animation program expertise section is SMK that expected to produce animators that are reliable and ready for work in industry. One of the objectives of expertise animations that educate learner into middle-level worker, who able to develop career, professional attitude and competence on the job, whether to be independent or fill work vacancies in animation section. Animation program at SMK, learner are directed to enter film industry and advertising.

Based on reality, interviews result with animation teachers from Surabaya, malang, Semarang, Bandung and Cimahi, it can be concluded that there are obstacles in the process of learning and teaching in schools, especially animation department, :

- Curriculum is not suitable for industry needs
- Teacher shortages and difficulties to find teachers who have competence in animation
- Learn hours less productive

- Difficulties to search and update animation material course with industry development
- Not to apply dual mode (conventional and PJJ)
- Teacher teach for 24 hours/week

In the other hand, basically potential Assessment Formal Education Vocational High School Animation in Cimahi, 2011 by Moh.Rizaldi. There are many problems that are often complained of by business or industry world to vocational school graduates are:

- It is difficult to get competent human resources
- Animation skill at vocational graduates is still lack appropriate with industry needs
- Needs graduates vocational high school
- Weak Softskill
- Formal Institutions (SMK) has not been qualify to fulfill human resources needs who can make animation in quantity and quality

One of problems of education are a priority to solve immediately is quality of education, especially quality of learning. learning process is expected to appropriate with PP No. 19 of the SNP in 2005, learning process in educational unit organized in an interactive, inspiring, fun, challenging, motivating students to actively participate and provide enough space for initiative, creativity, and independence that suitable with talents, interests, physical and psychological development students. This indicates that teachers as subject learning process

inclassroom, to be able to plan a instructional strategy, so that learning can be successfully it can appropriate with educational purposes. Oriented learning on the learner can be done by building a learning system which allows students to have the ability to learn longer, varied, and not just studying its area of expertise. Learners must be able to have the key competencies and soft skill competencies that are useful for the future. While the demand of continuing education can be done through a continuing education program (continuiting education program), both for degree and non-degree education with flexible learning models, such as distance education, part-time education, and credit collection. Along with perkembangan following technologies supporting infrastructure, improving the quality of education above among others, can be done through the use of technology in a system known as e-learning. There are several variations of e-learning and one diantaranya Learning Management System (LMS). Learning Management System (LMS) is a system that can facilitate learners to learn a broader, more numerous and too varied. Through the facilities provided by the system, students can learn anytime and anywhere (any time any where) without limited by space and time. Material they can learn also more varied, not only in the form of a dish of words (text), but can be richer with visual variation, audio, and motion better known as Multimedia. In addition to a system that required course content in LMS containing appropriate materials, weighing and uptodate as a source of knowledge for students. Is a content-based approach with SKKNI (National Competence Indonesia) According to the Regulation of the Minister of Manpower and Transmigration Republic of Indonesia Number: Per. 21 / Men / X / 2007.



SKKNI is the formulation workability covers aspects of knowledge, skills and / or skills and work attitudes that are relevant to the duties and terms of office are determined in accordance with the provisions of the legislation. SKKNI. RSKKNI drafting Expertise Animation held in cooperation with the Human Resources Development Agency Animation and Content Industry Association of Indonesia (Ainaiki). Activities organized in the form of plenary sessions and group session was attended by 70 (seventy) people stakeholders in the field of animation, which consists of representatives from government, industry associations, professional associations, professional certification institutes, educational and training institutions, experts and practitioners Animation , Hopefully, through this design results obtained based animation instructional media learning content management system with appropriate SKKNI on vocational animation department.

## 2. RESEARCH METHOD

The research method is a method used descriptive qualitative study using the method of experimental approach to students and teachers. A structural work in a study is needed to draw up the good work plan, in planning the study, performed the design stage will be divided into 3 parts, namely data collection phase, the process of research and data analysis, and instructional media design process.

The concept used is the concept of e-learning. Self-learning is defined as an autonomous individual business students to achieve academic competency

(Kozma, Belle, Williams, 1978). E-learning as a form of self-study is not an attempt to isolate students from the guidance of professors as lecturers serve as a source, guide and encouragement. Self study indicate where the student does not depend on supervision (supervision) and directing faculty continuous, but students also have the creativity and initiative of its own, and able to work alone by referring padabimbingan obtained (Self Directed Learning, Knowles, 1975) term-based learning Web (e-learning) is an attempt to make a transformation of teaching and learning processes into digital form that is bridged by the Internet technology. This web-based learning objectives focused on the efficiency of the learning process. Ways of teaching and learning materials still refer to the SAP and the national curriculum. The concept of knowledge management, self-learning based on the creativity of the students, will encourage students to do an analysis to synthesize knowledge, generate text, information, and knowledge itself becomes the focus is more directed to the future (Winastwan, 2005: 2).

According Sembel (2006), there are three main benefits of e-learning teaching methods, namely:

- a. E-learning (especially web-based) provide flexibility
- b. E-learningmemberikan independence for students. Students are given the opportunity in control of its own to the success of the learning process that he did.
- c. In general, e-learning method gives the consequences are relatively cheaper cost.

### 3. OBJECTION

- Improving the quality of vocational school graduates majoring in animation
- Design a instructional media LMS-based that support teaching and learning activities with user friendly with content materials for vocational courses based SKKNI Animation major

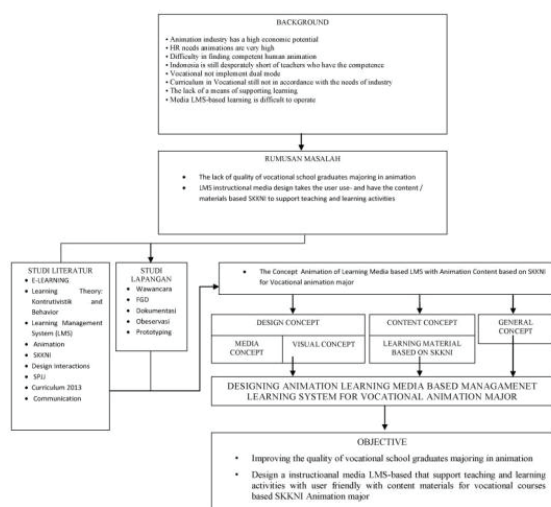


Figure 1 Design Framework

### 4. EDUCATION & ANIMATION

#### 4.1 Animation School of vocation

In the Law of the Republic of Indonesia Number 20 Year 2003 on National Education System, Article 1, paragraph 1 and 2 is written that:

1. Education is a conscious and deliberate effort to create an atmosphere of learning and the learning process so that learners are actively developing the potential for him to have the spiritual power of religion, self-control, personality, intelligence, noble character, and skills needed him, society, nation and state ,

2. The National Education is education based on Pancasila and the Constitution of the Republic of Indonesia Year 1945 is rooted in religious values, national culture of Indonesia and responsive to the demands of changing times.

Based RI Law No.20 of 2003, it is clear that education is an activity carried out in a planned manner to produce quality human in life in accordance with the times. Various attempts were made to produce quality human, to make Indonesia as a civilized nation, morals, and dignity best. Organized educational process organization and a natural or a family known as the path of formal and informal education.

RI Law No.20 of 2003 Article 1, paragraph 20 become clear: Learning is a process of interaction of learners with educators and learning resources in a learning environment

An overview of the quality of vocational education graduates extracted from Finch and Crunkilton (1984), that: "The quality of vocational education applying double size, the quality according to the size of the school or in-school success and quality standards according to the size of the community or out-of school success standards" , The first criteria include aspects of student success in meeting the demands of the curriculum that has been oriented to the demands of the working world. The second criterion, the ability of graduates to succeed outside of school related to the job or the ability to work normally carried out by the business or industry.

Graduates of vocational expected to be able and ready to work as a expert, and can open up employment opportunities, but in fact numeric absorption of graduates in the world of work and industry is still far from the expected numbers, in addition to the availability of jobs are still not in accordance with the number of graduates produced, the quality factor is still the cause of many graduates of graduates who have not worked.

vocational school (SMK) majoring in animation has been 11 years since it was first initiated by Denny A Djoenaid in 2004 who is chairman AINAKI with the Director of Secondary and Vocational Education, Gatot Hari Priowirjanto. This animation majors originally formed in eight vocational, among SMKN 5 Bali, SMK 1 Malang and Yogyakarta SMKN. Currently there are 74 vocational courses Animation scattered all over Indonesia by Source: <http://datapokok.ditpsmk.net/>. But this is less offset by the number of universities that Conducting Studies Program Animation, Bulk Its Still Specialisation. Institutions or non-formal educational institutions Whatever the number is still very low. This has an impact on the number of professionals and academics in the field of animation that eventually led to the scarcity of professional teachers who have competence animation.

## 4.2. Animation

Animation is a collection of images are processed so as to produce movement. Animation realize the illusion (illusion) for movement by describing or showing a sequence of images that change gradually (progressively) at high speeds. Animation is used to describe the movement of an object for something. It lets something

fixed or static objects can move and looked as if alive.

Animation may take the form of two-dimensional, three-dimensional or through various distinctive impression. Although what form of animation is also used, he was able to make a difference in the programs that support it because human nature likes something dynamic rather than static. Nevertheless, the process of earning the animation is not an easy task. The necessary experience, skills and expertise are high for revenue purposes. Animation experts who are often identified as an animator needed in large amounts to produce a high-quality animation. Computer animation computer graphics continue to add the dimension of time to show the movement (motion).

Animation is a practical art which combines art, technology and communication. Animation is very multidisciplinary and complex enough so that it takes a considerable time and the right curriculum in studying. Animation curriculum is still not in line with the development of the industry. This resulted in the need for qualified human resources are difficult to fulfill by the educational institution.

## 5. LEARNING MEDIA

Media education play an important role in the learning process. The use of educational media, can assist teachers in presenting the material in the classroom. Learning success is determined by two main components, namely the methods of teaching and learning media. Both of these components are interrelated and inseparable. Use and selection of one particular teaching method has an consequence on the use of appropriate types of learning media. The function of

media in teaching and learning is to increase the stimulation of learners in learning activities. Ali, M (2005) states that the use of computer assisted learning media has a significant influence on the attractiveness of the student to learn the competencies being taught. The use of instructional media can save preparation time, improve student learning motivation, and reduce misunderstanding students against lecturers explanation given.

### 5.1. Learning management System

LMS according to the experts is:

- A software or software used to manage (administrative purposes), documentation, training materials and teaching materials as well as reports of teaching and learning online (connected to the internet). In other words, LMS is a software used to manage the activities and learning outcomes.
- Environment that is used by teachers / instructors to create, store, reuse, manage and deliver learning materials to students. (Ann Gordon).
- Application used to manage learning, submit content, (Content Delivery System), and track the online activities such as ensuring the presence in the virtual classroom, ensuring the collection time tasks, and track the results of student achievement. (Courts and Tucker, 2012)
- An application that functions automatically

mengadministrasian various learning activities. (Kerschenbaum 2009 in LMS Selection Best Practices).

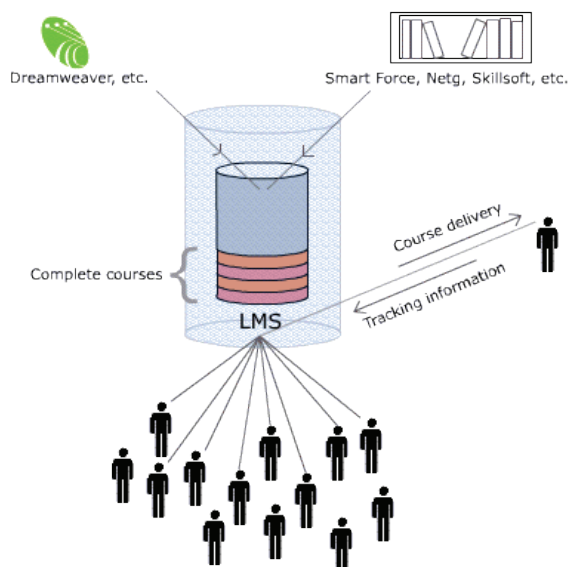
- Currently there are many types of LMS are offered, each type of LMS has its features according to each facility that has been given.

Generally functions to be possessed LMS include:

- Uploading and sharing material: LMS provides services to simplify the process of publishing material the learning process. Instructors will upload teaching materials in accordance with the syllabus that has been made, could be material notes, articles, quizzes, assessments and other. *Forum and chat* :
- Forum and chatting online is two way communication between teacher and student. either synchronous (chat) or asynchronous (forum, email). With existing facilities allows learners to write response, and discuss them with other friends
- *Quizzes and surveys* : Quiz and survey online can give grade instantly to learner. This is a good tool to get responses (feedback) from learner that appropriate with ability and their absorbtion.
- *Gathering and reviewing assignment* : Results obtained from evaluation / monitoring learning success is giving value or score to students automatically and online



- *Recording grades* : For evaluation learner in LMS has facility to monitoring and recording grade data from learner automatically.



**Figure 2** LMS System

LMS has scope :

- Administration
- Material Delivery
- Evaluation
- Monitoring
- Communication

Pengelola LMS terdiri dari tiga bagian dengan fungsinya, yaitu :

### 1) Administrator

- a. Student registration
- b. Determining teachers and materials
- c. Melakukan *back up* data
- d. *website management*

### 2) Instructor

- a. Making syllabus
- b. *file management*
- c. Make a test item , *quiz*
- d. Monitor activity learner or students
- e. Interaction with participant/student (*forum, chat, email*)
- f. See the progress participant/student

### 3) Student

- a. Syllabus access and material
- b. See result of assessment
- c. Working test / quiz
- d. Interaction with teacher, participant/student, ext (*forum, chat, email*)

#### 5.1.1 LMS Features

LSM generally provide some features :

- Instructional learning, such as user access rights to a learning material, it can be as a teacher, or a student, learning time limit, learning materials per week, etc.
- Provide activity reports and grades of students.
- Media communication between teachers and students, in forums, chat, blogs and wiki
- Provide means to collecting assignments, quizzes and exams
- Provide repository data (storage) of learning material that is being taken

More detail about LMS Features :

## 1. Administration

Goals and objectives

- Syllabus
- Teaching methods
- learning Schedule
- Taks
- exam schedule
- List of reference or reading material
- Profile and contact teachers
- Tracking / tracking and monitoring

## 2. Material Delivery

- Diktat and lecture notes
- Presentation materials
- Sample exams ago
- FAQ (Frequently Asked Questions)
- Sources of reference for task execution
- Useful sites
- The articles in online journals

## 3. Evaluation

## 4. Online exams and collecting feedback

## 5. Communication :

- Online discussion forum
- *Mailing list* discussion
- *Chat*

### 5.1.2 Platform LMS

Development of technology and e-learning, now available so many different types of e-learning platform has to offer, start from simple to complex, from free to paid, from self-hosted to hosted vendors,

and from made children of the country to abroad. Each platform brings advantages and disadvantages each platform which certainly has the same goal which is aimed at facilitating the needs of teachers and students in the learning process, sharing teaching materials, discussion, test, chat, etc.

*Platform e-learning yang berbasis Open Source (self-hosted), yaitu :*

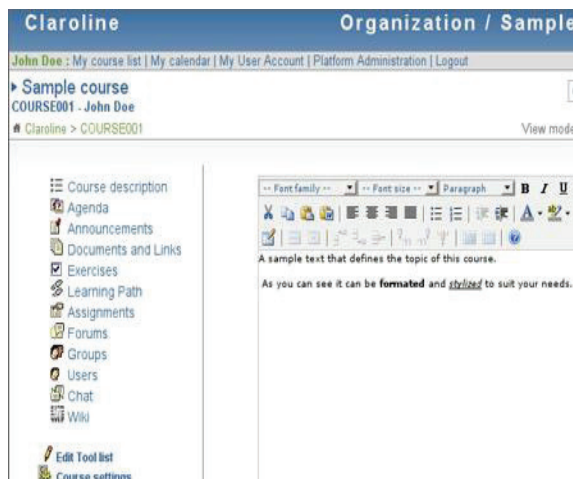
## • Moodle



**Figure 3** Moodle

Moodle is a name for an application program that can change a learning media into a web form. This application allows students to enter into the digital classroom for accessing learning materials. By using Moodle, can make learning materials, quizzes, electronic journals and others. Moodle itself is an acronym for Modular Object Oriented Dynamic Learning Environment. To get Moodle can visit the site at the address

- **Claroline**



**Figure 4** Claroline

Claroline is platform open source e-learning and teachers enable to develop online class and effective to manage learning activity and web collaboration. Claroline has been translated into 35 languages and has users and community developers around the world.

Claroline has been developed following teachers' pedagogical experience and needs. Offers intuitive and clear interface administrative space. Daily platform management does not require any special technical capabilities. Platform quickly installed and use a web browser allows to manage a variety of courses and sections registered users smoothly. The concept of space held Claroline platform associated with a program or pedagogical activities. Each space provides a list of tools that enable to create learning contents, manage training activities and interact with learners

- **Dokeos**



**Figure 5** Dokeos

Dokeos is type of many LMS development .Dokeos is e-learning tools for web based application. Dokeos is free and dokeos is software that realease by GNU GPL and supported by internasional development. Certified operating system that can be used as a content management system for education. Contents include distribution of teaching materials, calendars, learning progress, conversation via text / audio and video, exercises, tests, and save file.

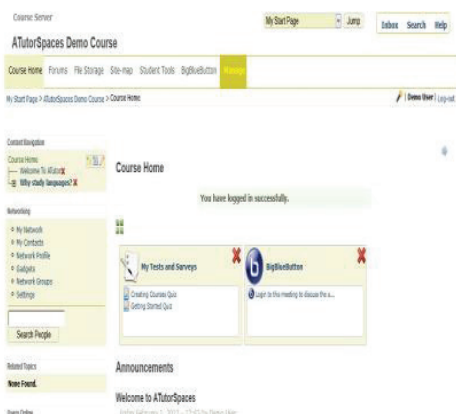
- **LMS Joomla**



**Figure 6** Joomla

Joomla is an open source development of the Mambo project, previously known as the Mambo Open Source or MOS. Used to create or build a dynamic website that has various facilities that support them.

- **aTutor**



**Figure 7** aTutor

aTutor is a LMS that designed with ability to quick access and ease to adaptation. Admin can install (and update) aTutor, set a new theme, and easily develop all functions with module features easily and quickly. Students can quickly add, package, and redistribute Web-based instruction content, easily import content of new packaging package and combine courses online. Students learn in adaptive learning environment. To get aTutor you can visit address <http://atutor.ca/>

- **Docebo**



**Figure 8** Docebo

Docebo LMS is an open-source software package for e-learning (LMS - Learning Management System and LCMS - Learning Content Management System), entirely created and developed by Docebo Srl. The program, which is released under the GPL license, has no license fees.

The Docebo Features :

- ~ Competence management
- ~ modules and gap analysis
- ~ Course and curriculum management system
- ~ Standard and customized reports terraced
- ~ Generation and printing PDF certificates
- ~ Track monitoring and SCORM 1.2 and 2004 support
- ~ Administrator manajemen and *profiling*
- ~ Multimodel Didaktik support (Cognitivism, constructivism and blended learning)
- ~ Exporting reports in Excel format and others, scheduling reports for automatic delivery of third party software / services interfacement
- ~ Third-party software / import and export data services..

Official site

<http://www.docebo.com/>



Which need to be considered in developing e-learning system is:

1. *Course Management*: Content can be updated and shared in internal or external agency if permitted.
2. *Testing & Quizzess*: This is to find level student understanding
3. *Communication*: Forum conducted between teachers and students in order to create an atmosphere that supports the teaching and learning process.
4. *Assignment*: Assignments is recorded so each student can know and do the tasks assigned by teacher
5. *Recording grades*:. Recording value, good value tasks, Quiz, UTS and UAS so students can be motivated to improve learning strategies which more effective.
6. *Glossary*: Terminology and units / dimensions involved in object of study.
7. *Survey*: To assess the degree of success and effectiveness of e-learning system for future improvements.
8. *Site Management*. Management e-learning site to be better, comprehensive, and integrated with other systems

## 5.2 The Success Factor of Developing LMS

LMS development requires planning and feasibility studies were done on the program for all levels, facilitating learners to study individual or group, to establish effective communication and creating a learning community that this

development is able to answer the various problems in education, employment and scientific world.

LMS development in an institution can not be separated from the following factors: (i) policy and planning, (ii) leadership, (iii) the infrastructure and resources, (iv) management, (v) the ability and competence of teachers and staff, and (vi) the level of technical support.

## 6. THE CONTENT

Most of the vocational curriculum of 2013 as the reference for the teaching and learning program, but the development of the animation industry is so fast that raises many knowledge-knowledge and new skills that require students to master it. This is a challenge the school to keep abreast of industry developments and update the curriculum along with the material. But in fact the school is very difficult to get an update from the industry. Program link & match with the industrial world tends to be difficult to realize given the industry is very busy with the routine and the school does not persistent enough to synergize with the industrial world.

Indicators of success of the program design is the existence of a learning system LMS that has been filled with content that dikembanangkan become more complex and complete as a learning Course Media

Online learning. To make the necessary course material content or curriculum guidelines in accordance with the needs of industry. Because every industry has its peculiarities, the government set up a

national competency standards called SKKNI (National Competence Indonesia). In the SKKNI Animation has set about abilities to possess someone to perform a task or job that is based in accordance with the required performance. In the latest Animation SKKNI explained that for the level of vocational competency standards that must be achieved is Level 2 and level 3.

LEVEL ANIMASI	KUALIFIKASI NASIONAL	JALUR PENDIDIKAN	
		FORMAL	NON FORMAL
I	I	SMK	--
II	II	--	--
III	III	Universitas	Kursus
IV	IV	Universitas	Kursus
	V	Universitas	Kursus
V	VI	Universitas	--
--	VII	Universitas	--
--	VIII	Universitas	--
--	IX	Universitas	--

**Figure 9** SKKNI Level of competence

**B. Pemetaan dan Kemasan Standar Kompetensi**

**1. PEMAKETAN BERDASARKAN JENJANG KUALIFIKASI KKKNI**

Kategori	: INFORMASI DAN KOMUNIKASI
Golongan pokok	: Produksi gambar bergerak, video dan program televisi, perekaman suara dan penerbitan musik
Nama pekerjaan/profesi	: Operator
Area pekerjaan	: Technical
Jenjang KKKNI	: Sertifikat II

No	Kode unit	Judul unit kompetensi
1	J.591120.001.01	Melakukan pemindaian digital
2	J.591120.002.01	Melakukan pewarnaan gambar karakter (coloring)
3	J.591120.003.01	Melakukan perekaman rancangan dialog
4	J.591120.004.01	Membuat gerak digital non character
5	J.591120.005.01	Membuat sekuensial gambar gerak sela (inbetween)
6	J.591120.006.01	Melakukan penyuntingan suara dan gambar bercerita (animate / previsualisation)
7	J.591120.007.01	Membuat kumpulan aset digital (layout 3 dimensi)
8	J.591120.008.01	Membuat model digital hard surface 3 dimensi
9	J.591120.009.01	Membuat model digital organik 3 dimensi
10	J.591120.010.01	Membuat elemen gambar digital puppeteer
11	J.591120.011.01	Membuat pencitraan UV mesh

**Figure 10** Level 2 Package of learning material

Kategori	: INFORMASI DAN KOMUNIKASI
Golongan pokok	: Produksi gambar bergerak, video dan program televisi, perekaman suara dan penerbitan musik
Nama pekerjaan/profesi	: Operator
Area pekerjaan	: Technical
Jenjang KKKNI	: Sertifikat III

1	J.591120.012.01	Membuat pencitraan gambar digital (rendering)
2	J.591120.013.01	Membuat pencitraan tekstur permukaan
3	J.591120.014.01	Membuat rancangan antar sambungan mekanika dan objek digital (skinning)
4	J.591120.015.01	Membuat rancangan mekanika gerak digital (rigging)
5	J.591120.016.01	Membuat sekuensial gambar gerak utama (keyframing)
6	J.591120.017.01	Membuat gerak digital character
7	J.591120.018.01	Membuat gerak digital puppeteer

**Figure 11** Level 3 Package of learning material

Animated learning content in LMS will be based SKKNI, so the material prepared is the result of translating the competencies that have been arranged according to at each level.

## 7. CONCLUSION

From the results of research on the constraints faced by the school in the course of learning in vocational animation department especially productive learning and research about the level of satisfaction of students majoring in animation SMK found that (1) the difficulty in getting a school teacher who has the competence fields of animation are ideal (2) curriculum and materials that had been given by the government is still not in accordance with the development of the industry (3) hours of animated lessons are still less productive (4) is still minimal use of technology for learning or learning support media. In the end, these problems lead to the quality of the

graduates of vocational students majoring in animation industry is still not qualified, while the need for human resources vocational animation very high level, which in turn led to the development of the animation industry in Indonesia very slow.

Through learning technology by utilizing advances in technology can be a solution to the problems of education in vocational courses animation. Learning materials of animation subject are very complex and multidisciplinary thus require a medium of learning that can accommodate activities ideal learning in class. One of the media that is ideal is Learning Management System (LMS). LMS is A software or software used to manage (administrative purposes), documentation, training materials and teaching materials as well as reports of teaching and learning online (connected to the internet). In other words, LMS is a software used to manage the activities and learning outcomes. Indicators of success of the program design is the existence of a learning system LMS that has been filled with content that developed become more complex and complete as a learning Course Media Online learning. To make the necessary course material content or curriculum guidelines in accordance with the needs of industry. Because every industry has its peculiarities, the government set up a national competency standards called SKKNI (National Competence Indonesia). Animation SKKNI explained that for the level of vocational competency standards that must be achieved is Level 2 and level 3.

Finally, designing animation learning media based management learning system for vocational animation major can help reach the objective.

The objectives are

- Improving the quality of vocational school graduates majoring in animation
- Design a instructional media LMS-based that support teaching and learning activities with user friendly with content materials for vocational courses based SKKNI Animation major

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# Implementation of Squeezer Algorithm in Fashion E-Catalogue

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**Abstract**—This paper describes about the design process of fashion e-catalogue by implementing web-based squeezer algorithm. There are still many fashion stores that don't have any e-commerce website for their marketing purposes, so the author did a research on this algorithm. Squeezer algorithm is used to provide recommendations to the store customers, and according to Zengyou HE et al, the squeezer algorithm is very good on creating clusters because it is effective in using its memory. Poy Collection store have been chosen for this research case study because of its location in Mangga Dua Mall - Jakarta, its' become one of the most crowded fashion store. The PHP (Hypertext Preprocessor) have been considered as a very appropriate programming language for developing an open source web-based applications. This research proved that the squeezer algorithm can be implemented to provide recommendations about the fashion to buy for the customers based on the history lists of fashions had been seen by the customer.

**Keywords**—squeezer algorithm, fashion, e-catalogue, recommendation

## I. INTRODUCTION

Internet technology grows rapidly these days either in developed countries, as well as in developing countries. According to the data from Internet World Stats[1], world population in the year 2014 have reached 7.182.406.565 people, and internet users worldwide is June 2014 have reached 3.035.749.340 people or about 42.3% of the total world population. Especially for Indonesia, according to the data from Internet World Stats [1], the population of Indonesia in 2014 have reached 253.609.643 people, and internet users in Indonesia have reached 71.190.000 users in June 2014. It is expected that internet user will increase along with the advancement of internet technology. And also internet has changed life style of the people in daily life, either in business activities.

There is a fashion store in Mangga Dua Mall, Jakarta, called Poy Collection Shop. This shop has hundreds of items of fashion, consists of shirts, t-shirts, and many others. The huge collections make the customers confusing how to choose the items that will be bought. This shop does not provide any catalogues, due to the rapid move of the items. At that time, the Poy Collection Shop has not yet use the Internet technology for its marketing effort. And then the shop owner was offered to build website for online marketing. Based on

the owner agreement, a website of online marketing was develop.

In this research squeezer algorithm was used to provide a recommendation about what kind of fashion products should be bought by the customers. Firstly, the customers must registered himself or herself to the website as a member. Recommendation will be provided to the customers are based on the items frequently sees in the website, so that the recommendation will be different from on customer to the others.

## II. RECOMMENDATION SYSTEM

Recommendation system is a system that capable of provides recommendation to the system users. The recommendation given can be based on the characteristic of users' data [2].

Collecting data for recommendation system building can be directly or indirectly [3].

Direct data collecting can done as follow [3]:

1. Ask the user to give rating of the item.
2. Ask the user to give rank to the most favorite item, at least by choosing one item.
3. Provide a selection of item to the user and ask the user to choose the best one.
4. Ask the user to give preferred item list or not-preferred item list.

Indirect data collecting can be done by [3]:

1. Observe items viewed by the users in e-commerce website.
2. Collecting user transaction data in online shop.

The collected data are then become input to be processed with the output is a recommendation to the user in online shop or e-commerce website, by using certain algorithm. Recommendation system can also be used as an alternative of searching engine in searching an item to be found out by user.



### III. E-CATALOGUE

E-catalogue (Electronic catalogue) contains information about products and services offered and sold by an enterprise through internet [4].

E-catalogue has some advantages and disadvantages. The advantages of e-catalogue are [4]:

1. Reduce marketing cost.
2. No worry about printing specification, like color separation accuracy, paper thickness, and printing qualities.
3. No distribution cost of catalogue.
4. Enhance the service to customers by fast reaching the customers, provide the information, and update the catalogue.
5. Reduce time and cost in maintaining catalogue that always needs renewal.

6. Enable customers to search information about certain products quickly.

The disadvantages of e-catalogue are [4]:

1. Too frequent prices and inventory update will increase the cost to design and maintain the website or the e-catalogue application.
2. E-catalogue needs synchronization of customer database with databases of products, inventory, finance, and so on.
3. The users of E-catalogue need to have computer and internet.

### IV. SQUEEZER ALGORITHM

Squeezer algorithm is an algorithm used to make clustering of categorical data. Squeezer algorithm repeatedly will read every data pair (tuple) from a set of data, one by one. When the first pair is read, it will make a new data cluster. The next data pair will be insert in existing data cluster, or rejected by all existing data clusters, so that it will make new cluster based on similarities of the given function between clusters and data pairs [5].

There is a definition used in the squeezer algorithm. Let say  $A_1, \dots, A_m$  are the set of attributes categorical with the domain  $D_1, \dots, D_m$  sequentially. Let say the data set of  $D$  is the set of data pairs where each data pair  $t : t \in D_1 \times \dots \times D_m$ . Let say TID are the set of unique ID of every data pair. For every  $tid$  TID, the attribute value of  $A_1$  from its data pair will be represented as  $val(tid, A_1)$  [5].

Here are some definitions used in squeezer algorithm [5].

**Definition 1.**  $Cluster = \{tid \mid tid \in TID\}$  is subset of TID.

**Definition 2.** Given Cluster  $C$ , the set of attribute value in  $A_i$  contains in  $C$  is defined as:

$$VAL_i(C) = \{val(tid, A_i) \mid tid \in C\} \quad (1)$$

**Definition 3.** Given Cluster  $C$ , and  $a_i \in D_i$  so support (tuple quantities in the cluster with attribute value) of  $a_i$  in  $C$  with its  $A_i$  is defined as:

$$Sup(ai) = |\{tid \mid tid.A_i = a_i\}| \quad (2)$$

**Definition 4.** Given Cluster  $C$ , Summary for  $C$  is defined as:

$$Summary = \{VS_i \mid 1 \leq i \leq m\} \quad (3)$$

where

$$VS_i = \{a_i, Sup(a_i) \mid a_i \in VAL_i(C)\}$$

**Definition 5.** Given Cluster  $C$ , Cluster Structure (CS) of  $C$  is defined as:

$$CS = \{Cluster, Summary\} \quad (4)$$

**Definition 6 (Similarity Function).** Given Cluster  $C$  and one data pair  $t$  with  $tid \in TID$ . Similarity between  $t$  with  $C$  is defined as:

$$Sim(C, tid) = \sum_{i=1}^m \left( \frac{Sup(ai)}{\sum_j Sup(a_j)} \right) \quad (5)$$

where

$$tid.A_i = a_i \text{ and } a_j \in VAL_i(C)$$

The pseudo code of squeezer algorithm can be read on figure 1.

```

Algorithm Squeezer( $D, s$ )
Begin
1. while ( $D$  has unread tuple) {
2.   tuple = getCurrentTuple( $D$ )
3.   if (tuple.tid == 1) {
4.     addNewClusterStructure(tuple, tid)
5.   } else {
6.     for each existing cluster  $C$ 
7.       simComputation( $C$ , tuple)
8.     get the max value of similarity :  $sim\_max$ 
9.     get the corresponding Cluster Index:  $index$ 
10.    if ( $sim\_max \geq s$ )
11.      addTupleToCluster(tuple, index)
12.    else
13.      addNewClusterStructure(tuple, tid)
14.  }
15. handleOutliers()
16. outputClusteringResult()
End

```

Figure 1. Squeezer Algorithm [5]

Figure 2 and 3 describe the pseudo code for sub function addNewClusterStructure() and addTupleToCluster().

```

Sub_Function addNewClusterStructure( $tid$ )
1.  $Cluster = \{tid\}$ 
2. for each attribute value  $a_i$  on  $A_i$ 
3.  $VS_i = (a_i, 1)$ 
4. add  $VS_i$  to Summary
5.  $CS = \{Cluster, Summary\}$ 

```

Figure 2. Sub-function addNewClusterStructure() [5]

```

Sub_Function addTupleToCluster( $tuple, index$ )
1.  $Cluster = Cluster \cup \{tuple, tid\}$ 
2. for each attribute value  $a_i$  on  $A_i$ 
3.  $VS_i = (a_i, Sup(ai)+1)$ 
4. add  $VS_i$  to Summary
5.  $CS = \{Cluster, Summary\}$ 

```

Figure 3. Sub-function addTupleToCluster() [5]

```

Sub_Function simComputation(C, index)
1. Define sim = 0
2. for each attribute value ai on Ai
3. sim = sim + probability of ai on C
4. return sim

```

Figure 4. Sub-function *simComputation()*[5]

Figure 4 above are functions to calculate similarity of tuple to a cluster. Firstly, it is defined similarity as 0, then check each attribute of its cluster against the tuple attribute. After getting the end result of similarity, the function will return the value of similarity.

## V. IMPLEMENTATION AND TESTING

### A. Implementation

The main interface of the system can be seen on Figure 5. It shows us the home page with random recommendation for the customer, since there is no log history yet.

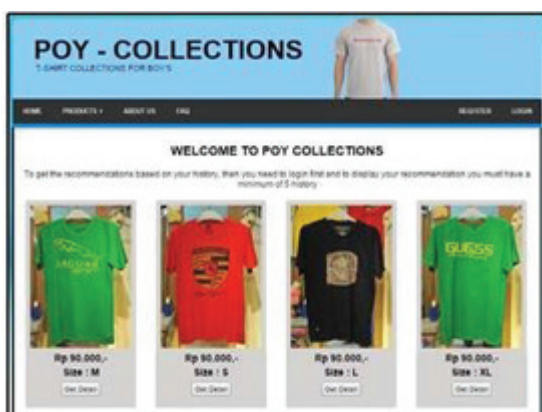
Figure 5. Home Page with *Random Recommendation*

Figure 6 shows us the user interface of the system when the customer already login to the member page. When a customer already login, all the activities done by the customer will be stored and become base history for future recommendation which is calculated by using squeezer algorithm.



Figure 6. Home Member Page where the Recommendations are based on the User Preferences

### B. Testing

The testing was done by preparing two scenarios of choosing fashion. Here are the scenarios of choosing the fashion and the results of recommendations of squeezer algorithm.

Table 1. Testing table Squeezer Algorithm 1

TUPLE ID	SIZE	COLOUR	KIND OF ITEM
1	S	YELLOW	T-SHIRT
2	M	GREEN	T-SHIRT
3	XL	BLUE	T-SHIRT
4	S	RED	T-SHIRT
5	M	RED	T-SHIRT
6	M	GOLD	T-SHIRT
7	XL	GREEN	T-SHIRT
8	M	GREY	T-SHIRT
9	L	BLUE	T-SHIRT
10	S	RED	T-SHIRT
11	L	RED	SHIRT
13	S	YELLOW	SHIRT
14	M	BLACK	SHIRT
15	XL	PINK	SHIRT

In Table 1 there are 15 list of fashion, consist of 10 t-shirts and 5 shirts. From the calculation by using squeezer algorithm, the system had formed seven clusters, i.e.:

$$\begin{aligned}
 C1 &= \{1,4,10\} & C4 &= \{9\} & C7 &= \{15\} \\
 C2 &= \{2,5,6,8\} & C5 &= \{11,15\} \\
 C3 &= \{3,7\} & C6 &= \{12,14\}
 \end{aligned}$$

From the seven clusters then it was chosen three clusters with the biggest set member. And based on the above results, the clusters with the biggest member are cluster 2 (C2) with four set members, cluster 1 (C1) with three set members, and cluster 3 (C3) with two set members.

Based on the three clusters, then the system will search for the size, color, and the dominant fashion type or the most quantity in each cluster. If there is only one cluster, then the recommendation will be made based on that cluster. If there are two clusters formed, then there will be displayed two recommendations, each with two fashion, either from the most dominant cluster and the second cluster.

If there are three clusters or more then the system will display recommendation from two dominant categories in cluster 1 with the biggest set members, and 1 dominant category in cluster 2 with the second biggest set members, and

1 dominant category from cluster 3 with the third biggest set members. The resulted recommendations are

- C2: Size M, any color, and item type t-shirt.
- C1: Size S, red color, and item type t-shirt.
- C3: Size XL, any color, and item t-shirt.

This means that the recommendation results that will be given to the member are:

- two items with M size, any color; and t-shirt item;
- one item with S size, red color, and t-shirt item,
- one item with XL size, any color, and t-shirt item.

Table 2. Testing table Squeezer Algorithm 2

TUPLE ID	SIZE	COLOUR	KIND OF ITEM
1	M	GREEN	T-SHIRT
2	L	RED	T-SHIRT
3	L	YELLOW	T-SHIRT
4	M	WHITE	T-SHIRT
5	M	BLUE	T-SHIRT
6	S	GREY	T-SHIRT
7	XL	RED	T-SHIRT
8	M	BLACK	T-SHIRT
9	XL	BLUE	T-SHIRT
10	M	GREEN	T-SHIRT
11	M	WHITE	T-SHIRT
13	S	RED	T-SHIRT
14	XL	BLUE	T-SHIRT
15	M	BROWN	T-SHIRT

In Table 2 there are 15 fashion lists, consist of 15 t-shirts. From the calculation by using squeezer algorithm, the system was formed four clusters, i.e.:

$C1 = \{1,4,5,8,10,11,12,15\}$        $C3 = \{6,13\}$

$C2 = \{2,3\}$        $C4 = \{7,9,14\}$

From the four clusters it was chosen three clusters with the biggest set member. And based on the above results, the clusters with the biggest member are cluster 1 (C1) with eight set members, cluster 4 (C4) with three set members, and cluster 2 (C2) with two set member.

Based on the three clusters, then the system will search for the size, color, and the dominant fashion type or the most

quantity in each cluster. If there is only one cluster, then the recommendation will be made based on that cluster. If there are two clusters formed, then there will be displayed two recommendations, each with two fashions, either from the most dominant cluster and the second cluster.

If there are three clusters or more then the system will display recommendation from two dominant categories in cluster 1 with the biggest set members, and 1 dominant category in cluster 2 with the second biggest set members, and 1 dominant category from cluster 3 with the third biggest set members. The resulted recommendations are

- C1: Size M, green color, and item type t-shirt.
- C4: Size XL, blue color, and item type t-shirt.
- C2: Size L, any color, and item t-shirt.

This means that the recommendation results that will be given to the member are

- two item with M size, green color; and t-shirt item type;
- one item with S size, blue color, and t-shirt item type,
- one item with L size, any color, and t-shirt item type.

## VI. CONCLUSION

Based on the research conducted, it can be conclude that the implementation of squeezer algorithm in fashion e-catalogue can be done very well. The system can provide recommendation to the users about the fashion type (shirt or t-shirt), the size, and the color.

As for future work, the recommendation system can be improved so that it's not only using the historical log data done by customer to give the recommendation, but also by using collaborative filtering so that it can give a popular recommendation by the other customer.

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# **Strategic Information System**



# Implementing ERP Systems : challenges for increasing synchronize business strategic

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## ABSTRACT

The conditions of high competition, it requires each company to have a breakthrough in business strategy in an effort to have a competitive advantage with other companies, so the company can survive, grow, and increase profit. To that end, the company should seek to improve the performance of the business process. One way to achieve this is by implementing Enterprise Resource Planning (ERP) system. ERP system is an integrated system to support the company's core business, which includes manufacturing, logistics, finance and accounting, sales and marketing, and human resources. ERP systems will help improve the workings of a more efficient and effective in sharing data and information, which ultimately companies can survive and even improve the lucrative and growing into a better direction. However, in reality, The companies are faced with a number of complexities that have the risk of failure of ERP implementation, which also affects synchronize strategic business. To that end, taking into account the benefits, companies need to consider the risks of experiencing a significant loss of value of investments in procurement (software), telecommunications, infrastructure systems, and MIS personnel recruitment.

This study aims to describe how the impact of ERP implementation for increasing synchronize business strategic, with a study case research about evaluation of ERP implementation in production module at manufacturing companies.

### Keywords :

*Enterprise Resource Planning System, Implementation*

## 1. INTRODUCTION

ERP system are computer based systems designed to process an organization's transactions and facilitate integrated and real-time planning, production, and customer response [2, 2009:9]. ERP system is the core software used by the company to coordinate information on each business area. ERP systems help enhance business processes and presenting a variety of information that can be used for management decision making.

Based on the explanation of the definition of ERP systems mentioned above, it can be concluded that the ERP system must be developed as needed to achieve the improvement of business processes across the enterprise business unit functions. The objective of ERP system is to improve ways of working more efficiently and effectively, providing value-added companies, such as: reducing the double work, streamlining work processes, process integration, and process automation.

An ERP system is an integrated package of multi-module application program, which is designed to serve and support a variety of business functions in an integrated way, to achieve a more efficient way of working, improving the company's performance, which ultimately can provide the maximum benefit for the company. To achieve that, the implementation of ERP systems for a company is an important and urgent needs.

## 2. LITERATURE REVIEW

### 2.1 Why ERP System can increase efficient ?

Considering the complexity of the issues facing business, therefore the company should have the ability to analyze, respond to issues potentially significant and have problem solving skills, so expect the company to compete and increase profit maximally. Through an ERP System, it is hoped will be the synergy of all the functions of existing departments within the company. For example: when a customer order data input in application program, then the customer will automatically get all the information is complete and detailed matters relating to orders, such as: the value of consumer debt, history of previous orders, order inventory level in the warehouse, order delivery schedules, and other necessary information. This happens, of course, with the existence of a value chain (value chain), where the company's activities begin with the existence of a customer and market demand for a particular product.

In addition, ERP system all the functions expected of synergies existing departments within the company. ERP systems can involve all management functions, such as Accounting and Finance function, Manufacturing function, Sales and Marketing function, Purchasing and Inventory Functions, Human Resource functions. ERP systems manufacturing functions, the company can process the use of raw materials, labor use, charging overhead costs to be finished products efficiently and effectively.

In general, Implementing an ERP system will have benefits as follows:

- **Reduce unnecessary cost.** ERP systems can significantly reduce the cost of processing transactions that supported the use of Information Technology when compared with systems that are not integrated. This is caused by an integrated ERP system, then the managerial level is not only monitors the operations, but rather focus on how strategies should be done in order to become better corporate performance
- **Increase working efficiency.** ERP system can create a framework to integrate and enhance the company's internal business processes to produce a significant improvement in the quality and efficiency for customer service, production and distribution.
- **Improve coordination between functional areas.** Implementing ERP system can eliminate the cultural differences between departments, so the data can be integrated. And eliminate the walls departments and functions of business processes, information systems and information resources, resulting in organizational structure, managerial responsibility and the role of a more flexible work, and therefore generate the organizational structure and workforce more agile and adaptive which can be more easily exploit new business opportunities.
- **Reduce double jobs.** Implementing ERP system will not occur repetition of work processes, where other parts that require this information, do not need to enter again, just look in the application of ERP programs.
- **Improve customer satisfaction.** Through the working process of ERP system, fast and available all the information needed by the customers who use the ERP system, then this is certainly going to increase trust and customer satisfaction.
- **Assist decision-making.** ERP systems can simplify the tasks of managerial level in decision making and perform management functions in planning, organizing, monitoring and control. ERP systems can provide information about business performance across the function which is essential for rapid decision-making and managerial levels in order to significantly enhance the ability to make decisions on the cross-company business.
- **Integration and consistency of data.** ERP systems produce accurate information from relevant input data for planning activities that involve inter-departmental resources to be managed and allocated in an efficient and effective.
- **Improve business performance.** ERP system controls the entire business process by combining all activities of each department in a single integrated system. Thus, unavoidable leakage, waste, misuse of company resources and resource allocation that is not appropriate.
- **Increase profitability.** Improved profitability is the goal in using ERP systems, where this is happening due to companies using ERP systems, in order to reach synergy and efficiency at work, which the company ultimately have competitive advantage.

## 2.2 Issued in Implementation of ERP System

Although it is known that ERP systems can provide competitive advantage, but in its business practices, common obstacles in implementing ERP system, not even a few companies have failed in implementing an ERP system. This is often not understood by many companies and subsequently trapped at the time of implementing ERP system.

In general, the barriers or problems faced companies in conducting an ERP implementation are as follows:

- Technical Management Language problem an ERP application and the changes in the workings of the model become a model display hardcopy is to be the technical controls that need attention.
- Culture ERP systems implementation based on the use of Information Technology, would require changes that must be done in using the ERP program application. For that, need to do change the corporate culture that makes work become more efficient and effective.
- Politics obstacles that hinder the implementation of ERP systems can be sourced from department of information technology itself and from outside the department of information technology. Where if the majority of IT personnel feel that the job will replaced by the ERP system, which the IT department which was originally responsible for the making of the application program will create an application program that does not fit the needs of users. Similarly outside the IT department personnel will feel threatened by reduced power because most of the work will be done by the ERP system.

One of the factors of failure of ERP implementation is people factor. The people have working with patterns not integrated systems, already feel comfortable with the system running, so will experience a reluctance to learn to use a new system that is integrated. This is experienced especially for old people, so do not want to risk in the use of a new system with the use of Information Technology sophisticated. The high level resistance to using of ERP systems can be caused by the existence of people who feel harmed by the use of integrated systems, where these people feel the fear that fraud will easily be known by the integrated system. Actually, with the implementation of ERP systems, so a company does not need to throw a lot of time to do the processes that are administrative, but the human resources can spend more time thinking about things that are strategic.

## 2.3 Critical Success Factors of ERP Implementation

ERP System need to streamline and improve business processes to be better in manage expenditure, competitive pressures, increased responsiveness to customer and their needs, integrate business processes. ERP systems by their very nature impact on a company's business strategy, organization and culture. However the potential benefits across the entire organization often outweighs the losses in individual areas.

Many researchers have attempted to identify the critical success factors (CSF) which impact on the successful implementation of ERP system. Critical success factors of

ERP Implementation are strong executive sponsorship and management support of the project mission and project team, Management will continue to provide best full time resources as agreed so as not to impact implementation, clear roles and responsibilities defined for the project in order to assure accountability, ownership, and quality, committed and well-informed project manager and project team having a thorough understanding of the project mission, goals, and milestones, A comprehensive project work plan and Project Management Plan, A thorough understanding of known project risks and assumptions, throughout the executive committee and project team, High quality of data, Committed and Capable and trained users. Important issues to consider when planning deployment include : incurring costs of operating both systems in parallel, Detecting and correcting errors in the new system, Potentially disrupting the company and its Information System operations, Training users and familiarizing customers with new procedures. Training Users is an essential path of any system deployment project. End users are people who use the system for day to day to achieve the system's business purpose. System operators are people who perform administrative functions and routine maintenance to keep the system operating. Training for end users must emphasize hands on use for specific business processes or functions, such as order entry, inventory control, accounting. System operator training can be much less formal when the operators aren't end users. [7,2012:429]

CRITICAL Success Factor	COMPONENTS	RESEARCHERS
Management structure and strategy	Lack of senior management support	Holland and Light, 1999
	Lack of proper management control structure	Summer, 1999
	Lack of a champion	Summer, 2000
	Ineffective communications	Shanks et al, 2000
	Lack of a change management strategy	Esteves, Casanovas and Paster, 2003
Software system design	Failure to adhere to standardized specifications which the software supports	Holland and Light, 1999
	Failure to effectively integrate "add on" modules	Allen Keru and Havenhand, 2002
	Failure to recognise the importance of applications specific knowledge	Esteves, Casanovas and Paster, 2003
Organizational fit	Failure to re-design business processes	Holland and Light, 1999
	Failure to follow and enterprise-wide design which supports and integration	Shanks et al, 2000
	Lack of data integrations and lack of data standardization	Esteves, Casanovas and Paster, 2003
Skill Mix	Insufficient training and re-skilling	Holland and Light, 1999
	Insufficient internal expertise	Summer, 1999
	Lack of business analysis with business and technology knowledge	Summer, 2000
	Failure to effectively mix internal and external expertise	Shanks et al, 2000
	Lack of ability to recruit and retain qualified ERP systems developers	Esteves, Casanovas and Paster, 2003
User Involvement and training	Insufficient training of end users	Holland and Light, 1999
	Ineffective communications	Shanks et al, 2000
	Lack of full time commitment of customer to project management and project activities	Summer, 1999
	Lack of sensitivity to user resistance	Allen Keru and Havenhand, 2002
	Failure to emphasize reporting	Esteves, Casanovas and Paster, 2003
Technology Planning	Inability to avoid technological bottlenecks	Holland and Light, 1999
	Lack of support client server implementation	Summer, 2000
	Attempting to build bridges to legacy application	Esteves, Casanovas and Paster, 2003
Project Management	Lack of disciplined flexible project management	Holland and Light, 1999
	Failure to recognise the risk of scope expansion (time cost)	Shanks et al, 2000

Table 1 – Critical Success Factor for ERP implementations

## 2.4 Business Process and Information Systems

The information is data that has been assimilated and evaluated by humans to solve a problem or make a decision. [5,2005: 498]. A Process is a coherent set of activities carried out by a collaborating group to achieve goal. The chunking of organizational activity into processes must be driven by an understanding of the business the organization is in. [3,2005:6]. Despite the rapid growth in networks and information technology, many companies today are still using separate subsystems in their daily operations to support such specialized functions as accounting information systems. When management make decision based on information obtained within one functional area, those decisions, which are apt to be made from a narrow perspective may not be in the best interest of the company. Given the current environment, companies should carefully examine every step in their business process and question the necessity of each step. It is critical for companies to use information technology such as ERP system to improve company performance. With ERP system, the database approach emphasizes the integration and sharing of data across major functional areas based on the company's business process. The design of an information system is event driven according to business process. [1,2007:1]

## 2.5 ERP Implementation

ERP Implementation are complex processes because they consist of so many interdependent activities. Testing is a key activity of implementation and deployment. Software components must be constructed in an order that minimizes the use of development resources and maximizes the ability to test the system and correct errors [7,2012:437]

The impact of ERP implementation is data can be extracted to produce some information. The information that accurate, up to date and informative is needed for management can make strategic decision making. Therefore, The organizations need to make improvements in order to achieve better work efficiency and effectively. In other words, it can be said that the information system can increase well performance and increase profitable. The successful of ERP Implementation need to be supported improvement of business processes running by adjusting the business processes of information systems used. To support this, The organization need people who have the competence to make changes of the business processes and organizational behavior for the better. ERP Implementation can be managed well, with better optimize the ability to utilize Information Technology to support business activities.

## 3. RESEARCH METHODOLOGY

The Collection of data and information that will be processed in support of this research, the researcher as authors do things as follows:

1. Primary data for research was collected from related books, publication, annual reports, and records of organization under study.
2. Secondary data has been collected through questionnaire and interview technique. For this purpose questionnaire was created on already established models and survey of literature.

#### 4. RESULT AND DISCUSSION

Researchers conducted a study on ERP implementation in production module at manufacturing companies, which the ERP system development is done in-house development by MIS internal department of company.

The Results of data collected by each end-user production department. Questionnaire method is considered able to get the results objectively whether the ERP implementation in accordance with the business processes and is able to provide solutions to performance for the development of a better system. Category choice answers to the questions contained in the questionnaire:

Category choice answers question No. 1

- a. Highly Efficient (> 5 minutes)
- b. More Efficient (> 3-5 minutes)
- c. Efficient (> 1-3 minutes)
- d. Less Efficient (<= 1 minute)
- e. Very In-efficient (longer than the old system)

Category choice answers question No. 2

- a. Very Good (6 modules)
- b. Good Enough (5 modules)
- c. Good (4 modules)
- d. Less Good (3 modules)
- e. No Good (2 modules)

Category choice answers question No. 3

- a. Very Easy (<1 week)
- b. Quite Easy (> 1-2 weeks)
- c. Easy (> 2-3 weeks)
- d. Less Easy (> 3-4 weeks)
- e. Not Easy (> 4 weeks)

Category choice answers question No. 4

- a. Very Rare (<3 times)
- b. Rarely (> 3- 6 times)
- c. Often (> 6-9 times)
- d. Quite often (> 9-12 times)
- e. Very often (> 12 times)

Category choice answers question No. 5

- a. < 10 days
- b. 10-20 days
- c. 20-30 days
- d. 1-2 months
- e. 2 months

Category choice answers question No. 6

- a. < 3 times
- b. > 3-6 times
- c. > 6-9 times
- d. > 9-12 times
- e. > 12 times

Weight rating is used for selection of each question is:

Value 5 is given to the choice of answers:

- a. Highly Efficient (> 5 minutes)
- b. Excellent (6 modules)
- c. Very easy (<1 week)
- d. Very rarely (<3 times)
- e. <10 days
- f. < 3 times

Value 4 is given to the choice of answers:

- a. Efficient enough (> 3-5 minutes)
- b. Good Enough (5 modules)
- c. Easy enough (> 1-2 weeks)
- d. Rarely (> 3- 6 times)
- e. 10-20 days
- f. > 3-6 times

Value 3 is given for the choice of answers:

- a. Efficient (> 1-3 minutes)
- b. Good (4 modules)
- c. Easy (> 2-3 weeks)
- d. Often (> 6-9 times)
- e. 20-30 days
- f. > 6-9 times

Value 2 is given to the choice of answers:

- a. Less Efficient (<= 1 min)
- b. Less Good (3 modules)
- c. Less Easy (> 3-4 weeks)
- d. Often enough (> 9-12 times)
- e. 12 months
- f. > 9-12 times

Value 1 is given to the choice of answers:

- a. Extremely Inefficient
- b. Very Not Good (2 modules)
- c. Very Not Easy (> 4 weeks)
- d. Very Often (> 12 times)
- e. 2 months
- f. > 12 times

After weight rating multiplied by the number of users of each choice answers, it will get the total value. Then the total value compared with a range of categories of answers to each question are obtained from a reduction in the total value of the maximum and minimum total value of the total value of the results of the questionnaire.

The questionnaire aimed to people administrative of production department, are as follows:



## Question No. 1

How long the ERP system can help speed up the completion of work compared to the old system?

Choice answer question	answer	score	total
> 5 minutes	0	5	0
> 3-5 minutes	1	4	4
> 1-3 minutes	15	3	45
<= 1 minute	5	2	10
longer than the old system	0	1	0
Total	21		59

Table 2 – Questionnaire

The total value for question 1 is 59, it can be concluded that the ERP system has been implemented efficiently and may speed in completing the work as compared with the old system.

## Question No. 2

How many modules of the ERP system are already well integrated?

Choice answer question	answer	score	total
6 module	0	5	0
5 module	0	4	0
4 module	2	3	6
3 module	19	2	38
2 module	0	1	0
Total	21		44

Table 3 – Questionnaire

The total value for question 2 is 44, then it can be concluded that the modules of ERP system in the company is already well integrated

## Question No. 3

How many days are required by people administrative of production department understanding and using the ERP system?

Choice answer question	answer	score	total
> 1 week	0	5	0
> 1-2 weeks	1	4	4
> 2-3 weeks	13	3	39
> 3-4 weeks	7	2	14
> 4 weeks	0	1	0
Total	21		57

Table 4 – Questionnaire

The total value for question 3 is 57, then the number of days about 2-3 weeks mean ERP system easily understood and used by users production department.

## Question No. 4

Is the ERP system that is applied in the production department is still frequently encountered errors within the last 1 year?

Choice answer question	answer	score	total
< 3 times	0	1	0
> 3-6 times	15	2	30
> 6-9 times	6	3	18
> 9-12 times	0	4	0
> 12 times	0	5	0
Total	21		48

Table 5 – Questionnaire

The total value to question 4 is 48, it can be concluded that the ERP system is applied in the production department rarely has an error within the last 1 year.

## Question No. 5

How long is the number of days of training that has been held for the user (user) for the last 1 year?

Choice answer question	answer	score	total
< 10 days	2	5	10
> 10-20 days	1	4	4
> 20-30 days	16	3	48
> 1-2 month	2	2	4
> 2 month	0	1	0
Total	21		66

Table 6 – Questionnaire

The total value for question 5 is 66, which proves that the number of days of training have been conducted for users of ERP system is more than 20 to 30 days each year.

## Question No. 6

How often the user needs help team support in dealing with problems that occur on the system each month?

Choice answer question	answer	score	total
< 3 times	0	5	0
> 3-6 times	1	4	4
> 6-9 times	5	3	15
> 9-12 times	15	2	30
> 12 times	0	1	0
Total	21		49

Table 7 – Questionnaire

The total value for question 6 is 49, it can be concluded that end user of department production requires 9-12 times assistance team support to solve problems that occur on the system each month.

The Results of the questionnaire can be concluded that the implementation of the ERP system is running well, but needs to develop ERP system in order to produce a better performance. Implementation of the ERP system can prove to increase the efficiency and effectiveness of production and increase productivity, generate information in real-time. It should be noted that the involvement of people actively using the ERP system is to determine the successful implementation of ERP system. It helps managers make decisions and ultimately improve the synchronization of strategic business, and can be optimized to integrate all data and information flow of business processes

## 5. CONCLUSION

ERP systems have become critical infrastructure for many businesses that provide integration to support core business processes achieve the work becomes more effective and efficient. However ERP implementation faced a number of issues because of their complexity and have a high risk of failure in the implementation of ERP. The challenges of ERP implementation is to ensure that the value of the investment can be empowering and useful to the interests of users, managerial, and parties related to the achievement of good performance and optimal in business process improvement. The challenges of ERP implementation can run well, not only depend on the software and the device used, but is determined by the end user and managerial ability in responding to enhance business processes. This is a challenge how the results of ERP implementation in an effort to improve and align business strategy, which is ultimately the company can increase profitable. It required a strong commitment of end-user and management to become an agent of change to managing the human resources within the organization to support changing business processes that focus managing on data and information for supporting decision making and help achieve management flexibility, which in the end the company have competitive advantage .

This research is limited by the size sample and far from comprehensive however it provides a starting point in an area of research which was virtually nonexistent. It provides future researchers with a foundation to expand upon.

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# The Maturity Level of Information Technology Governance of Online Cosmetics Business

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**Abstract**— The tendency of the management that focuses on facets of strategies and business risks without comprehending the procurement, the implementation, the availability of services, and information technology governance supports leads to not centralised online cosmetics business management and an increasing level of the customer turnover. The aims of this research are to cognise the gap value of each process of DS (Deliver and Support) and AI (Acquire and Implement) Domains and to recommend the information technology which is suitable for COBIT 4.1 Framework. The maturity level of the information technology governance of DS Domain shows that the average score is 2.301 and the lowest one is on the process of DS4, i.e. 1.968. This condition reflects that all processes have not reached 2.51. Meanwhile, the average score of AI Domain is 2.674 and the lowest one is on the process of AI4, i.e. 2.456. Evenly, AI Domain has been at the interval 2.51-3.50 (defined process). The relationship among DS4 and other information technology processes is on the control objective input comprising PO2, PO9, AI2, AI4, and DS1 and the control objective output consisting of PO9, DS1, DS8, DS9, DS11, and ME1. On the other hand, AI4 Domain has the control objective input comprising PO10, AI1, AI2, AI3, AI7, and DS7 and the control objective output consisting of AI7, DS4, DS8, DS9, DS11, DS13, and DS7.

**Keywords**—IT Governance; Maturity Level; Deliver and Support; Acquire and Implement; COBIT 4.1 Framework

## I. INTRODUCTION

The use of information technology in online business becomes a new breakthrough to improve the competitiveness of companies. Better information technology devices supported by information technology infrastructure and prices tending to be lower also improve this kind of business [1]. Online business eases the management to transform business and becomes a crucial part in increasing the productivity of companies. The more roles that information technology plays result in the changes of business processes and of business strategy development of companies. Nevertheless, getting and applying information technology accurately and giving additional values to online business models rely on routines and continual system solutions, clarity of application design procedures, scheduling and infrastructure maintenance, updating of manual procedures, system verification, documentation of changes, and information technology governance [2].

The easiness of obtaining information which is relevant, punctual, and accurate is necessary to provide services to the public and the customers of the companies [1-2]. The fact shows that correct information technology governance is needed in order to achieve the service level of reliable information technology performance. Therefore, there is an assurance that the performance of each business process is more effective and efficient in achieving the goals [3]. Possessing information technology services with the availability of complete information becomes the main concern of companies in dealing with online business.

Companies dealing with online business processes, especially the ones in Pontianak, Indonesia concern more on the alternatives of the selling models, are not able to achieve optimal benefits, and are apt to create incompatibilities for the management and the staff. There are a lot of important problems which are frequently neglected or obviously unidentified, incomplete coordination of a clear structure of relationship and process mechanisms, and lack of responsiveness in noticing changes occurring in online business processes. Moreover, reactive patterns used with each decision are owned by companies and tendency of waiting for stimuli from customers. Mistakes of managing customers' data, communication gaps, computer misuse, miscalculation, and patterns of information technology investment have not become strategic factors. The lack of comprehension on business function integration for providing online services makes customers easily move from one company to the others. Online business should be able to ascertain the information of all product guarantees and have a payment security system.

An essential implication of the management and the stakeholders is that the need of having correct information technology governance is for assuring the continuity of the competitiveness. Information technology governance importantly serves guarantees to achieve the goals and prevents risks of irrelevance among business processes by concerning the appropriateness of managing the data/information. Information technology governance is an integral part of governance of companies, comprising the elements of leadership, structures, and business processes [4].

Attempts to do online business should always be encouraged by interactive communication capabilities to attract the customers. This fact requires a superfine service system of the information technology. The availability of good

service system solutions is essential to fulfil the performance indicators of the companies. There should also be needs to have a standardised system of information technology services between the management and the online service providers, adequacy of secrecy, integrity, and information availability. This fact requires processes to cognise the two principal aspects of the maturity level of information technology governance such as procurement and implementation of system solution device and information technology infrastructure, and availability of current and future information technology supports and services.

Online business is always related to disloyal customers. Thus, mechanisms, processes, and structures are used in managing the information technology. The performance of information technology governance is to satisfy the conformity of information technology goals and business strategies and the use of information technology enabling companies dealing with online business to get new opportunities and maximal benefits through management, empowerment of information technology, and correct risk management of information technology [5]. In order to measure and to score the maturity level of information technology governance of online business, COBIT 4.1 (Control Objectives for Information and Related Technology) Framework can be performed. This research merely focuses on AI (Acquire and Implement) and DS (Deliver and Support) Domains.

A number of empirical research results show that there is a strong relationship between AI and DS for the criteria of conformity, reliability, and efficiency [6]. The growth of information technology investment at a governmental sector has not been supported by good governance due to the lack of attention paid to information technology management. The measurement of information technology governance requires continual improvement of information technology services [7]. The selection of control processes of information technology needs capabilities to identify and implement business strategies and information technology [8]. Despite suitable frameworks that the companies have, they fail to identify the criteria of information and resources based on their needs [9].

The evidence suggests that the companies have not had appropriate procedures in ascertaining a continual service system, a security system, and mechanisms of managing the data/information. The mechanisms of getting and maintaining information technology solutions tend to be centralised and do not have the capabilities to adjust new system changes, automatic solutions, not optimal software maintenance and information technology infrastructure, unidentified operations and uses of information technology resources, and implementation which is unsuitable with business strategies and goals. The appropriateness of information technology service procedures is still limited to the procedure availability, reflecting that it is not at the level of implementation with the element of supervision of each procedure.

The relevance of previous researches is more on the validity and the capability of measuring the maturity level of information technology through the use of COBIT 4.1 Framework. Nevertheless, the case of this research focuses

more on AI and DS since online business emphasises on the procurement, the implementation, and the service system of the information supports, especially in the area of cosmetics in Pontianak, Indonesia. This research also discusses the implications of managerial aspects and the process models of information technology governance of control objective.

The aim of this research is to cognise the existing and expected gap value of each process of AI and DS Domains. In addition, based on the maturity level value, the recommendations of information technology governance models referring to indicators of company goals and performance in the relationship among processes of AI, DS, and others are given. The investment optimality relies on business strategies and value determination within the limits of acceptable risks.

This research was in the form of survey and employed the research and development (R&D) method. IT managers working for 30 online business companies of cosmetics with an upper-middle scale were the respondents of this research. These companies are located in Pontianak, Indonesia. Purposive sampling was used. The instruments were questionnaires in which each comprised groups of processes. Each process was divided based on the level and each level used the Guttman scale. The maturity level was measured through COBIT 4.1 Framework. The result of the maturity level was found by seeking its average. This average will become the maturity level of each process of information technology. In the data processing, the scores of the maturity level were initially computed. This step was followed by the processing of the maturity level of each business process. Ultimately, the aggregation results were calculated using Microsoft Excel software and presented in a table and a radar graphic [10].

## II. LITERATURE REVIEW & RESEARCH FINDINGS

Information technology governance is an integral part of company governance comprising leadership, structures, and processes applied to ascertain its sustainability and enhance the aims and the strategies of the companies. Information technology governance specifies the right decision and the accountability framework to direct the expected behaviour of using information technology. Furthermore, it determines the ones systematically creating and contributing to the decision [11]. Its performance is intended to fulfil the conformity of information technology and company purposes, to enable the companies to have recent business opportunities, to get maximal benefits through a responsible management system, and to apply risk management. To be successfully done, information technology is not only controlled by the department of information technology, but it has to be also managed by the corporate level to integrate all units of business processes [12].

### A. COBIT 4.1 Framework

COBIT 4.1 Framework consists of four domains such as PO (Plan and Organise), AI (Acquire and Implement), DS (Deliver and Support), and ME (Monitor and Evaluate). Regarding the availability of service and information



technology supports, the focus is merely on DS Domain. The maturity level evaluation of DS Domain reflects the readiness of utilising the information technology governance to achieve the conformity of the strategies and the goals of the companies [13]. The implemented information technology has the models of business control and information technology. COBIT 4.1 Framework can bridge the gap between them through the control objective level covering activities and tasks, processes, and domains (see Figure 1). COBIT 4.1 Guidelines comprise Control Objectives, Audit Guidelines, and Management Guidelines. The focus is mainly characterised by the orientation of business processes and controls through a measurement to yield a more accurate result on the basis of the need [12-13].

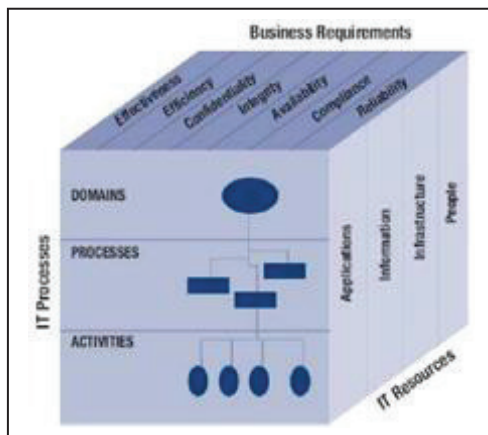


Fig. 1. The Model of COBIT Cube

### B. Deliver and Support (DS) Domain

This domain covers the delivery of an actual result and the information, the security management, the service supports towards users, the data management, and the facility operation. On the viewpoint of a successful and critical factor, DS Domain encompasses the conformity of the information technology service and the business priority, the optimisation of the information technology costs, the capabilities of the users to productively and safely use the information technology system, the secrecy, the integrity, and the availability of the information flows [13]. DS1 (Define and Manage Service Levels), DS2 (Manage Third-party Services), DS3 (Manage Performance and Capacity), DS4 (Ensure Continuous Service), DS5 (Ensure Systems Security), DS6 (Identify and Allocate Costs), DS7 (Educate and Train Users), DS8 (Manage Service Desks and Incidents), DS9 (Manage Configuration), DS10 (Manage Problems), DS11 (Manage Data), DS12 (Manage Physical Environment), and DS13 (Manage Operations) are those included in the information technology processes at DS Domain [13-14].

### C. Acquire and Implement (AI) Domain

AI Domain includes the processes of technically recognising the worthiness and cost-effective solutions, ensuring the development of cost-effective and punctual

applications, infrastructure, and acquisition and maintenance of information technology skills, reducing the risks of applying information technology, controlling the implementation of all changes of infrastructure, applications, and technical solutions, and cessation of applications of undesirable changes. Acquiring/implementing strategies needs to be accurately planned, managed, and communicated. Information technology processes of AI Domain comprise AI1 (Identify Automated Solutions), AI2 (Acquire and Maintain Application Software), AI3 (Acquire and Maintain Technology Infrastructure), AI4 (Enable Operation and Use), AI5 (Procure IT Resources), AI6 (Manage Changes), and AI7 (Install and Accredited Solutions and Changes).

### D. The Model of the Maturity Level

Evaluation of the maturity level of each information technology process varies when referring to each of its fulfilment criteria. The maturity index value is obtained through this formula (Index Value =  $\{\sum (\text{sum of answers} \times \text{the maturity value}) \div (\text{the number of questions} \times \text{the number of respondents})\}$ ). The rounding index scales of the levels of the maturity model are shown in Table 1 [15].

TABLE I. ROUNDING INDEX SCALES

Scale	Maturity Level Model
4.51 – 5.00	5 – Optimised
3.51 – 4.50	4 – Managed and Measurable
2.51 – 3.50	3 – Defined Process
1.51 – 2.50	2 – Repeatable but intuitive
0.51 – 1.50	1 – Initial/Ad Hoc
0.00 – 0.50	0 – Non-Existent

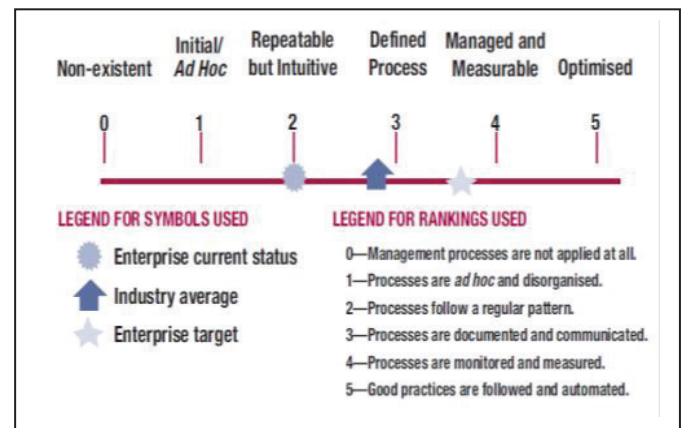


Fig. 2. Maturity Level Graphic

Levels of classifying the management capability of information technology processes starting from 0 (zero/non-existent) to 5 (optimised) emerge in the maturity level model of information technology governance (see Figure 2). It is helpful since the management can easily have concise comprehension through the description of each maturity level

in general. The research result of the maturity level can be considered when determining the criteria. The increment of the maturity level cannot be interpreted as the capability of the compliance of the lower level to rise to a higher level and be identified as the compliance of several maturity criteria in several levels despite a similar process [15-16].

#### E. The Maturity of Information Technology Governance

The measurement results of the maturity level of information technology governance show the current and expected conditions. All the maturity level values of processes of DS are at level 2 (repeatable but intuitive) and none of them reaches level 3 (defined process). The highest maturity level of DS Domain is at DS1 (2.493) and DS2 (2.435). DS1 and DS2 have maturity levels approaching 2.51 (see Table 2). In average, DS Domain is valued at 2.301, not reaching the maturity level scale of 2.51–3.50. Meanwhile, the highest maturity level of AI Domain is at the process of AI3 (2.822) and this value is at the interval 2.51–3.50 (see Table 3). Evenly, AI Domain has the value 2.674 and is at the interval 2.51 – 3.50 (the third position, i.e. defined process).

TABLE II. MATURITY LEVEL GAPS OF DS DOMAIN PROCESSES

Domain	Process	Testing Result	Maturity Level
DS1	Define and Manage Service Levels	2.493	3
DS2	Manage Third-party Services	2.435	3
DS3	Manage Performance and Capacity	2.213	3
DS4	Ensure Continuous Service	1.968	3
DS5	Ensure Systems Security	2.284	3
DS6	Identify and Allocate Costs	2.298	3
DS7	Educate and Train Users	2.295	3
DS8	Manage Service Desk and Incidents	2.289	3
DS9	Manage the Configuration	2.269	3
DS10	Manage Problems	2.295	3
DS11	Manage Data	2.285	3
DS12	Manage the Physical Environment	2.399	3
DS13	Manage Operations	2.388	3

TABLE III. MATURITY LEVEL GAPS OF AI DOMAIN PROCESSES

Domain	Process	Testing Result	Maturity Level
AI1	Identify Automated Solutions	2.737	3
AI2	Acquire and Maintain Application Software	2.646	3
AI3	Acquire and Maintain Technology Infrastructure	2.822	3
AI4	Enable Operation and Use	2.456	3
AI5	Procure IT Resources	2.796	3
AI6	Manage Changes	2.742	3
AI7	Install and Accredited Solution and Changes	2.520	3

#### F. The Analysis of the Maturity Gap

Based on the computation of the maturity level of information technology governance, apparently, not all values are at the third position (defined process) of maturity criteria. The highest one is at processes of DS1 (Define and Manage Service Levels), i.e. 2.493 and DS2 (Manage Third-party Services), i.e. 2.435. Conversely, the lowest one is at

processes of DS4 (Ensure Continuous Service), i.e. 1.968. The system is not completely in accordance with structures, mechanisms, and processes of business and merely relies on the planning without obvious formulation and implementation. This occurs because most of online business companies cannot ascertain the sustainability. This condition elucidates that responsibility ensures continuity of service provision and information supports not completely having standard conformity, continuity of unstructured services, partial availability, and continual service practices in which success depends on individuals (see Figure 3). The highest value of the maturity level is at AI Domain, more particularly at the process of AI3 (Acquire and Maintain Technology Infrastructure), i.e. 2.822. In contrast, the lowest one is at the process of AI4 (Enable Operation and Use), i.e. 2.456. This happens since definition of operational needs and good service levels is excluded, maintenance of infrastructure is merely a need, manual procedures of utilisation are not specifically stated, structured standardisation is created, and elucidation of training materials is incomplete and incomprehensible (see Figure 4).

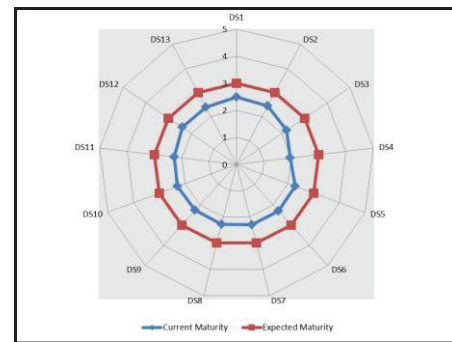


Fig. 3. A Maturity Level Model for DS Domain

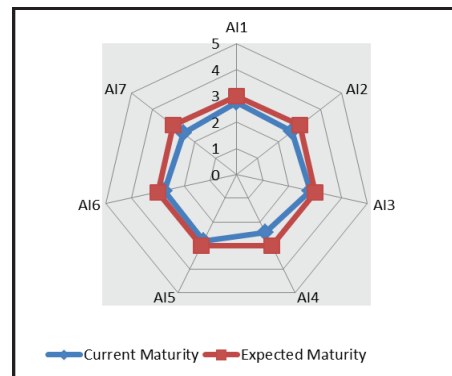


Fig. 4. A Maturity Level Model for AI Domain

#### G. Implications of Managerial Aspects

The implementation of information technology governance in online business of cosmetic products is expected to be able to reach the third position (defined process) of the maturity model. Meanwhile, based on the computation results, it is evident that the maturity level of information technology governance has not exceeded a maximal limit value, i.e. 2.50.

This indicates that there are a number of gaps needed to be eliminated to reach the maturity level. Accordingly, the whole information technology processes of DS and AI Domains should be improved by referring to details of control objectives.

The research results show that DS4 and AI4 are the processes that need a high priority. Also, the other processes should be concerned (see Table 4). The value of the maturity level indicates that better measurement results of performance determine a better maturity level of processes. Hence, the management should observe and identify the results of performance measurement and the maturity level of each process by directing the fulfilment of control objectives in each information technology process, define policies and procedures, change the values of performance indicators, add control objectives and improve the information technology processes until there is assurance that the process management fulfils a good standard.

In addition to the process improvement, the heads of the companies should take corrective actions to evade the unsuitable business processes existing in the future. Due to the importance of the improvement of the process management, the capabilities to determine the indicators of the performance measurement and to comprehend the existing conditions through the determination of the maturity level are requisite. There should be obvious and continual involvement among the heads of the companies, the users, and the public in the information technology processes to ascertain that the actions taken are based on the actual occurrences.

TABLE IV. IMPLICATIONS OF MANAGERIAL ASPECTS

Domain	Process	Current Maturity	Expected Maturity	Difference	Priority Type
DS1	Define and Manage Service Levels	2.493	3	0.507	Priority
DS2	Manage Third-party Services	2.435	3	0.565	Priority
DS3	Manage Performance and Capacity	2.213	3	0.787	Priority
DS4	Ensure Continuous Service	1.968	3	1.032	Super Priority
DS5	Ensure Systems Security	2.284	3	0.716	Priority
DS6	Identify and Allocate Costs	2.298	3	0.702	Priority
DS7	Educate and Train Users	2.295	3	0.705	Priority
DS8	Manage Service Desk and Incidents	2.289	3	0.711	Priority
DS9	Manage the Configuration	2.269	3	0.731	Priority
DS10	Manage Problems	2.295	3	0.705	Priority
DS11	Manage Data	2.285	3	0.715	Priority
DS12	Manage the Physical Environment	2.399	3	0.601	Priority
DS13	Manage Operations	2.388	3	0.612	Priority
AI1	Identify Automated Solutions	2.737	3	0.263	Priority
AI2	Acquire and Maintain Application Software	2.646	3	0.354	Priority
AI3	Acquire and Maintain Technology Infrastructure	2.822	3	0.178	Priority

Domain	Process	Current Maturity	Expected Maturity	Difference	Priority Type
AI4	Enable Operation and Use	2.456	3	0.544	Super Priority
AI5	Procure IT Resources	2.796	3	0.204	Priority
AI6	Manage Changes	2.742	3	0.258	Priority
AI7	Install and Accredited Solution and Changes	2.520	3	0.480	Priority

#### H. Recommendations of IT Governance on DS4 and AI4

The performance indicators of DS Domain are related to control objectives of the process of DS4, i.e. to ensure continual services in information technology governance related to the other control objectives. Control objective input covers PO2, PO9, AI2, AI4, and DS1, while control objective output comprises PO9, DS1, DS8, DS9, DS11, and ME1. The foci of improvement of information technology governance of DS4 should be on redefining and stating the tasks and the responsibilities to ensure the continuity of the service system and the information supports, having continual plans of online business information services to provide information to the customers more accurately, guaranteeing products, keeping payment transparent and punctual, and having specific documentation of all working system and activity needs in serving information needs to the customers and information system periodically and consistently showing offering of new products (see Figure 5).

The performance indicators of AI Domain, however, are related to control objectives of the process of AI4, i.e. to enable operations and utilisation of information technology governance and other control objectives. PO10, AI1, AI2, AI3, AI7, and DS7 are included in control objective input, whereas the control objective output consists of AI7, DS4, DS8, DS9, DS11, DS13, and DS7. The improvement of information technology governance of AI4 concentrates on end-users' satisfaction from offering and overall service levels of all business functions. The heads and the management of online business companies should develop obvious planning, technical documentation, operational capabilities, and required services and transfer knowledge to the management of universities to clarify the possession of systems and information. Therefore, the delivery of services and their qualities, internal controls, and administrative processes of applications become easier to use (see Figure 6).

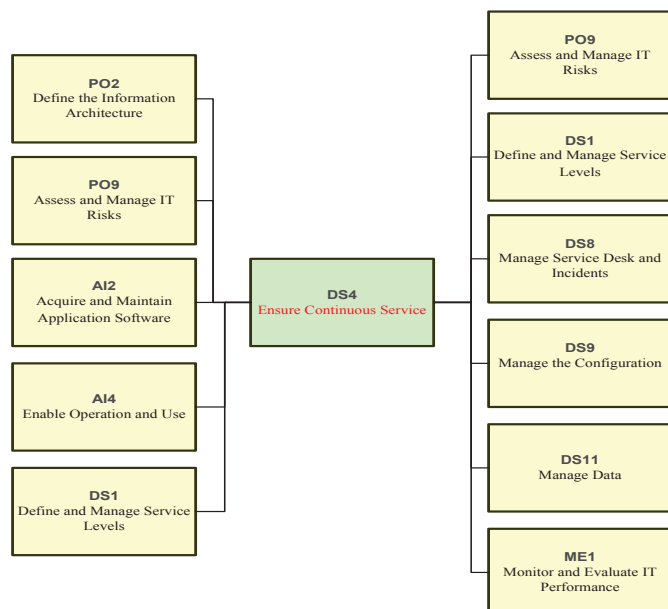


Fig. 5. Relationship among DS4 Process and Other Information Technology Processes

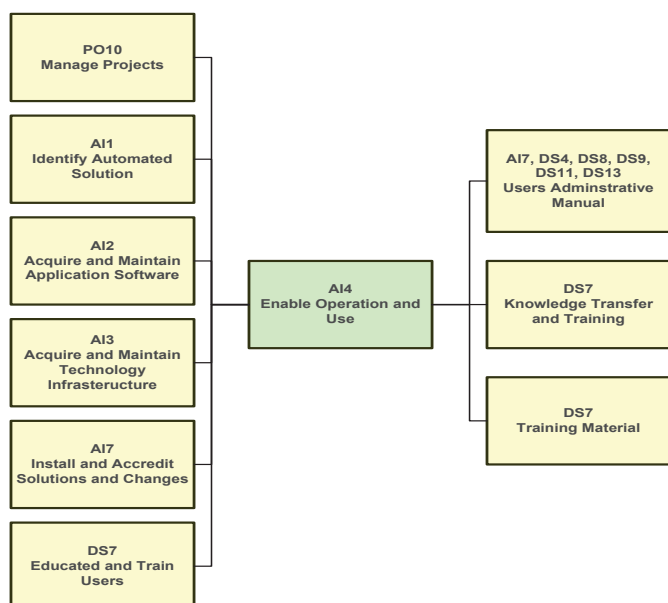


Fig. 6. Relationship among AI4 Process and Other Information Technology Processes

### III. CONCLUSIONS AND PERSPECTIVES

The maturity level of information technology governance of online business of cosmetics reflects that the average scores of DS and AI Domains are consecutively 2.301 and 2.674. Regarding each process of DS, the lowest score is at DS4 (Ensure Continuous Service), i.e. 1.968, while AI4 (Enable Operation and Use) is the one with the lowest score, i.e. 2.456 in AI Process. The measurement results indicate that all processes of DS have not reached the third position (defined process) in comparison to all processes of AI. The evaluation

of the maturity level should be measured periodically and involve all processes of PO and ME Domains to have obvious and measurable unified information in the formulation of information technology governance. Thus, conformity of online business and information technology strategies used to reach the expected maturity level emerges.

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# E-COMMERCE WEBSITE SUPPORTED BY PRODUCT CUSTOMIZE APPLICATION AS A MARKETING SOLUTION FOR SME CORPIES TO FACE A NEW WAVE MARKETING ERA

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**Abstract**— This study discusses about how technology development could affect all fields, including marketing. Legacy Marketing era has now been replaced by New Wave Marketing era, which proposes 12 new marketing elements and new customer segmentation which is Youth, Women, and Netizen. This change also made Corpies as a SME must reform its marketing pattern so that it could survive in this New Wave Marketing era. Technology development especially Web 2.0 brings many possibilities for its user to have a lot of interaction on the internet. The utilization of Web 2.0 in supporting SME Corpies can be an e-commerce website supported by product customize application which refers to Corpies product characteristic as a co-creation product. This research aims to find the importance of that website creation as a means for the product to be able to follow the current development suitable with the new marketing elements in New Wave Marketing so the company's credibility could be enhanced.

**Keywords**— *New Wave Marketing, Corpies, e-commerce, Customize*

## I. INTRODUCTION

Technological developments bring many changes to the character of the community. In the present time, there are various gadgets which are affordable and easier to access the internet and it makes the number of netizens in Indonesia increasing. The increasing the number of netizens also eventually have an impact on the field of trade. Netizens are potential consumers and many are targeted by manufacturers. Advances in technology also change the culture of public purchasing. The culture of conventional purchase is constantly decreasing as many consumers start to get used to buying via online. One of the product of technology developments namely the presence of web 2.0 change the character of the Internet into a more interactive and dynamic media. People are easily express themselves through networking by forming a community, collaborating, and participating in an activity, and many more. This is reasonable as Shopping online activities via puWeb horizontalisasi 2.0 makes the process faster [1]. Consumers who are netizens want to be served horizontally demanding the same service from the same brand.

Changes in consumer character raise a new phenomenon in the field of marketing, namely New Wave Marketing where

offline and online marketing are facilitated by the use of sophisticated technology to support each other.

The development of information technology has made human beings to be more productive and this results in increasingly broad market enhancing higher competition. It becomes the trigger for the creation of "creative economy" in which creative industries are required to intensify information and creativity. To be able to continue to competition globally and face the era of New Wave Marketing, creative industries need to utilize appropriate technology. Most sub-sectors of creative industries contributing to the economy are fashion and crafts. In 2013, the fashion industry subsector contributed GDP amounted to 65.1 trillion rupiah (42.2 percent) and the craft industry subsector accounted for GDP of 25.4 trillion rupiah (45.2 percent) [8].

Creative industries, especially SME (small and medium enterprise) in Indonesia have to be aware of these changes in the New Wave era of marketing. To keep survive, they should be able to compete among many other brands that are available in the community. SME (small and medium enterprise) must be able to optimally utilize technology in addition to selling it manually. Web 2.0 is more interactive and horizontal which can be used by SME (small and medium enterprise) to market their products. One form of product marketing on the internet is in the form of an e-commerce website. One of the SMEs (small and medium enterprise) that require online marketing tool for their products is Corpies. Corpies is an SME which focuses on producing handmade painting product and applying the principle of co-creation which are so closely associated with the consumer. This study aims to determine the relationship between e-commerce website Corpies customize products as a means of dealing with the era of New Wave Marketing. This study will be used as a basis for preparing Corpies product marketing strategy in order to survive in the era of the new wave of marketing which is dominated by three segments, namely Youth, Women, Netizens.

## II. NEW WAVE MARKETING: "THE 12 CS OF NEW WAVE MARKETING"

Along The flow of information flowing affects every area of field marketing is no exception. With the flow of information

that is always updated, this makes customer behavior changes and demands the marketer to change strategy. Approach to marketing in the era of marketing which is vertical legacy now is changed into New Wave Marketing which is more horizontal. New Wave Marketing can also be referred as the era of participation. An era where every person has the right to participate in a variety of ways. New Wave Marketing positions people as the main focus [1]. Producers and consumers have the same position. The position of manufacturers and consumers is increasingly parallel, which does not depend on status, age, religion, or skin color. In the era of New Wave Marketing, the manufacturer and the customer increasingly appreciate each other knowing that they both need each other.

The most important thing in a New wave of marketing is access. Smooth access will allow the creation of value together through a network of people who share, interact, and solve problems. In New wave marketing (NWM), there are 12 new elements which are the form of refinement of 9 elements of Legacy marketing era. In this study, those elements will be discussed as they greatly affect the existence of SME (small and medium enterprise) Corpories in the era of NWM.

#### *A. Elements of Strategy: Communication, Confirmation, and Clarification*

Elements of the strategy aims to win mind share. The three elements of the strategy consists of Segmentation, Targeting, and Positioning [1]. Segmentation is the first step in formulating marketing strategy in an era of legacy marketing. But in NWM, segmentation is turned into communization. Because in this era, technological sophistication strongly supports the creation of a community within the community and NWM should be able to take advantage of the existence of the community. In the era legacy marketing, the segmentation is vertically formed by company from producers to consumers and it costs a lot. While on the NWM, communization is formed horizontally by individuals equally and it costs a little. A community that is growing in this era is an online community which is a potential target for targeted marketing.

Targeting is the next step that should be done after segmenting in the legacy era for the company to precisely target the marketing segment. In NWM, targeting is replaced by confirming. Confirming is the next step after communization which is done by identifying a number of communities, the manufacturer will confirm to join the community. The community has two options, namely clicking confirm or ignore. Community decisions are as strong as the manufacturer so in this case the position of communities and producers are in parallel and there is no compulsion on both of them [1].

After doing the targeting, the next step is positioning. Positioning is what the producers want is in the consumer's mind when they hear the manufacturer brand. Positioning is related to consumer perception of the product. In NWM, positioning is changed into clarifying where the manufacturer has to clarify the character or manufacturer product to the communities that have previously confirmed them [1].

#### *B. Elements of Tactics: Coding, Crowd Combo, and Commercialization*

The second element is a tactical element consisting of Differentiation, Marketing Mix (Product, Price, Place, Promotion), and Selling, with Differentiation as its core. Elements tactic aims to win market share. The first element is differentiation tactics. Differentiation is an attempt to create a significant difference to a brand. Differentiation support is previously defined as positioning. In NWM, differentiation is replaced by Coding. Companies must be able to identify differences in the products compared to competitors' products to the level of the smallest and the connection to the customer should be able to establish very well products which can be completely personalized for the customer so that there is no single product that resembles the product [1].

Next is the Marketing Mix consisting of Product, Price, Place, and Promotion (4P). The fourth element is the most visible of the company's activities. Marketing Mix is the NWM is turned into Crowd Combo (Co-creation, Currency, Communal Activation, and Conversation) which is a combination of a number of creative marketing activities that focus on individuals, which is expected to have the same interest and value to the company [1].

The product is the first element in the marketing mix in the era of legacy marketing. Product is a medium that causes the exchange value of the producer to the consumer. In NWM, product is replaced by Co-creation where the product can be highly dynamic, interactive, and comes from multi sources. Co-creation enables consumers to participate in contributing ideas for the development of a product so that producers will be able to produce a product that can really fit with the character and the real needs of consumers. Co-creation leads to products that will create more personal and exclusive characteristics.

The second element of the Currency Crowd Combo is a form of refinement of Price. Price tends to stay constantly the same. On the other hands, currency is influenced by various factors such as exchange rate, time, and materials. Thus, the co-creation of products will not have a fixed price. Prices can go up or down depend on the factors that influence it.

Place is the third element in the marketing mix which is commonly known as the marketing channel that plays a role in delivering the product from the manufacturer to the customer. In simple terms, it is usually called as channels of distribution (marketing channel) including retailers and whole sellers. In NWM, place is turned into Communal Activation. Communal activation is a strategy by activating people in the community who will be able to market the co-creation product that we produce to members and other communities.

The final element of the Marketing Mix is a promotion that aims to inform, persuade, or remind the customer. In NWM, promotion is turned into a conversation. Promotions are unidirectional, vertical, top-down, and one-to-many. While the conversation is more horizontal, two-way, peer-to-peer, and many-to-many. Conversation means the discussion or interaction between two parties which are equal in status and leads to the creation of the truth together. Consumers will

believe more on the communal truth generated from discussion than the truth informed through company's promotion [1].

The last of tactic element is Selling. Selling is a strategy to create a relation of the producer to the consumer in long term through the company's products. Selling subsequently has undergone improvements into commercialization. It is called as Commercialization because there is two-way exchange of value between producers and consumers. Because their positions are equal then there is a process engagement among them first through co-creation products offered. It is very different from the selling that is one direction and focus only on product sales alone.

### C. Element of Value: Character, Caring, and Collaboration

The final element of the 12 Cs of New Wave Marketing is a value element consisting of Character, Caring, and Collaboration. Value Element aims to win the heart share.

The first element of Value is Character which is a form of refinement of the Brand. Creating the character of a product is very important that when a character has been created and embedded in the hearts of consumers, the product can do anything for example changing color, packaging freely according to the dynamic side showing them freely but with the same character. Consumers will easily recognize a product even though it looks different if the character is embedded in the hearts of consumers.

The second element undergoing changes is service. Service is something that should be exist in a company, all the customers expect it and make it as their right and the service which is an extraordinary thing again. In an era of NWM, a more fitting term used is no longer a service, but "Caring". Caring has a deeper meaning than the service. Caring not only provides customers RATER (Reliability, Assurance, Tangible, Empathy, Responsiveness) and an experience, but also provides with the understanding that they should pay attention towards humans [1].

The last element undergoing changes is Process. In the New Wave Marketing, elements of the process is not just about how to make the process starts starting from the creation of ideas (ideation) to sales (commercialization) a new product or service to improve the quality at minimum cost and with time as soon as possible, but rather to the process creating and delivering value to customers thoroughly. The more appropriate term in this era of NWM is no longer a process, however Collaboration. This is because the process must be carried horizontally by using multiple sources and collaborate with many parties in order to create a higher value to customers [1].

### III. SEGMENTATION OF 'NEW WAVE READY CUSTOMER': YOUTH, WOMEN, NETIZEN

With the new era of marketing known as New Wave Marketing, vertical marketing system has now turned into a more horizontal way demanding marketers who is in this case the manufacturer to not only determine the need and want of the market, but also must be able to capture the anxiety and desire of the market. In the era of the internet today, there are three community subcultures that help creating the era of New

Wave Marketing namely Youth, Women, and Netizen in which three of them are New Wave Ready Customer [5]. According to a research by Markplus Insight, the most potential market share is a young woman who was also a netizen known as community subculture Youth, Women, and Netizen [6].

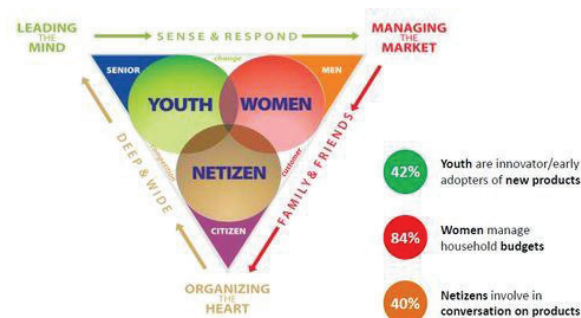


Fig. 1. The Segmentation of New Wave Ready Customer by Markplus

The first is a community of young people (Youth). The existence of the current Youth shift Baby Bomer generation due to differences in the mindset of young people today are "leading the mind" because they always do "sense and response" that is not done by previous generations. Young people are also able to absorb more information so that it makes them more creative. The previous generation was considered less creative because they maintain the habit "Glorify the past" so they are not as creative as their juniors [5].

The second community are women. Women now have a more active role than men. In the past, men were considered as a determinant of the decision, but now women are considered to have more great purchasing power and can make their own decisions. When shopping, women will consider "family and friends", not like men who generally shop for their personal use [7]. It makes women to be more consumptive than men. Another factor that is important is exclusivity. Women always follow the trend and lifestyle and always want to have different look than others. It then pulls a woman to have the habit of forming communities. This is because women are naturally better in communicating horizontally. This is in accordance with the character of the New Wave Marketing and this is already there in her own prior to NWM found.

The last communities of New Wave Ready Customer is netizen. Netizens are people who every are connected to the internet and can be defined as a customer who is active in cyberspace. Keywords of the netizens are sharing conversation and gadgets. Netizens are known as persons who love doing and sharing conversation so that it can be ascertained that every netizen usually always follow the development of websites, blogs or online communities. while gadget is a device that is inseparable from the life of a netizen. The gadget connects to the Internet and netizens are basic necessity today as the conversation done by netizen using the current gadget often form a national issue and shape public opinion [1].\

### IV. THE SOPHISTICATION OF WEB 2.0 TECHNOLOGY

Web 2.0 was introduced the first time in October 2004. Web 2.0 is also known as the semantic web. There are a lot of



the advantages offered by Web 2.0, one of which is that it is able to read and write so that users can interact both directions and bring features share, collaborate, and exploit. The number of social media today is a result of the advent of Web 2.0. the existence of Web 2.0 technology makes us as users remain civilized (civilized) in the middle of an increasingly changing lifestyles, which are more and more individual. We can keep in touch with friends and relatives through cyberspace (online) in the midst of our activity which is increasingly crowded. Web 2.0 technology helps us not to feel lonely and always be able to connect with people just by typing on a laptop or mobile phone.

## V. WEBSITE APPLICATIONS OF CUSTOMIZE PRODUCT

Web-based application is an application (graphics, word processors, chat, mail) which can be accessed via the internet, such as Facebook, Twitter, Yahoo Mail. With the presence of Web-Based Application of this technology, users who want to use applications no longer need to install the application once on the computer. Users can directly use these applications by calling the address of the web based application through a browser with an internet connection. Simply, web-based application can be accessed at any time via a browser such as Google Chrome or Mozilla Firefox, if connected to the Internet. Another advantage is that users do not need to be afraid of losing the program because of a virus that is commonly experienced by desktop of general application.



Fig. 2. The home view of customize application on the Corpies website

Application Website for customize product is modified so that in it there are features that can be selected by the user. Users can choose to change the content in accordance to a menu that is available in the website. For example, users can be given the opportunity to design or change the format of the products shown in accordance with his wishes so that the products ordered will be able to be very representative character. Customize products application is normally used for products that come with the theme of co-creation. Website applications of customize shoes for example, can be used so that the consumer can determine the model of shoes, color of shoes, strap color, soles color, shoes pattern in accordance to the customers wishes. The representation of product customize application in the Corpies website as shown in the figure 2 and 3.



Fig. 3. Example of features on the customize application website that allows the user to modified product.

## VI. CORPIES AS CO-CREATION PRODUCT

Corpies is one of the SME (small and medium enterprises) which comes from the city of Malang was founded in 2011 and focused as a manufacturer of fashion and gift brush painting. Corpies products produced generally bring some themes like funny cartoons and have female nuanced. The products include shoes, shirts, bags, books, dolls, key chains, cutting boards, and glasses are all made with a touch of paint. But the best-selling product of Corpies is painted shoes. Corpies target market of the product itself is the women with upper middle economy class. The themes brought by Corpies theme are co-creation products so that each product can be ordered in accordance with the wishes of consumers so that products become very exclusive. In the co-creation concept, customers are actively involved to create an added value of a product. The product is not designed unilaterally by the company, but the company opens a wide space for customers to participate.

From the theme is, it is often difficult because consumers are interested in modifying products as he wishes so that complicates the administrators and designers in dealing with prospective customers. The absence of written provisions or clear limits to customize products also make customized product ordering process becomes longer, tedious and sometimes end up with cancellation. Cancellation is also caused by long response from the admin due to handling process of consumer is done manually one by one. To be able to survive in the era of New Wave Marketing, there must be a balance between online and offline marketing. Corpies itself does not have outlets and only markets its products more when exhibitions come. Promotion through online media is also less than expected as it just depends on the utilization of social media such as Facebook and Instagram. The absence of a special website which is a means of ordering the product of Corpies become an obstacle to the marketing of products. Moreover, the absence of the website will also affect the credibility of the product.

## VII. E-COMMERCE WEBSITE FOR SME (SMALL AND MEDIUM SIZED ENTERPRISES)

Small and medium-sized enterprises (SME) is one of the areas that give significant contribution in spurring economic growth in Indonesia. This is because the absorption of SME to



labor is quite high in helping those living under poverty. The main problem faced by SME is the marketing [3]. Marketing with the conventional method requires a high cost. Along with the technological developments and changes in the era of New Wave Marketing which is widened, then the internet is the most appropriate media to be used as a marketing tool. The development of Web 2.0 technology provides an efficient means to open up marketing channels for the new models of SME products. In addition to the cost which is relatively low, the use of the Internet also leads to the spread of information which is faster and reach out to the wider community [4].

E-commerce is a type of electronic business mechanism that focuses on individual-based business transactions using the Internet (technology-based digital network) as a medium of exchange of goods or services between two institutions (business to business) and direct consumer (business to consumer). In the past, the constraints of space and time become the dominant stuff. With e-commerce applications, the relationship between companies with other external entities (suppliers, distributors, partners, consumers) can be done faster and more intensive, and less expensive than conventional application of management principles (door to door, one-to-one relationship).

To continue to improve the competitiveness of SME and to obtain export opportunities and other business opportunities, one of its ways is by taking advantage of the development of Information and Communication Technology (ICT). Utilization of ICT is used to help the marketing issue of SME to be one of the forms of an e-commerce website.

With e-commerce, the customer services are more evenly. Consumers will be able to order the product more easily by just pressing a menu that is in the computer screen. Steps from the selection of products to end on payments will also be shorter than having to manually offer products to consumers. E-commerce can also be accessed by many people at the same time so that services become more efficient so that it saves time and energy. E-commerce that could be used for marketing and online sales will certainly increase the volume of sales, increase revenues, and at the end will develop the small and medium businesses.

#### CONCLUSION

Technological sophistication brought about many changes in various areas of public life, not leasone of it is in the field of marketing. Legacy era of marketing that had now now has been replaced by the era of New Wave Marketing. NWM puts human as the main focus and has horizontal communication as its character. Producers and consumers have the same level and have the same power so that both can respect each other because they both need each other. NWM also brings 12 new marketing elements that must be applied by the company if it wants to remain survive in this era. There are three potential target market in NWM era namely Youth, Women, and Netizen. Corpies targets a woman as the main target. But in the era of NWM this time, the target market may be to specify longer than a young woman who is also a netizen. It is intended to generate more opportunities for Corpies and this is also in line with this NWM era.

In order to be able to exist in this era of New Wave Marketing, Corpies products must perform offline and online marketing to its fullest. In this case, online marketing of Corpies products needs to be improved with the use technology such as Web 2.0. This type of websites are suitable for use as a medium for marketing and selling online media once the product is an e-commerce website. With the e-commerce website, the process of buying and selling a product becomes easier and faster. E-commerce website is also in accordance to the new habits of people who are already familiar with online shopping.

As a product of co-creation, Corpies needs to set boundaries for prospective customers to modify the product in accordance to the customers wishes. This is to avoid a long process of ordering and the feeling of boredom because the options are set too much. In addition, the sense of disappointment is also another a fear arises because consumers have too much expectation on the items ordered because the choices have too many modifications. Besides, it is necessary to customize application products containing modifications menus and restrictions modified products clearly so consumers can modify their products in accordance to their wishes, but still within clear limits. Customize application also aims to make consumers can imagine what would the products become later. This is to limit the expectations of consumers that is not too excessive. In the main focus, consumers will have an interesting experience when buying a product. Consumers will not just buy a product, they can contribute to make it. The activities of designing a product will suitable for the New Wave Ready customer that really like to experiment.

Based on the problems experienced by Corpies and changes in the era of New Wave Marketing, it will require an e-commerce website with a customized application for Corpies products. It is considered appropriate to address the issue of Corpies as one of the SMEs which will have an impact on improving the sense of consumer confidence in the product.

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# YOUTUBE AS A VIDEO BASED SOCIAL MEDIA AND PROMOTION MEDIA FOR TOURISM

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**Abstract—** This study discusses the potency of video compared to other media and its influence to person's perception on the content presented. The development of video into the digital world and the Internet also affect the way people consume the video. Youtube as one of the social media and part of the Internet has also become part of one of the influential media in the development of video, both from the production, distribution, until the way video enjoyed by society. The world of tourism as one of the areas that have business potential can be optimized through video and Youtube. Youtube user nature that are responsive and likes to disseminate information which he knows to relatives around can be a great opportunity for tourism to promote its products more quickly, efficiently and cheaply. At the end of this study we expected that people on the tourism business will be triggered to continue to be creative in promoting their tourism products.

**Keywords—** *Social Media, Video, Internet, Tourism, Travel*

## I. INTRODUCTION

Video is one example of many digital products that used in a lot of purpose, such as promotion, education, campaigns, and others. Video has things that are not owned by other media. When we look at the video, (or its variants such as movies, television programs, etc.) our emotions triggered by visual stimuli we receive visually. These emotions can be interest, anger, laughter, relax, love, or even boredom. These emotions are created because of the presence of some elements contained in the video such as the scenes, or background music [1]. These video's capabilities is used by many people to convey a message to the public about many things. In the commercial, the video creator sought to influence people to buy or use the products that they offer through the visual stimuli that they used in the video, like the shape of a perfect product, its benefits, the background music which gives the theme of a product, and also narrative that invites the audience to agree that the products they see a product that is appropriate for them. In other shape of video, like movie, creator tried to get the audience to drown in the story. Through its actors, the creator triggers audience's emotions to get sad, happy, disappointed, angry, and others. Through the storyline the audiences are shaken "up and down" in a story that even after they watch the movie, it still gives the impression to the audience.

Video is a medium that is highly effective to persuade the public or to improve user awareness about the particular

products or services. According to their survey conducted in 2014, Animoto found that 96% of consumers surveyed found videos helpful for making online purchase decisions, 71% of consumers surveyed confirmed watching a corporate video left them with a positive impression of the brand, service or company, and 73% of all consumers are more likely to make a purchase after watching videos explaining a product or service [2].

## II. VIDEO IN A DIGITAL WORLD

Along with the development of the world, nowadays video can be enjoyed not only through recording media such as Compact Disc or televisions. Through the Internet, people can publish and enjoy videos produced throughout the world. Websites that are on the internet have evolved from static and one-way into multi-ways interaction between its users. This development is called the development of Web 1.0 to Web 2.0. The concept of Web 2.0 itself is a user can be a contributor to the website that he consumed [3]. This website provides facilities such as forums, and instant feedback. The development of this website has lead to interaction and virtual community that developed into a "digital society."

One of the sites that provide video sharing service is Youtube. Since its launch in 2005, this site has been used by the entire Internet community in the world. Every day, more than 1 billion people watching videos on Youtube. Every hour more than 100 million hours of video watched, 300 hours of video uploaded every minute, and until now Youtube has more than 1 billion users [4]. Although not the only website which provides the facility of video sharing, Youtube still remains the first choice for most of Internet users to share and watch videos online. Youtube is used by people for variety of interests, from commercial, entertainment, education, and others

Youtube changed the way people consume video. In the age before internet, video depends on media such as CD and television broadcasting to distribute its content. Now with the existence of Youtube, video distribution becomes easier and faster. For the example, in the era before Youtube, music industry relied its distribution around the world through compact disc and television. Consumers can only enjoy the music video clips of their favorite musicians from CD they buy, they can only enjoy the videos that available in the CD, if he wants to enjoy another videos, he had to buy another CD. With television, the distribution of video clips is also limited, the audiences just "surrender" to the videos on television

programs aired by broadcasters, consumers did not have full control of the videos they want to enjoy. But with Youtube it is changed. Musicians can upload their videos on Youtube, it is free and fast, they also can create special channels for their video so that consumers do not need to be confused to enjoy their videos among billions of other videos available on Youtube. As for the consumer the advantage is that they can enjoy videos anytime they like for free. In addition they also have full control of the video they consume. They can choose which video they want to watch and which ones are not video they want to watch.

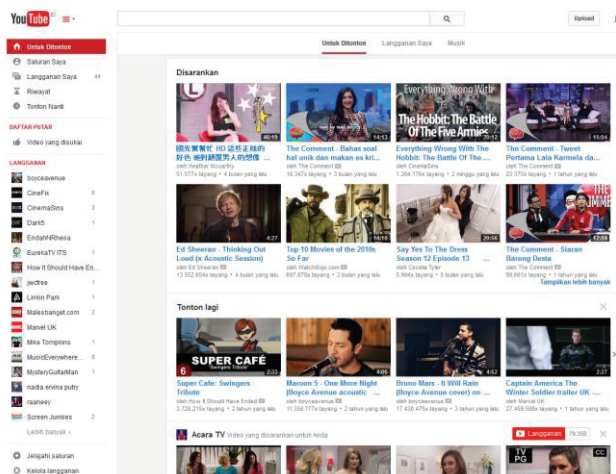


Fig 1. Youtube's Home Page

### III. VIDEO AND SOCIAL MEDIA

Youtube is a video sharing website that can be categorized as social media. This website allows us to interact with others through feedback that we give in a comment section on a video, and instead we can upload videos and get feedback from others. These interactions do not occur at the time when the video is only displayed in a compact disc or a television. Its ability to allow the user interacts with each other make Youtube into one of social media website that most used in the world [5].

With so many users and cyberhood in Youtube all the information contained in this site could easily spread from one user to another. As in the real world where everyone can disseminate information or news they heard from other people, in Youtube this situation can also occur. One thing that is interesting or provocative can easily spread from one to another, it is possible to occur in Youtube due to share facilities and the "most popular videos" section that appear on the main page of Youtube. Videos that easily spread and talked by Youtube users are often referred to as "viral video". According to Porter and Golan, Viral advertising itself can mean a communication between one user to another whose content is derived from a product / brand that is known, use the internet to influence the audience to pass from one to the other [6]. The only video ever uploaded on Youtube and get a view over 2 billion is a video clip titled "Gangnam Style" sung by a singer

who comes from South Korea, Psy. This video that uploaded at July 15, 2012 has gained 2.327.738.862 view. Gangnam Style appeared as a phenomenon among Internet users, and even Youtube server must update their maximum capacity number of "view" in a video just because Gangnam Style video has reached the maximum limit permissible view [7]. "Gangnam Style" by Psy proved that a video can be easily consumed by the public without having to incur the expense and effort that are too big. This is proving that cyberhood has ability to create a phenomenon that quickly spread widely in society.

### IV. RESEARCH METHODOLOGY

Youtube's ability to let every users interact each other gives the opportunity for producers to publish their products or services on Youtube. A large number of users also allow producers to get consumers without having to spend a lot of effort. This potential has been widely seen by various producers in all kinds of fields to publish their products or services through Youtube. One area that can easily get attention is tourism.

Like any other business, tourist agents need a media to promote their tourist objects. The problem is, not every tourist agents have enough budgets to promote their destination. Most of tourist objects, especially in Indonesia, managed by a small group of people who didn't get billions of money from their business. They use word-of-mouth method to promote their tourist destination. The weakness of this method is that the information about this tourist destination didn't spread widely. The information only spread to the consumer's relatives, the other weakness is that people can't see the actual embodiment of this tourist object. They only imagine what it looks like from their relative's description.

Video and Social Media that fused in Youtube can solve low budget tourist agent's problem. With video that uploaded in Youtube, these tourist agents can promote their tourist object freely with huge amount of impact for their tourist destination. The high impact of Youtube for tourism can be seen from the numbers of each channel's view amount. This is the rank of the most viewed Youtube channel that have "Travel and Event" as their main video theme.

TABLE I. TOP 10 MOST VIEWED TRAVEL AND EVENTS VIDEO PRODUCERS

Rank	Video Producer	Views	Youtube View Rank	Subscribers
1	Sen Momo and Ai Channel	851.575.050	405	308.000
2	radiocfg	471.369.460	849	237.000
3	Inside the Magic	461.122.624	875	476.000
4	Theme Park Review	416.722.442	1004	630.000
5	Turkish Airlines	403.519.009	1044	95.000
6	Disney Parks	254.983.852	1747	457.000



Rank	Video Producer	Views	Youtube View Rank	Subscribers
7	Moneysaving Videos	251.414.004	1773	186.000
8	JCVdude	179.845.522	2598	46.000
9	jfrissina	179.330.014	2604	41.000
10	CoasterForce	172.280.969	2714	213.000

Source: vidstatsx.com/youtube-top-100-most-viewed-travel-events

From these data we know that a tourism video can become a viral video with millions of view. The main aspect that causes a Youtube channel becoming viral is uniqueness of its content and the way they represent it. “Sen Momo and Ai” channel got their success because they represent a tourism review with children as their main attraction. Kid’s cuteness is the main factor that differentiates them from other tourism channel on Youtube.

Youtube videos also have a big impact for the tourist object that featured on it. People who already see the tourist object that featured on Youtube video more likely make decision to go to that tourist object. One example of the most viewed Youtube video that featured tourism object in Indonesia is “Jalan Jalan Men”. This webseries is developed by an Indonesian website that has millions of subscribers, “malesbanget.com”.



Fig 2. Jalan-Jalan Men by Malesbanget.com

“Jalan-Jalan Men” featuring a lot of tourist destination in Indonesia. They review every potential city and their popular and hidden tourist object with a comical way through its presenter. “Jalan Jalan Men” included in the most viewed video in Malesbanget.com’s Youtube channel.

TABLE II. TOP 10 MOST VIEWED MALESBANGET.COM’S YOUTUBE VIDEOS

Rank	Video Title	Views	Year of Production
1	Warning: Sexy video! Cara mencontek 1	6.556.093	2012
2	Celotehan anak disko   shits indonesian disco party people say	910.455	2013
3	Warning: sexy video! cara mencontek 2: kerjasama	825.294	2012
4	[Indonesia Travel Series]	519.445	2012

Rank	Video Title	Views	Year of Production
	Jalan2Men 2012 – Yogyakarta – Episode 1		
5	[Indonesia Travel Series] Jalan2Men 2013 – Bandung – Episode 1	432.143	2013
6	Sexy Ninja Gangnam Style Dance [Indonesia]	430.061	2012
7	Macam Macam Cerita Taksi	384.186	2011
8	[Indonesia Travel Series] Jalan2Men 2013 – Bali – Episode 9	363.683	2013
9	[Indonesia Travel Series] Jalan2Men 2013 – Bromo – Episode 7	353.064	2013
10	Hitler Ngamuk Sama Foke	323.326	2011

Source: youtube.com

The most viewed “Jalan Jalan Men” video in “Malesbanget.com’s” Youtube channel is “Jalan2Men 2012 – Yogyakarta – Episode 1”. With 519.445 views, this video placed in the fourth place of the most watched “Malesbanget.com’s” video. These data show that people have a special interest in tourism video in Youtube. With the appropriate approach strategy for special target user Youtube video will become a new phenomenon in its user. “Jalan Jalan Men” understand their target user which is youth and pre-adult. They use a special approach to get close with their target, such as using a comical public figure as their presenter, as a result, target audience feel a special relationship with presenter and its video because of their similarities.

In “Jalan2Men – Yogyakarta – Episode 1”, the presenter explore some tourist objects in Yogyakarta, Indonesia. One of that tourist objects is Tamansari. Tamansari is a site of a former royal garden of the Sultanate of Yogyakarta. It is located about 2 km south within the grounds of the Kraton, Yogyakarta, Indonesia. Built in mid 18th century, the Taman Sari had multiple functions, such as a resting area, a workshop, a meditation area, a defense area, and a hiding place. Since its appearance in Jalan Jalan Men in 2012, the numbers of visitors growing in steady numbers.

TABLE III. NUMBERS OF VISITORS IN YOGYAKARTA’S TOURIST OBJECT

Tourist Objects in Yogyakarta	Numbers of Visitors		
	2012	2013	2014
Tamansari	188.010	227.483	320.911
Kraton	586.744	686.282	714.385
Taman Pintar	941.230	1.067.166	1.000.000
Vredenburg Fort Museum	139.325	250.000	315.000



From Table III we can see that numbers of visitors in Tamansari is steadily growing in 3 years. We can say that this growth not only happen just because its appearance in “Jalan Jalan Men”, but we can assume that at least some of these visitors came to Tamansari after they watching the video.

## V. RESULT AND DISCUSSION

In “Social Learning Theory” explained that people have tendency to mimic and reconsidering information they get from various stimuli. The final result of this process is an act, ideas, or motivation to do something. The process is described as follows [9].

- Attention

In this process people gain information as much as possible from stimuli they get around them

- Retention

In this process people converting that stimuli into images, symbol, and another shape they can easily remember

- Reproduction

To reproduce a behavior, people must organize responses in accordance with the model. Observer characteristics affecting reproduction include physical and cognitive capabilities and previous performance

- Motivation

The decision to reproduce (or refrain from reproducing) an observed behavior is dependent on the motivations and expectations of the observer, including anticipated consequences and internal standards.

This “Social Learning Process” also happens when people watch Youtube’s tourism videos. The first stage before people decide to go to some tourist object is they must aware where they are about to going. This awareness came from information and knowledge they get before they decide to go. Tourist agents can enhance their prospective consumer’s awareness about tourist object with video in the Youtube. There are a lot of Youtube’s video producers that gain huge amount of success. Their success can be identified from their amount of view and people that subscribe their channel. From Table 1 we know that a unique content and the way it represent have a big impact for the amount of view. “Sen Momo and Ai” channel, a Youtube channel that gain millions of view is the clear example for this. From the numbers of viewer we can assume that at least 800 million people already saw their videos, which mean 800 million people having knowledge about tourist objects that featured on this channel. This can be a huge start for tourist agents who featured on this channel, they can expect millions of people already know their tourist objects and they can prepare for their coming.

The next stage after people know the information about tourist object is they deciding whether they will go or not. A video that has uniqueness and understand their audience’s characteristic will have the stronger bond than a regular videos. Uniqueness can came from its content, the way they represented it, and the presenter itself. This bond will affect to audience mind and becoming the main aspect whether they will go to that tourist object or not.

The final stage is when people making their decision about such tourist objects. From the process before, people will get clear motivation and if the bond between the video and the audience is strong enough, people wouldn’t hesitate to visit tourist object that they already saw in Youtube video. There is a lot of example of tourist objects that becoming more popular because of its appearance in Youtube video, Tamansari is one of them. Because of its appearance in “Jalan Jalan Men” more people especially young people have more interest to visit this cultural heritage site.

## CONCLUSION

Internet and video is a powerful tool for tourism marketing. Any tourism agent can use its advantage to enhance their business by promoting it on Youtube. Tourist agent can aim the big community inside Youtube to gain people’s awareness about their tourist objects, with the right approaching technique they can leave the best impression for their potential customers. These approaching techniques include impressive content, and unique presentation. Tourist agents must know the characteristic of their target, different ages and different location need a different approach technique. If tourist agents can done it, their potential customers will have a strong a strong bond with their tourist objects and finally they will more likely to decide to go to their tourist objects.

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# **Visualization Technology, User Interaction and Experience**

# Influence Of Twitter's Perceived Value, Perceived Ease of Use and Perceived Usefulness On Information Needs Fulfillment For Telkomsel Customer

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**Abstract**— The utilization of social media Twitter is a common thing for its users. As a social media that owns over 19 million users in Indonesia, Twitter is also used by Telkomsel customers as a source of information. The use of twitter media was evaluated from three aspects: perceived value, perceived ease of use and perceived usefulness, the study aimed to determine how much influence arising from the use of twitter media to the fulfillment of Telkomsel customers' information needs. This study was quantitative causal by using path analysis method to test hypotheses simultaneously and partially. The population in this study was followers of Telkomsel twitter account. Questionnaires were distributed to Telkomsel twitter account followers using simple random sampling technique and obtained 400 samples. The results showed that the perceived value and perceived usefulness significantly influence the fulfillment of the information needs.

Based on these results, twitter account of Telkomsel is expected to provide more detailed information when overcoming obstacles encountered by followers in the use of Telkomsel products and services.

**Keywords**—*Social Media; Twitter; Information Need; Telkomsel; Customer*

## I. INTRODUCTION

In the era of digitalization, the Internet becomes one of the things that are essential for its users. With the formation of the Internet network, allowing information to be easily distributed to a wide scope and accepted by the audience in real time. In other words, the Internet became the most complete source of information with all content contained in it. Internet Live Stats noted that in 2014, Internet users in the world had reached more than 3 billion users. While in Indonesia, the number of Internet users reached 42 million users. One of the services offered by the Internet is social media. Now, a lot of companies, such as Telkomsel, which utilizes social media as a means to distribute information and interact with their customers, one of them through Twitter. Twitter is a social media which facilitates its users to send tweets of 140 characters per tweets. Twitter is one of social media are widely used in Indonesia with a total of 19.5 million active

users that make Indonesia as the country with 5<sup>th</sup> largest twitter accounts in the world [1].

In the arena of social media Twitter, Telkomsel which is the market leader in the telecommunications industry in Indonesia has the highest growth compared with the followers of other operators account. The growth in the number of followers shows the number of customers who follow Telkomsel account in order to get information about the products and services delivered by the account. According to Vice President of Customer Care Management Telkomsel, one of the efforts made by Telkomsel to maintain its position is to strengthen customer service in digital channels, especially social media. So Telkomsel used social media, namely Facebook and Twitter to serve responses provided by customer [2]. In the last 2014, Socialbakers crowned Telkomsel Twitter account as an account of the most responsive in the world. Based on the data cited from Sotrender [3], Telkomsel's Twitter was also the account which most often mentioned by other users with more than 70 thousand mentions in 2014 ago. The development of customer service through social media in line with customers' lifestyles that increasingly digital with high mobility, where customers require quick solutions to the problems they face related to the service or product of Telkomsel. In an era like today there is a tendency for consumers to search for information or assistance customer support to customers through Twitter [4]. Results of study conducted by Edison Research also showed that consumers are using Twitter to exchange information.

The majority of users utilized Twitter to learn the information related to the products or services of a particular brand. Still referred to the data above indicated that Twitter can be an option that allows the information distribution activities by the company that can be used by consumers as an attempt to fulfill their information needs. Uses and Gratification theory also suggested that a medium chosen by the audience to be used can produce satisfaction or fulfillment of the needs they have. Fulfilling the needs of information will occur when consumers get satisfaction with the information

they received because it's in accordance with what they need. More than 500 thousand Telkomsel customers/ Telkomsel twitter account followers have used this Twitter account with the hope of meeting the needs of the information. By reviewing the use of Twitter by the consumer's perspective that is perceived value, perceived ease of use and perceived usefulness [5], this study was intended to determine whether to access the Telkomsel Twitter account then the customers' information needs can be met. Therefore, based on the background that had been described, the authors were interested to investigate how much influence arising in the use of social media Twitter in meeting the customers' information needs.

## II. GROUND THEORY

### A. New Media

New media is media that uses the internet, *online* media with technology based, characterized by flexibility, interactive and could potentially work in private and public [face]. Flew suggests that the development of *new media* itself is inseparable from the emergence of the Internet and the *World Wide Web* as a result of the globalization of information technology [7]. The Internet is one of the forms of new media, is rated as the most important information tool to be developed in the future. Internet is not owned, controlled or managed by a single entity but a computer network connected in intentional and operates based on a mutually agreed protocol. A number of organizations especially telecommunications providers and agencies play a role in the operation of the Internet [8].

### B. Social Media

According to Treadaway and Smith [9], "The term social media refers to the collection of technologies that capture communication, content, and so on across individuals, Reviews their friends, and their social networks." Which means that the term social media refers to a collection technology that captures communications, content, and the like throughout the individual, their friends, and their social networks. Social media is perceived as a new form of communication, social media is a means of conversation going on the internet and supported by tools such as application or software. As said by Vollmer and Precourt, "Consumers are in control; they have greater access to information and greater command over media consumption than ever before" [10]. So with the facilities provided by social media as discussed previously, the customer has more control in the use of social media in getting and finding information. Social media allows companies dealing with various layers of consumers including young consumers known as a youth.

### C. Twitter and Microblogging

Microblogging is a form of blogging that has a size limit of each post. Such as Twitter which allows its users to post a 140 characters tweets. Twitter was popular in the early 2009, and now its use has become very common. Companies can use Twitter to announce offers, promotions, or providing

information to readers about new things relating to products or services of the company [11]. To measure the use of Twitter, Lee and Cho provides three measures, perceived value, perceived ease of use and perceived usefulness..

#### a) Perceived value

The value and benefit gained by the user when using Twitter. Value and advantages can be seen from:

- Interactivity is based on Twitter as interactive media types with provide distribution information to followers and too enable occurrence communication two direction.
- Mobility refers to the level of mobility as value added for Twitter users and enable User interacting when only where only with fast.

#### b) Perceived ease of use refers on the easiness in using Twitter.

#### c) Perceived usefulness refers on user's confidence that with using Twitter will produce useful benefits for them [5].

### D. Uses and Gratification Theory

Uses and Gratification approach leads to the answers to the revelation of "What the media do to people" or what to do in the public media. Uses and Gratification Model shows that the main focus is how the media meet personal and social needs of the audience. In essence, the audience is an active party who intentionally use the selected media to achieve specific goals [12]. This theory suggests that basically audiences using media based on certain motives. A media considered trying to meet the audience's motives. If the motives were met then the audience needs will also be met. So the audience is considered actively using the media to meet their needs. Therefore, this theory focuses on the use (uses) media to obtain satisfaction (gratification) upon fulfillment of the needs facing the audience. Audiences using media based on specific motives. Results from consuming media based on the motives will lead to the satisfaction of consuming media. One of these motives is the information needs motive relating to the confirmation of information, knowledge and understanding. Information must be obtained quickly and accurately in order to have the necessary support so that the value of the latest technology, like the internet and social media, to support the confirmation of the information [8].

### E. Information Need

Information is data that had been processed into a form that is meaningful to the recipient and have a real value or understood in the action or decision [13]. Estabrooke in Yusup [14] revealed that the need for information changes with the users' job and the development of time. According to Guha in Anwar [15] the user's information needs can be viewed through several approaches:

#### a. Need Current Approach

User's information need that is up to date. Users interact with information systems in a way that is very common in order to improve knowledge.

#### b. Need Everyday Approach

User's information need that are specific and fast. Information needed is information that routinely encountered by users.



### c. Exhaustive Need Approach

User's information need about the depth information, the information the user has a high dependence on the required information that is relevant, specific and complete.

### d. Catching Up Need Approach

User's information need for information concise, but also complete in particular regarding the recent developments a subject that is required.

Based on the literature reviewed, this paper is using research framework as follows:

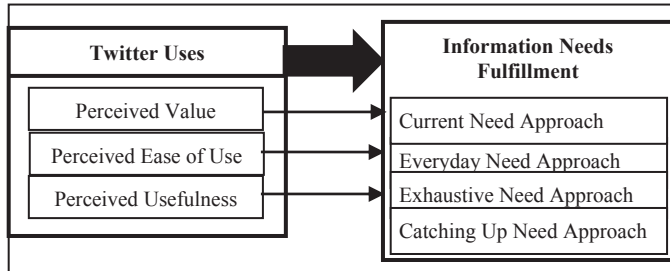


Fig 1. Framework Research

## III. RESEARCH METHODOLOGY

This study used a quantitative method with a descriptive approach and causal. Descriptive analysis used to analyze the data in ways that describe or depict the data that has been collected [16]. This research used a causal relationship due to examine causality of Twitter media usage to meet the needs of the customer information.

### A. Sample

The sampling technique used was simple random sampling technique. Where the simple random sampling technique is a technique of determining a randomized sample without regard to strata that exist [17]. Therefore, the samples taken in this study were yet still be within the scope of Telkomsel Twitter account followers.

To determine the sample size, this study used Slovin formula with an error rate of 5%. Here was the result of the calculation:

$$n = \frac{N}{(1 + N \cdot e^2)} = \frac{589.230}{(1 + 589.230 \times 0.05^2)} = 399.72 \quad (1)$$

From the calculation, the number of samples that would be used in this study were 400 respondents.

### B. Respondents Characteristics

Based on 400 respondents surveyed in this study, the majority of respondents was female with a number of 227 respondents. The age range of Telkomsel Twitter account followers ranged between 17-22 years as many as 154 respondents, which indicated that the majority of Telkomsel Twitter account followers who were respondents in this study are among youth or young adults. It was also supported by data showing that the majority of respondents in this study were a learner or student.

## C. Descriptive Analysis

Descriptive analysis conducted by comparing scores on the questionnaire answers with the acquisition of ideal response scores. Table 1 below provides the summary of variables and item in questionnaire.

TABLE 2. SUMMARY OF VARIABLES AND ITEM

Variables	Item
<b>Twitter Uses</b>	
<b>Perceived Value</b>	1. I could access Telkomsel's Twitter anytime
	2. I could access Telkomsel's Twitter anywhere
	3. I could quickly access Telkomsel's Twitter
	4. Telkomsel's Twitter facilitates two way communication between its admin and other users
	5. Telkomsel's Twitter actively reply the mentions and direct messages from followers
	6. I could ask question and get answer from Telkomsel's Twitter
	7. I get informative feedback from Telkomsel's Twitter
	8. Telkomsel's Twitter give feedback quickly
<b>Perceived Ease of Use</b>	9. I could easily send <i>tweets</i> , <i>mention</i> , <i>direct message</i> to Telkomsel's Twitter
	10. I could easily find Telkomsel's Twitter using the search bar feature
<b>Perceived Usefulness</b>	11. I could access Telkomsel's Twitter from any platform
	12. Telkomsel's Twitter is useful for me to get information
	13. Telkomsel's Twitter helped me with the information provided
<b>Information Needs Fulfillment</b>	
<b>Current Need Approach</b>	14. Telkomsel's Twitter provides knowledgeable information for me
	15. Telkomsel's Twitter provides current information
<b>Everyday Need Approach</b>	16. I get specific information from Telkomsel's Twitter
	17. Telkomsel's Twitter routinely provided information
<b>Exhaustive Need Approach</b>	18. I depend on Telkomsel's Twitter to get information about its product and service
	19. Telkomsel's Twitter gives relevant information to which I needed
	20. I get comprehensive information from Telkomsel's Twitter
<b>Catching Up Need Approach</b>	21. I get follow up information regarding particular problem I addressed to Telkomsel's Twitter

Based on the questionnaire above a descriptive analysis was conducted. Firstly, The result showed that the average percentage of respondents' responses overall to the variable Perceived Value (X1) was amounted to 74.86%, while the percentage of the ideal score was 4 (Likert highest value) x 400 (respondent) = 1600 (100%). Then Perceived Value was

in the category of "good". Which mean that the respondents perceived the good value whenever they use Telkomsel's Twitter.

TABLE 3. DESCRIPTIVE CALCULATION

Item	Answer				Sum	Total Score	Category
	SA	A	D	SD			
1	137	191	65	7	400	1258	Good
	34.25%	47.75%	16.25%	1.75%	100%	78.63%	
2	134	166	82	18	400	1216	Good
	33.50%	41.50%	20.50%	4.50%	100%	76.00%	
3	125	178	75	22	400	1206	Good
	31.25%	44.50%	18.75%	5.50%	100%	75.38%	
4	131	168	79	22	400	1208	Good
	32.75%	42.00%	20%	5.50%	100%	75.50%	
5	115	154	103	28	400	1156	Good
	28.75%	38.50%	25.75%	7.00%	100%	72.25%	
6	144	141	89	26	400	1203	Good
	36.00%	35.25%	22.25%	7%	100%	75.19%	
7	123	154	110	13	400	1187	Good
	30.75%	38.50%	27.50%	3%	100%	74.19%	
8	101	163	119	17	400	1148	Good
	25.25%	40.75%	29.75%	4%	100%	71.75%	
Average Percentage of Total Score for Perceived Value						74.86%	Good

Secondly, the respondents' responses to the variable Perceived Ease of Use (X2) had a percentage of 77.10%. Then the percentage resulted for this variable in the category of "good". As calculated from the table below:

TABLE 4. DESCRIPTIVE CALCULATION

Item	Answer				Sum	Total Score	Category
	SA	A	D	SD			
9	162	164	61	13	400	1275	Good
	40.50%	41.00%	15.25%	3.25%	100%	79.69%	
10	150	172	75	3	400	1269	Good
	37.50%	43.00%	18.75%	0.75%	100%	79.31%	
11	97	180	106	17	400	1157	Good
	24.25%	45.00%	26.50%	4.25%	100%	72.31%	
Average Percentage of Total Score for Perceived Ease of Use						77.10%	Good

This shows us that the respondents who represent Telkomsel's customers as well as its Twitter followers perceived easiness in using Telkomsel's Twitter.

And lastly, as for the variable Perceived Usefulness (X3)'s percentage was 77% and it was included into the category of "good" which tells us that the respondents perceived the benefits in using Telkomsel's Twitter that is useful for them. As the calculation of descriptive analysis presented below:

TABLE 5. DESCRIPTIVE CALCULATION

Item	Answer				Sum	Total Score	Category
	SA	A	D	SD			
12	135	176	75	14	400	1232	Good
	33.75%	44.00%	18.75%	3.50%	100%	77.00%	
13	107	177	106	10	400	1181	Good
	26.75%	44.25%	26.50%	2.50%	100%	73.81%	
Average Percentage of Total Score for Perceived Usefulness						75.41%	Good

#### D. Path Analysis

Hypothesis testing was conducted to determine how much influence the perceived value (X1), perceived ease of use (X2), and perceived usefulness (X3) to fulfillment of customers' information needs. The method used to determine the size of the influence was by using path analysis. In path analysis method, to find a causal relationship or influence the study variables, first the correlation matrix of exogenous variables (independent variables) on endogenous variables (the dependent variable) should be calculated.

#### IV. RESULT AND DISCUSSION

##### A. Hypothesis Testing Simultaneously

To determine whether Variable Media Twitter Usage which are perceived value, perceived ease of use and perceived usefulness influence customers' information needs fulfillment simultaneously or not,  $F_{test}$  was conducted. Through  $F_{test}$ , it was known that determination coefficient (R Square) is 0,461. This indicated that customers' information needs fulfillment was influenced by Media Twitter Usage simultaneously to an amount of 46,1%. Therefore, factors that weren't studied amount of 53,9%. Proposed hypotheses in this study as follows:

$H_0$  : There's no significant influence of Twitter Media Usage on Customers' information needs fulfillment.

$H_1$  : There's a significant influence of Twitter Media Usage on Customers' information needs fulfillment.

The above hypotheses were tested using the  $F_{test}$  on the condition that  $H_0$  is rejected if  $F_{count} > F_{table}$  and  $H_0$  accepted if  $F_{count} < F_{table}$ . With a significance level  $\alpha = 5\%$  and  $F_{table} = 2.62$ . The value of  $F_{table}$  is obtained by determined the degrees of freedom numerator (dfn) and degrees of freedom denominator (dfd) as follows:

$$dfn = k - 1 = 3 ; dfd = n - k = 396$$

Based on the determined dfn and dfd, the value of  $F_{table}$  obtained is 2,62.

The results of the  $F_{test}$  shown that sig. (0,000)  $< \alpha$  (0.05) and  $F_{count}$  (112.966)  $> F_{table}$  (2.62), so  $H_0$  was rejected and  $H_1$  was accepted meaning perceived value, perceived ease of use and perceived usefulness on Twitter Telkomsel simultaneously influenced customer information needs fulfillment. This indicated that Twitter media usage may influence the fulfillment of customer information needs when all independent variables used are tested together.

##### B. Hypothesis Testing Partially

Individual testing was done to see the significance of the influence of variable Twitter Media Usage variables (perceived value (X1), perceived ease of use (X2) and perceived usefulness (X3)) partially towards the fulfillment of the information needs variable (Y) by  $T_{test}$ . For the variable Perceived Value,  $T_{test}$  showed that the value of 6.359 and  $T_{table}$  1.96. This showed that  $H_0$  is rejected because  $T_{count}$  was higher than  $T_{table}$  (6.359  $>$  1.96). This showed that there is significant

influence between the variables of perceived value to information needs fulfillment. One value that obtained by followers for making Telkomsel Twitter account as the source of information was the mobility aspects of the account. This indicated that Telkomsel Twitter account can be accessed at any time when required by its followers in search information activity.

Meanwhile for perceived ease of use variable was obtained  $T_{count}$  0,952 and  $T_{table}$  1,96. This showed that  $H_0$  is accepted because  $T_{count}$  was lower than  $T_{table}$  ( $0,952 < 1,96$ ). This showed that there is no significant influence between the variables of perceived ease of use to information needs fulfillment. Twitter media ease of use aspect did not give influence on Telkomsel Twitter account followers' information needs fulfillment.

Then, for perceived usefulness variable was obtained  $T_{count}$  9,746 and  $T_{table}$  1,96. This showed that  $H_0$  is rejected because  $t_{count}$  was higher than  $T_{table}$  ( $9,746 > 1,96$ ). This showed that there is significant influence between the variables of perceived usefulness to information needs fulfillment. The followers believed that Telkomsel Twitter account is useful for them for their information needs fulfillment activity as source of obtain trustworthy information regarding Telkomsel's offered products and services.

#### C. Path coefficient testing simultaneously: Trimming Phase I

In this study, the variable  $X_2$  (perceived ease of use) was issued and subsequently variables calculated were perceived value ( $X_1$ ) and perceived usefulness ( $X_3$ ) to the fulfillment of information needs ( $Y$ ). From the results of trimming calculation, it was known that the coefficient of determination (R Square) is 0.460 or 46%. This showed that the Twitter Media usage variables influencing information needs fulfillment variable by 46% and there were other factors that are not addressed in this study was 54%. Based on the results of  $F_{test}$  calculations, it was known that  $F_{count} > F_{table}$  ( $169.035 > 2.62$ ) so that  $H_0$  was rejected, thus it could be concluded that there is significant influence between Twitter Media Usage to fulfillment of information needs and perceived value and perceived usefulness variables jointly influenced fulfillment of information needs.

#### D. Path Coefficient Testing Partially: Trimming Phase I

Furthermore, individual testing was done to see the significance of the influence for the independent variables ( $X_1$  and  $X_3$ ) partially on the dependent variable ( $Y$ ), test used was  $T_{test}$ , with the acquisition  $t_{count}$  for perceived value variable was  $T_{count}$  (6.777)  $> T_{table}$  (1.965), it could be concluded that for this variable,  $H_0$  is rejected and there was a significant influence for the perceived value on the fulfillment of information needs. As for the perceived usefulness variables obtained  $T_{count}$  (12.369)  $> T_{table}$  (1.965), it could be concluded that for this variable,  $H_0$  is rejected and there was a significant influence for the perceived usefulness on the fulfillment of information needs.

#### E. Path Analysis Model

After obtaining the variables that have a significant influence simultaneously and partially, ie  $X_1$  and  $X_3$ , then the path analysis model could be made as follows:

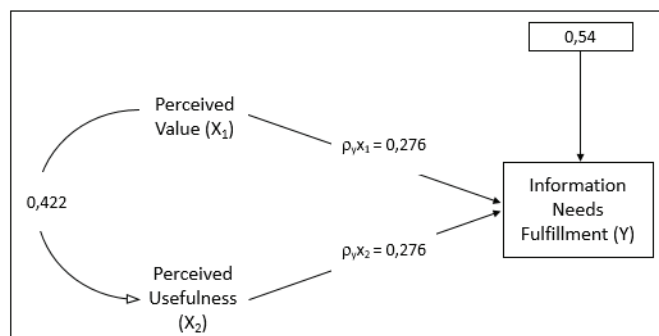


Fig 2. Path Diagram of Influence of Twitter Media Usage on Customers' Information Needs Fulfillment

#### F. Influence of Perceived Value and Perceived Usefulness on Customers' Information Needs Fulfillment

Based on the path diagram above, the influence of the independent variables ( $X_1$ , and  $X_3$ ) on the dependent variable ( $Y$ ) could be calculated as follows:

TABLE 6. DIRECT AND INDIRECT INFLUENCE

Through Variabel	Influence of Variabel	
	Perceived Value	Perceived Usefulness
Perceived Value	$(pyx1)^2 = 0,0761$	$pyx1 \times pyx3 \times rx1x3 = 0,0598$
Perceived Usefulness	$pyx1 \times pyx3 \times rx1x3 = 0,0598$	$(pyx3)^2 = 0,2641$
Total of Influence	$0,0761 + 0,0598 = 0,1359$	$0,0598 + 0,2641 = 0,3239$
<b>Total of Influence of X to Y</b>	<b><math>0,1359 + 0,3239 = 0,4598</math></b>	

Thus, based on table 1, it could be concluded the total influence of media usage (which consisted of perceived value and perceived usefulness) on customers' information needs fulfillment achieved 45.98%.

## V. CONCLUSION AND RECOMMENDATION

#### A. Conclusion

Based on the results of study and analysis that has been carried out, a number of conclusions to answer the problem formulation, among others:

- Aspect of perceived value acquired a percentage of 74.86%, included in the 'Good' category. This meant that followers of Telkomsel twitter account consider mobility becomes an added value that customers perceived when accessing Telkomsel's Twitter in search of information.
- Perceived usefulness aspect acquired a percentage of 75.41%, included in the 'Good' category. This show us

that the respondents consider Telkomsel Twitter account gives them benefit in terms of information needs fulfillment activities.

- c) Aspect of perceived ease of use acquired a percentage of 77.10% and categorized as Good. Meaning the majority of respondents considered that Telkomsel Twitter account may be used easily in meeting their information needs.
- d) The Telkomsel's Twitter Usage gave significant effect on fulfilling its user's information need. There is two aspects from Twitter Usage, Perceived Value and Perceived Usefulness, that gave significant effect on fulfilling the information needs of Telkomsel's Twitter followers by 46%. While, Perceived Ease of Use did not give a significant influence on the fulfillment of customers' information needs. Then, there was also influence of other factors which did not examined in this study amounted to 54%.

#### B. Recommendation

Based on the research results obtained, then the advice that can be given to the company are as follows:

- a) Telkomsel Twitter account admin should increase the speed in responding to tweets, mentions or direct messages sent by its followers. Increasing the number of officers who are responsible for monitoring and responding to customers in Twitter media may be a solution to improve the speed of Telkomsel Twitter accounts in providing feedback for its followers.
- b) Telkomsel should optimize the information distribution media other than Twitter which could possibly allow Telkomsel to directly communicate with its customers.
- c) Telkomsel Twitter account should give more detailed information when overcoming obstacles faced by its followers in terms of using products and services offered by Telkomsel. In addition, Twitter admin may routinely facilitates its followers to give feedback about the performance of information delivery from Telkomsel Twitter account admin.

In this study, note that there are two aspects of Twitter uses such as perceived value and perceived usefulness that give effect to the fulfillment of customer information. For further research, it is recommended to examine other aspects or dimensions of the media Twitter such as the content type or Twitter elements that might affect the fulfillment of customer information.

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# Sticker Wayang Design As Media Reintroduction of Art and Cultural Heritage Premises In Young Indonesian.

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**Abstract** — At present, the introduction of cultural heritage wayang, which has been recognized as belonging to Indonesia, became an obstacle for the young people of the nation and the world. Given the large number of characters is also visual overseas production more modern, both in the selection and presentation of media he uses, can be said to be appropriate, for young people, including in Indonesia. At this writing, author used a media chat with these stickers to introduce the culture of puppet characters with a contemporary approach to young people around the world. This method will be conducted by author include depictions classification of facial expressions of emotion, and collaborate with some general visualization in the sticker approach. This method also involves a journal belonging to previous research, the craft of puppet prototype visual. Author used puppet prototype as a visual basic character to deformation become contemporary puppet characters, so good visualization sticker applied to the target user's application characteristics and functions of communication.

**Keywords** — Chatting Stickers, Visual Character Indonesian Wayang, Visual Expression, Wayang Contemporary Indonesia, Chatting Application Sticker.

## I. INTRODUCTION

From the technology point of view; addressing and considering the development and trends lively chat text-based communication, requires a text media that can represent emotions in communication. With the development needs of this expression filled with text codes that evolved into an icon called emoticons. So, according to the Oxford dictionary definition of emoticons; is: A representation of a facial expression such as a smile or a frown, formed by various combinations of keyboard characters and are used in electronic communication to convey the feelings of the author or the intended tone. Taner Osman (2005) concluded in his thesis entitled: Emoticon Usage in Task-Oriented and Socio-Emotional Contexts in Online Discussion Boards, at Florida State University [1], conducted experiments communication with

whether or not an emoticon, apparently the result of this experiment is very big impact on the delivery of expression with an emphasis emotions required in a communication process.



Fig 1. Applied Sticker Line and Kakao.  
Source: play.google.com

Along with the development of technology, the role of delivering emotion and expression carried with sticker chat. The picture of character and emotional visual expression provided some chat applications that are now becoming audio-visual media. In Japan, sticker chat is widely used by the chat application called Line. Online chat is an application that top and evolved from era to era. For the characters in this application has a lot of users go to the heart, until there are specialty stores that sell everything merchandise of characters Line. In

Korea, stickers chat is also growing in harmony with the application Kakao Talk. Together with its development efforts, Kakao also has the character to convey emotion and expression. And like Line, Kakao has also been heavily in developing many other applications, as well as some of the games he made. Kakao for that character also has a special shop that sells all merchandise character.

In this study, author used the phenomenon of chatting with a sticker to reintroduce the cultural heritage of Indonesian wayang characters with a contemporary approach to Indonesian young people, in particular and in the whole world in general. Methods will be conducted by author in the first period; which includes: literature, data collection and classification. As well as tangible results in 10 prototypes stickers; included in the classification of visual by combining sketches simplified visual approach, to obtain the corresponding visual characteristics of the contemporary wayang puppet itself.

From the cultural re-introduction point of view; the introduction of cultural heritage wayang, which has been recognized as belonging to Indonesia, became an obstacle for the young people of the nation and the world. Given the large number of characters are also The international recognition of UNESCO in 2003 that the wayang shadow play is one of Indonesia's cultural heritage, but the sense of belonging and the sense of pride in this wayang is still slight among the next generation of Indonesia. So at this point, both the government and the educationers, still trying to improve the regeneration of the knowledge and recognition of this wayang so that can be received by the young nation around the world. An obstacle or a problem in itself, considering the number of characters anyway visual overseas productions more modern, both in the selection and presentation of media he uses, can be said to be appropriate, for young people, including in Indonesia. To that end, author tried to find the shape deformation puppets new contemporary visual and media gap that appropriate and effective to reintroduce the cultural heritage of Indonesia's wayang puppet.

The most well ancient wayang in Indonesia is called Wayang Purwa, there are also have two different varieties, such as a variant from Yogyakarta and from Surakarta. According to

Sunaryo (2008) [2], the visual of wayang as props performances of these two forces was not only in terms of the dimensions and proportions of the shape, but also many other elements that set it apart.



Fig 2. Visual Differences between Yogyakarta and Surakarta Wayang.  
Source: museumwayang.com

The differences of two styles wayang are about identity and appearance look. The portrayal attributes, type of clothing, accessories, pattern face, arms and hands to the feet, as well as carve decoration wayang has a real contribution to the differences in the two styles of wayang images. The researcher concludes that this variety also occurs due to the beliefs that are dominating at that time. In wayang Surakarta variant, the influence of the Islamic religion-based trust is very thick, so the proportion is more tangible symbolic form, so as not to resemble a human as opposed to the teaching of religion. Unlike the case with wayang Yogyakarta variant, is more affected by Kejawen which is Javanese believe and confidence, so that the real proportion is tolerant able in their religions. In this study, the researcher is more burdensome with visual reality; namely: the proportion of anatomy character, for it is the selected range of proportions puppet prototype Yogyakarta.

In addition, author also settled on the character selection Pandawa as a character representative expression and character sticker category Punakawan as the representative character sticker personality category. This election determined the scope of the development efforts of the author as a character trait characterization of Punakawan, namely: Semar, Petruk, Gareng, and Bagong. As well as author is also doing construction scope character trait characterization of Pandawa, namely:

Yudhisthira, Bima, Arjuna, Nakula and Sadewa. Recognizing the need for characterization of women, the author also conducted development scope character trait characterizations of the royal Pandawa heroine, namely: Drupadi, Srikandi and Subadra.

To sort the categories of emotion representation to be made to the sticker on this study, the authors also view and explore the underlying emotional division of some figures put forward about the various emotions, such as Descartes, Kurt Fischer, John B. Watson, Daniel Goleman and Florence Littauer. According to Descartes, emotion is divided into: desire, hate, sorrow, wonder, love and joy. While Kurt Fischer [3] suggests five kinds of emotions, which are: love, joy, anger, sadness and fear. Something similar to the division by Watson; fear, rage and love. The author took the decision to choose the category that summarizes Daniel Goleman [4] three previous division, and Florence Littauer [5] categories that divide it into 4 personalities in his book: Personality Plus is the reference world of psychology to this day. The categories of this Goleman include 8 divisions: happy, angry, sad, surprise, contempt, fear, and disgust. Personality Plus belongs Littauer divide it into: sanguine, melancholic, choleric, and phlegmatic.

## II. METHODS

Before determining method in this research, the author conducted a comparison method on some writing that has ever existed. In this case the sphere is taken topic paper also aims to reintroduce the cultural puppet. From 4 paper were analyzed, it was found several good point, however, authors feel about this research may provide better results in the reintroduction of cultural viewpoints.

For example in the writing titled: The Contribution of Shadow Puppet's Show through engaging Social Communication in Modern Society [6], which uses the method: perception and opinion; revival story and its social contribution, practitioners and educators, also self-experienced and observations. Perception and opinion method is a very good for qualitative research, with the deepening of the visual philosophy may be more pronounced. But to make it as an attempt to reintroduce a culture, considered less consideration

from the perspective of the target. This is caused by the lack of consideration of the use of popular media on the target.

Another example is the writing titled: Wayang Hip Hop: Java's oldest performance tradition meets global youth culture [7], which uses the method: applying adaptations; classical contemporary problems, Javanese wisdom, and production technique, musical intersections, also an extension of the conventions into a full performance. Adaptation method is a good effort for culture introduction, where the popular media considerations for the target becomes the main thing. However, in the application of the method, considered less consideration for the variety of the content itself. This happens because the puppet philosophy remains absolute, so it cannot be changed or modified.

In the writing titled: Wayang kulit: Digital puppetry character rigging using Maya MEL language [8], which uses the method: applying visual digital style; puppetry using manipulation and performance of digitally animated 2D or 3D figures and objects in a virtual environment. Digital media usage method is also good effort for culture introduction, visual style has begun to be changed out of the common grip which the approach has outdated. But in this paper, is considered less provide more sustainable; wherein the media used form of media is not performing daily media use targets.

Also in the writing titled: Wayang fighters: Preserving the art of wayang kulit (shadow puppets) through the game application [9], which uses the method: Gamification; provides an overview of related digitalization and interactive media using Wayang Kulit as a motivation for the development of a comprehensive. Gamification method is a better effort effort for culture introduction, where the realm of the story began to be modernized, as well as to reflect the target of the puppet characters in their daily lives. But the media selection as a game considered less range received target, only enthusiasts gamers will recognize the puppet, so the need to consider the wider range media.

Other Paper Title	Methodology	Evaluation	
		Visual Philosophy	Yes
The Contribution of Shadow Puppet's Show through	Perception and opinion; revival story and its social contribution,	Adaptation	No



Engaging Social Communication in Modern Society	practitioners and educators, also self-experienced and observations.	Value	
		Daily Used Media	No
		Sustainability	No
		Range Target	Short
Wayang Hip Hop: Java's oldest performance tradition meets global youth culture	Applying adaptations; classical contemporary problems, Javanese wisdom, and production technique, musical intersections, also extension of the conventions into a full performance.	Visual Philosophy	Yes
		Adaptation Value	Yes
		Daily Used Media	No
		Sustainability	No
		Range Target	Short
Wayang kulit: Digital puppetry character rigging using Maya MEL language	Applying visual digital style; puppetry using manipulation and performance of digitally animated 2D or 3D figures and objects in a virtual environment.	Visual Philosophy	Yes
		Adaptation Value	Yes
		Daily Used Media	Yes
		Sustainability	No
		Range Target	Short
Wayang fighters: Preserving the art of wayang kulit (shadow puppets) through game application	Gamification; provides an overview of related digitalization and interaction media using Wayang Kulit as a motivation for the development of a comprehensive.	Visual Philosophy	Yes
		Adaptation Value	Yes
		Daily Used Media	Yes
		Sustainability	Yes
		Range Target	Short

Table 1. Other Methodology Comparison.  
Source: Author's Works.

Therefore, in this research, author use visual digital style with sticker chatting media applied; visual analysis of the expression of the target which is applied in visual puppet. So that research results can be used as representation of emotions in everyday communication targets. So from the visual philosophy; Research will conduct an analysis of the visual characteristics of the puppet so that it maintains an appropriate visual grip, of the value of the adaptation; the authors also merge in popular expression used in chats needs of the target, the daily media selection has also been determined in the mobile media chat, so has the value of sustainability long, and the range of targets to be very broad.

Paper Title	Methodology	Evaluation	
Sticker Wayang Design As Media Reintroduction of Art and Cultural Heritage Premises In Young Indonesian	Applying visual digital style with sticker chatting media; visual analysis of the expression of the target which is applied in visual puppet. So that research results can be used as representation of emotions in everyday	Visual Philosophy	Yes
		Adaptation Value	Yes
		Daily Used Media	Yes
		Sustainability	Yes
		Range Target	Wide

	communication targets.		
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Table 2. Research Methodology.  
Source: Author's Works.

Application of visual process; was originally divided into 2 points of view: the introduction of visual culture over the selection of puppets and popular media targets. For the re-introduction, the authors review the deepening of the visual elements of distinctive character, both for the category of the Pandavas and Punakawan. Meanwhile, from the selection of the target media for reviews with visual expression. Good results puppets with the visual characteristics of this expression, back into one in the sketch sticker which is then followed by the completion of digital.

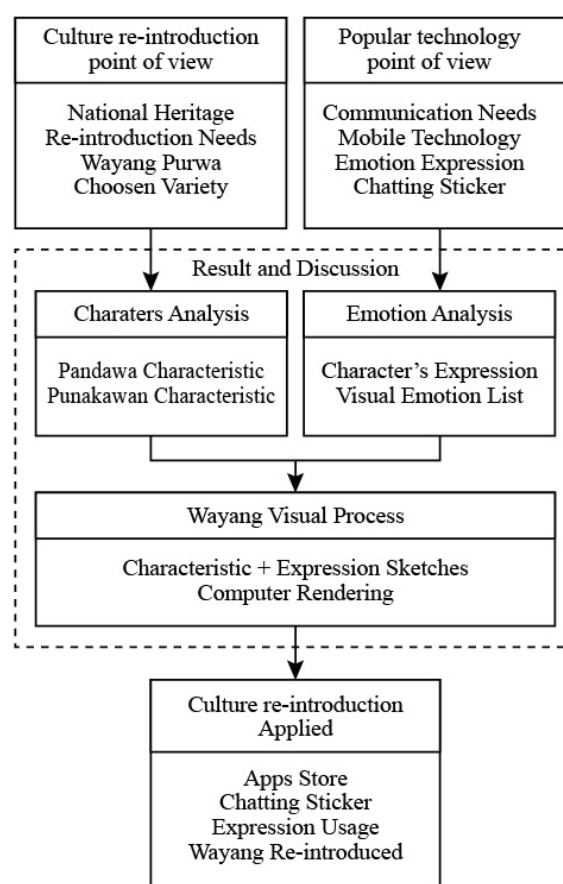


Diagram 1. Methodology Site Map.  
Source: Author's Works.

Applications in the sticker are not included in the results and discussion sections of this research, because the application of the sticker is another part issue of collaboration with a particular provider. In this research, the results and discussion only the visual design of the sticker, but the author will make



a simple simulation of the result of the sticker in chat application interface simulation.

### III. RESULT AND DISCUSSION

#### A. Emotion Analysis

In terms of semantics, the author tries to perform a visual expression with the expression proposed by Joe Navarro [10] a retired FBI and is known as a reader expression. In his book titled: *What Every Body Saying*, Navarro managed to clarify the movement in the facial expressions reveal the expression and / or certain emotions. The result of this division is the basis for the visualization of the author to do the sketch and manufacture sticker. The division consists of visual expression of the position of the eyebrows, eyes, nose, mouth, cheeks and gestures. Based on this, the authors classify positions to the needs of visual expression.

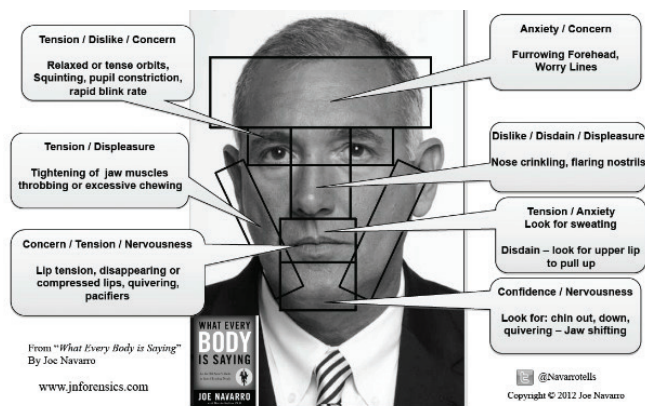


Fig 3. Navarro's Dissecting the Face.  
Source: psychologytoday.com

From the results of this cross, it was decided the selection of emotional expression and behavior based on the specific events of the characterizations. They were divided segmentation characterizations with emotional expression as follows: Yudhisthira - Sad expression, Bima - Happy expression, Arjuna - Angry expression, Nakula - Shocked expression, Sadewa - Paltry expression, Drupadi - expression Fear, Srikanth - Disgusted expression, Subadra - Shame expression. Similarly, the segmentation division characterizations with an expression of his personality as follows: Bagong - cheerful personality (sanguine), Petruk - decisive personality (choleric), Gareng - troubled personality (melancholy), Semar - Calm personality (plagmatic).

According to Navarro, every emotion gives expression on its own. In visual terms, the authors

capture the visual expression as a benchmark to represent an emotional expression of its own. As in the visual feeling sad; characterized by: eyebrows to the top, wet eyes narrowed, nose wrinkled in the middle, mouth down, cheek down, and body gestures down. For visual feeling happy; characterized by: eyebrows off upwards, eyes narrowed, nose down, mouth to the top, puffy cheeks above, and body gestures up. For visual feeling angry; characterized by: eyebrows fused in the middle, big eyes sharpened, nose wrinkled in the middle, open mouth bite, small puffy cheeks above, and body gestures forward. For visual feeling surprise; characterized by: eyebrows off upwards, dilated eye, off nose down, mouth wide open, cheek down, and body gestures to the back. For visual feeling contempt; characterized by: eyebrows one up one down, eyes narrowed, off nose down, one side of the mouth is up, one side puffy cheeks are up, and body gestures tilted to one side. For visual feeling fear; characterized by: eyebrows to the top, small dilated eye, small crimped nose in the middle, small open mouth, small cheek small down, and body gestures down. For visual feeling disgust; characterized by: eyebrows one up one down, eyes narrowed, nose wrinkled in the middle, mouth down, cheek down, and body gestures to the back. For visual feeling shame; characterized by: eyebrows in the middle, eyes closed, nose middle of a small wrinkle, mouth shut, cheek down, and body gestures down. And for visual feeling cheer; characterized by: eyebrows off upwards, eyes narrowed, nose down, mouth smiled to the top, puffy cheeks above, and body gestures up. For visual feeling firm; characterized by: eyebrows fused in the middle, big eyes sharpened, nose wrinkled in the middle, open mouth bite, small puffy cheeks above, and body gestures forward. For visual feeling sorrow; characterized by: eyebrows to the top, wet eyes narrowed, nose wrinkled in the middle, mouth down, cheek down, and body gestures down. For visual feeling calm; characterized by: eyebrows off upwards, eyes narrowed, nose down, mouth open slightly, small puffy cheeks above, and body gestures forward.

Emotion	Visualisation
Sad	eyebrows to the top
	wet eyes narrowed
	nose wrinkled in the middle
	mouth down
	cheek down
	body gestures down

Happy	eyebrows off upwards
	eyes narrowed
	nose down
	mouth to the top
	puffy cheeks above
	body gestures up
Angry	eyebrows fused in the middle
	big eyes sharpened
	nose wrinkled in the middle
	open mouth bite
	small puffy cheeks above
	body gestures forward
Surprise	eyebrows off upwards
	dilated eye
	off nose down
	mouth wide open
	cheek down
	body gestures to the back
Contempt	eyebrows one up one down
	eyes narrowed
	off nose down
	one side of the mouth is up
	one side puffy cheeks is up
	body gestures tilted to one side
Fear	eyebrows to the top
	small dilated eye
	small crimped nose in the middle
	small open mouth
	small cheek small down
	body gestures down
Disgust	eyebrows one up one down
	eyes narrowed
	nose wrinkled in the middle
	mouth down
	cheek down
	body gestures to the back
Shame	eyebrows in the middle
	eyes closed
	nose middle of a small wrinkle
	mouth shut
	cheek down
	body gestures down
Cheer	eyebrows off upwards
	eyes narrowed
	nose down
	mouth smiled to the top
	puffy cheeks above
	body gestures up
Firm	eyebrows fused in the middle
	big eyes sharpened
	nose wrinkled in the middle
	open mouth bite
	small puffy cheeks above
	body gestures forward
Sorrow	eyebrows to the top
	wet eyes narrowed
	nose wrinkled in the middle
	mouth down
	cheek down
	body gestures down
Calm	eyebrows off upwards
	eyes narrowed
	nose down
	mouth open slightly
	small puffy cheeks above
	body gestures forward

Table 3. Visual Emotion Guidance.  
Source: Author's Works.

The context of the creation of this chat, the author is divided into categories which Pandawa character emotions and expressions of Goleman, which include: happy, angry (angry), sad (sad), surprise (shock), contempt (trivial), fear (fear), and disgust (disgust). And the division's Punakawan character into the category of emotion and expression of Personality Plus belongs Littauer that includes: sanguine, melancholic, choleric, and plagmatic. Blend on the author to characterizations Pandawa (Yudhisthira, Bima, Arjuna, Nakula and Sadewa), Punakawan (Semar, Petruk, and Bagong Gareng) and Pandawa heroine (Drupadi, Srikandi and Subadra).

Characters		Emotion
Pandawa	Yudistira	Sad
	Bima	Happy
	Arjuna	Angry
	Nakula	Surprise
	Sadewa	Contempt
Heroine	Drupadi	Fear
	Srikandi	Disgust
	Subadra	Shame
Punakawan	Bagong	Cheer
	Petruk	Firm
	Gareng	Sorrow
	Semar	Calm

Table 4. Pandawa and Punakawan Expression List.  
Source: Author's Works.

With this division, the authors expect the visual results will reflect the personality character sticker respectively. So that upon use, the target will get a character known in representing emotions in chat.

### B. Character Analysis

In making visual wayang analysis, the authors conducted a visual division that characterizes the characters are related, but not like the division of emotions, visual puppet unstructured, but done with a personal introduction to the previous writer about the puppet characters. In Pandawa, visual Yudistira; characterized by: first brother of Pandawa, the Pandawa's king, roll top knot hair, thinker, lawn bowl, and small and short mustache. Visual Bima; characterized by: second brother of Pandawa, the biggest and strongest in Pandawa, big mouth and teeth, big nose, bushy mustache and beard, and have sharp nails. Visual Arjuna; characterized by: third brother of Pandawa, the most handsome in Pandawa, big eye, small beard, thick eyebrows, and long vowel. Visual Nakula; characterized by: twin brother with Sadewa, similar to Sadewa, youngest in Pandawa, no mustache and beard, long bowl, and thick eyebrows. For visual Sadewa; characterized

by: twin brother with Nakula, similar to Nakula, youngest in Pandawa, no mustache and beard, long bowl, and thick eyebrows.













Category	Characters	Wayang	Visual Characteristic
Pandawa	Yudistira		first brother of pandawa the pandawa's king roll top knot hair thinker long bowl small and short mustache
	Bima		second brother of pandawa the biggest and strongest in pandawa big mouth and teeth big nose bushy mustache and beard have sharp nail
	Arjuna		third brother of pandawa the most handsome in pandawa big eye small beard thick eyebrows long bowl
	Nakula		twin brother with sadewa similar to sadewa youngest in pandawa no mustache and beard long bowl thick eyebrows
	Sadewa		twin brother with nakula similar to nakula youngest in pandawa no mustache and beard long bowl thick eyebrows
Heroine	Drupadi		pandawa's goddess short hair big eye big mouth long eyelashes thin lip
	Srikandi		transgender heroine the bravest in pandawa heroine big lip dark eyeshadow chubby cheek
	Subadra		good with arrow and bow pandawa's wife the most beautiful in pandawa heroine glazed eye long hair sweet smile seductive lips
Punakawan	Bagong		youngest in punakawan round top knot big head flat nose oftenly smile big stomach
	Petruk		second brother of punakawan tall top knot long face long nose wide mouth long hand
	Gareng		first brother of punakawan small top knot sharp bowl round nose big teeth folded hand to front
	Semar		elder of punakawan white hair with topknot glazed eye chin forward with tooth folded hand to back big stomach

Table 5. Visual Analysis of Wayang.

Source: <http://wayangku.wordpress.com> and Researcher Works.

### C. Wayang Visual Process

Author conducted with the same approach to visual style for each character. In the process of sketching, equating visual style has begun to be applied. Although visual sketches done to represent a certain emotional expression, the authors also do a visual form on components equating Navaro's expression, but in the visual process, this equation has a sharp shift in visual perception still is an integral part of the visual system; namely syntactic. In addition to sketching process, the process of digitization or vectorization is also very need to be kept equation visual style. The implemented with a variety of colors and shapes, but the visual style can be achieved with a dark-light tone similar to the variety of colors, and the visual characteristic in the lines and volumes in shape. Author is also put several characters such as face painting for Punakawan and additional text and visual elements.













Characters	Sketch	Characters	Sketch
Yudistira		Srikandi	
Bima		Subadra	
Arjuna		Bagong	
Nakula		Petruk	
Sadewa		Gareng	
Drupadi		Semar	

Fig 4. Sketches of Wayang Stickers.

Source: Researcher Works.



In the process of computerization, it was being done by the computer process to have vector format, so it has advantages for synchronizing with the common specification sticker format. Besides vectoring, the authors also do the coloring based on the consideration of the color of the wayang costume characters.













Characters	Computerized	Characters	Computerized
Yudistira		Srikandi	
Bima		Subadra	
Arjuna		Bagong	
Nakula		Petrak	
Sadewa		Gareng	
Drupadi		Semar	

Fig 5. Vectoring Process of Wayang Stickers.  
Source: Researcher Works.

Author also added as an accent color circle and equalization visual style sticker. With this addition, the resulting sticker chatting became easier with its implementation of the media displays chat interface. Surely this also needs the support of other such ease and clarity and legibility navigation interface in a chat application. The circle elements was also make system between all the stickers, which are called syntax in order to unite the visual style of all stickers.













Characters	Final	Characters	Final
Yudistira		Srikandi	
Bima		Subadra	
Arjuna		Bagong	
Nakula		Petrak	
Sadewa		Gareng	
Drupadi		Semar	

Fig 6. Final Result of Wayang Stickers.  
Source: Researcher Works.

As mentioned previously, the results and discussion of this research only to the manufacture of visual sticker puppet with consideration of the best method, deepening the visual character of the puppet appropriate, as well as media selection with consideration of its function as representative of the emotions the target so that the results can be used to fit and favored targets. For the application of the sticker results in a chat application, requiring a minimum of 24 stickers in one model. This makes this research has not stopped at this point, the authors will continue this sticker into a real sticker. After that will be carried out research on the impact of the introduction of re-approach the wayang culture through in sticker way. However, the author makes the visual simulation when the sticker is applied to one chat application that is popular with



the target. This is done in order to give an idea of how when the results of applied research later.

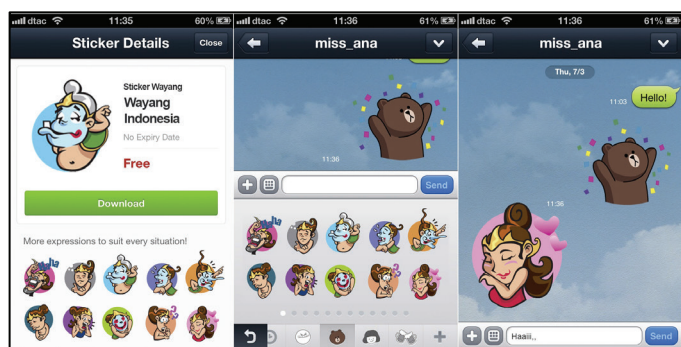


Fig 7. Simulation Wayang Stickers Applied.  
Source: Researcher Works.

Author have yet to provide a rigid boundary in terms of monetizing, but still open for free either in downloading, the duration of the period of use and its use in the process of chatting. New monetizing can run when he made another variation on the same sticker character, with a difference in delivery expressions, emotions and personalities of users chat application later. It should have the scope of this variation two sides that are internal; in terms of expression and visualization of interest) as well as external; relating to the delivery fitting with expression, emotion and personality of use, including for certain events, in any scale.

#### IV. CONCLUSION

The study has not been completed up to here, not all categories of expressions, emotions and personalities have been visualized, but with the same method, many kinds of this research with different variants, can also be materialized. The Author would like to suggest that for the continuation of this research in the future during the period.

For the results, this contemporary wayang stickers chat is the first step in bringing the one of Indonesian heritage to be re-introduced as the submission of expressions, emotions and

personalities in chatting activity for mobile application. With the depiction corresponding to the expressions, emotions and personalities targets, the duration of use will rise. The right to represent the sticker can be a good introduction to the culture media to our society and the global community.

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# Projection Technique for Creating 3D Computer Generated Assets of Borobudur Temple Virtual Reality

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**Abstract**—*Borobudur Temple as an icon of Buddhist civilization in Indonesia is one of UNESCO world heritage site. This temple is facing many problems that threat its existence. If this condition is allowed continuously, the next generation will have difficulties to know about Buddhism values which are implemented on Borobudur's relief and architectural. Therefore by creating virtual reality of this temple, hopefully it may help to preserve the existence of Borobudur. This 3D virtual reality of Borobudur Temple would benefit to the society for getting real experience of exploring Borobudur Temple through the computers or gadgets.*

*This paper aims to explain about the method for creating detailed 3D computer graphic (3DCG) assets with fewer polygons in 3D virtual reality of Borobudur Temple. Generally this technique is a 3DCG projection.*

**Keywords**— *virtual reality; 3DCG; projection; interactivity; cultural site*

## I. INTRODUCTION

Borobudur Temple is the greatest Buddhist monument in the world which has been approved by UNESCO as the world heritage site on 1991 [1]. Buddhists from around the world visit this temple which is located on Magelang, Central Java to have a pilgrimage. Not only for pilgrimage, many local and foreigner tourists also come because of The Borobudur's unique architectural, history, and philosophy. Each year there are around 2,500,000 visitors come to this temple [2].

On the other hand, Borobudur Temple faces many problems which may cause its beauty can not be enjoyed in the future. Various natural disasters such as earthquake and volcanic ash attacks from Mount Merapi and Mount Kelud, plus the evaporation after raining definitely can destroy this temple. The surge in the number of visitors who stomp on Borobudur along the poor environmental conditions have caused the foundation of the temple collapsed in 1.7 cm deep. Moreover the visitors' bad behavior such as touching the temple's ornament and littering around the temple also may cause the damages to Borobudur [3].

Virtual reality (VR) technology can become a solution for those problems because VR can be a powerful tool to tell the information and knowledge [4]. VR has an ability to preserve the geometric and spatial elements from an object in 3D or 4D form digitally, VR also use the perceptive-motory approach where all things can be explored and touched [5]. Therefore VR can be the best option to document and introduce the reconstruction of cultural site in a long period.

Technically, the Borobudur Temple VR will use the 3DCG assets. VR will calculate the assets by real time rendering. This means the 3DCG for assets should be optimized and effective for this purpose. This paper will explain the process of designing the 3DCG assets which are suitable to be applied in the 3D virtual reality of Borobudur Temple.

## II. DESIGN PROCESS

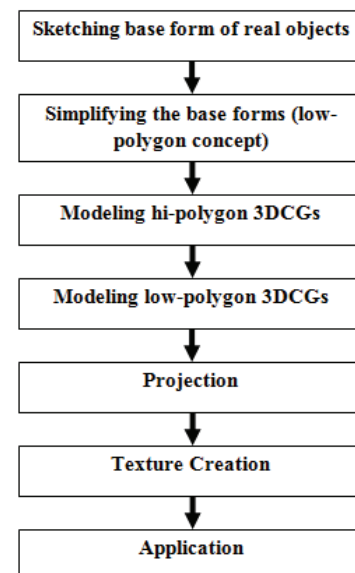


Fig. 1. Design process flowchart

Fig. 1. is the flow chart explaining the design process of 3DCG assets for Borobudur VR. Those steps are sketching base form of real objects, simplifying the base forms, modeling hi-polygon 3DCGs, modeling low-polygon 3DCGs, projection, texture creation, and application.

The process began from sketching the basic form of some ornaments in Borobudur Temple such as the balustrade and *Kala-Makara* gate. The sketches were simplified from their basic shapes to become simpler and more rigid form. This simplified form was conducted to reduce the polygons which are used in the 3DCG assets of Borobudur Temple ornaments modeling.

After the low-polygon concept had been designed, the next process was creating the 3DCG of Borobudur Temple ornaments based on the concept. Firstly, the assets were made by modeling their hi-polygon 3DCGs and then these 3DCGs were projected into the low-polygon 3DCGs prepared.

Texture will affect the reality of Borobudur Temple's ornaments in virtual world to make the 3DCGs look like the real Borobudur Temple ornaments. The textures were made based on the reference images, and arranged them on the projection image results. The low-polygon 3DCGs that were applied with the textures are the final 3DCG assets used in the 3D virtual reality of Borobudur Temple.

### III. LOW-POLYGON CONCEPT

The greater the amount of polygons in 3DCG assets, the slower the real-time rendering and the Frame per Second (fps) amount will be decreased as well [6]. The low-polygon concept of the 3DCG assets of Borobudur Temple 3D virtual reality aimed to produce the 3DCGs with the least amount of polygons, and it also can preserve the visual quality of the Borobudur ornaments.

#### A. Balustrade

The balustrades in Borobudur Temple have many ornaments with complicated details, and they surround along the building terrace. Planes were planed to be the low-polygon 3DCG assets of balustrades by placing the planes along the temple's terrace.

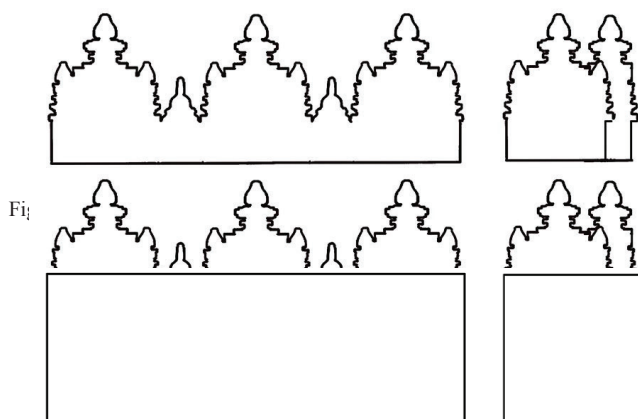


Fig. 3. Base form of a low-polygon balustrade (front and side)

#### B. *Kala-Makara* gate

*Kala-Makara* gates also have many ornaments with complicated details. The process creating *Kala-Makara*'s ornament is same as the balustrade. The *Kala-Makara*'s gates are also using the laid planes as the low-polygon 3DCG assets.

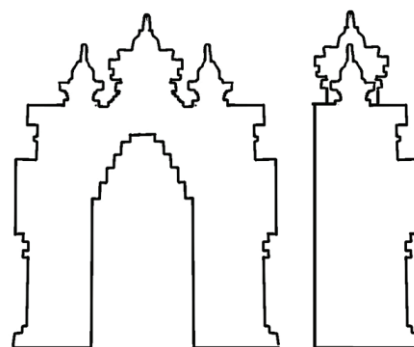


Fig. 4. Base form of a real *Kala-Makara* gate (front and side)



Fig. 5. Base form of a low-polygon *Kala-Makara* gate (front and side)

### IV. PROJECTION

The aim of projection process in creating 3DCG assets for virtual reality is to give details and depth illusion on the low-polygon 3DCG surfaces. The results of projection are the materials which can be used as templates for creating textures of low-polygon 3DCGs. The kinds of the projected 3DCG materials that were used in creating 3D virtual reality of Borobudur Temple assets are complete map, normal map and alpha map. Some projected materials were also modified to make the textures required for 3DCG assets.

In Autodesk 3ds Max, the modifier named projection is used to make the 3DCGs projection. This modifier requires one low-polygon 3DCG as the target and at least one hi-polygon 3DCG as the source. The low-polygon 3DCG must be put behind the part of the hi-polygon 3DCG that is expected to be projected. After the projection target has been chosen, a projection cage will appear. That projection cage acts as a boundary of which area contains the projected

3DCGs. Make sure the cage position covers all of the hi-polygon 3DCG's parts which are wished to be projected.

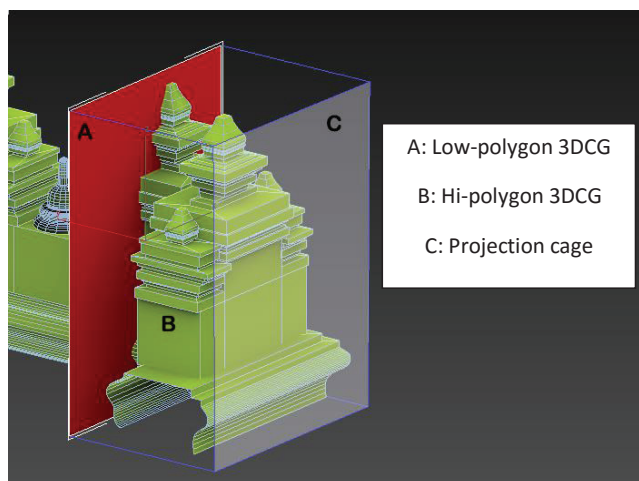


Fig. 6. 3DCGs arrangement of projection

## V. TEXTURE CREATION

The environment in the virtual reality must be proportional enough to give a real experience [7]. Therefore the right textures must be applied to the 3DCG assets to make them look like the real ornaments, and to make users not realize that the assets are just the simple planes.

### A. Balustrade

First, the hi-polygon 3DCG of a balustrade was built based on the reference image. Next, a plane was created with the same size of the hi-polygon 3DCG. Then, the hi-polygon 3DCG was projected into the plane and this projection produced a complete map, a normal map, and an alpha map. Complete map is an overall display image of the 3DCG material. Normal map is an image which indicates the depth of the 3DCG surface. Alpha map is an image which indicates the transparency of the 3DCG material.



Fig. 7. Reference image for balustrade



Fig. 8. Projected complete map of balustrade



Fig. 9. Projected normal map of balustrade



Fig. 10. Projected alpha map of balustrade



After the projection had been done, the textures for the balustrade were prepared. In this case the alpha map produced didn't need to be modified, because this image was only used to cut the plane textures to make the edge looks like the real ornament. However the complete map and the normal map must be modified with the other textures needed to make the assets look like the real objects surface.

The projected complete map was used as the basic pattern for the texture arrangement. After the modified complete map was arranged, the projected complete map was overlaid on it to give the proper shading.

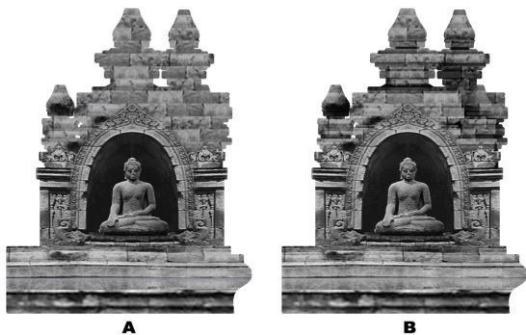


Fig. 11. Balustrade complete map without overlay (A), balustrade complete map with overlay (B)

To make an appropriate normal map, the final complete map was generated into software called Crazy Bump to make a normal map automatically. Then the normal map produced in Crazy Bump was overlaid by the projected normal map to emphasize the depth indication like the hi-polygon 3DCG.

Finally the textures prepared could be applied to the low-poly 3DCG. Each texture must be placed into the right section in the material editor. The complete map was placed into the diffuse slot, the normal map was placed into the bump slot, and the alpha map was placed into the opacity slot.

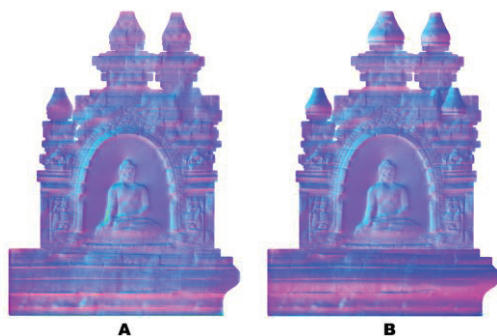


Fig. 12. Balustrade normal map without overlay (A), balustrade normal map with overlay (B)



Fig. 13. Final result of balustrade textures application

#### B. *Kala-Makara gate*

Same method like making the balustrade textures was also done in making the *Kala-Makara gate* textures.



Fig. 14. Reference image for *Kala-Makara gate*

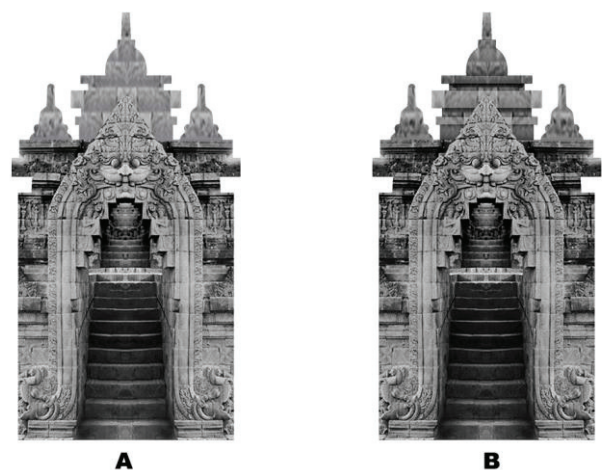


Fig. 15. *Kala-Makara gate* complete map without overlay (A), *Kala-Makara gate* complete map with overlay (B)

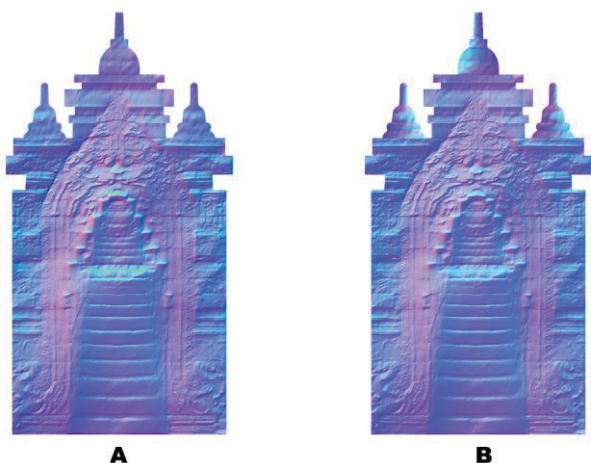


Fig. 16. *Kala-Makara* gate normal map without overlay (A), *Kala-Makara* gate normal map with overlay (B)



Fig. 17. Final result of *Kala-Makara* gate textures application

## VI. HI-POLYGON AND LOW-POLYGON COMPARATION

One of balustrade hi-polygon 3DCG has 3,532 polygons or 7,068 triangles, while its low-polygon 3DCG has only 2 polygons or 4 triangles.

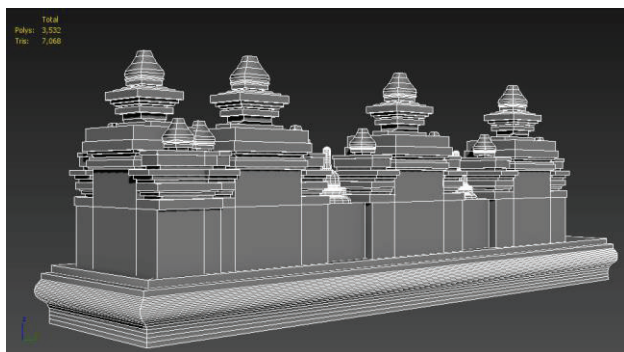


Fig. 18. Hi-polygon 3DCG of a balustrade

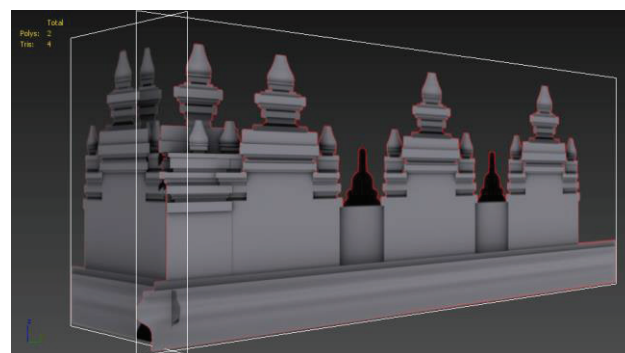


Fig. 19. Low-polygon 3DCG of a balustrade

A *Kala-Makara* gate hi-polygon 3DCG has 1,838 polygons or 3,806 triangles, while its low-polygon 3DCG has only 3 polygons or 6 triangles.

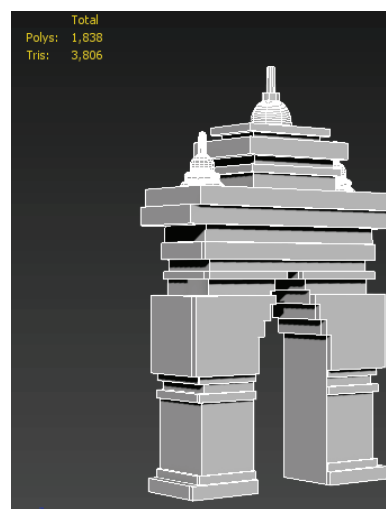


Fig. 20. Hi-polygon 3DCG of *Kala-Makara* gate

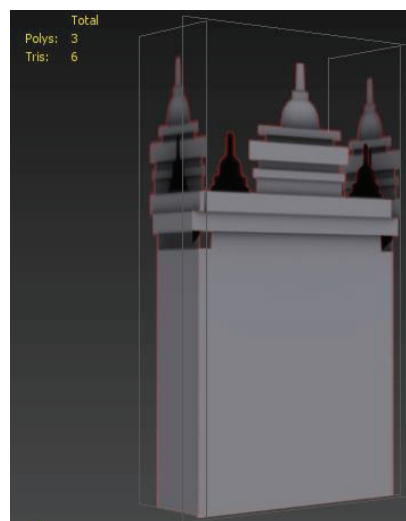


Fig. 21. Low-polygon 3DCG of a *Kala-Makara* gate

## VII. PROJECTION CAGE ANALYSIS

An experiment was conducted to analyze the possibilities of cage's distance in 3DCGs projection affecting the projected image material result. In that experiment, author arranged a low-polygon 3DCG and a hi-polygon 3DCG in skylight lighting. Then author gave different numbers in X axis of the cage position. Variables X which author used in experiment are -10.1 m, -30 m, and -100 m. Based on that three variables, author compared the complete map and normal map results from each projection.

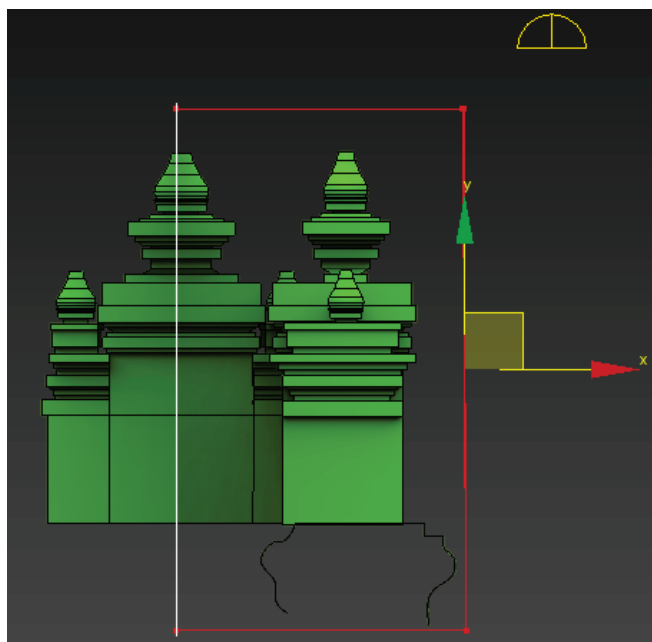


Fig. 22. 3DCGs arrangement of projection experiment

TABLE I. COMPLETE MAP RESULTS COMPARISON







X (m)	-10.1	-30	-100
Complete Map			

TABLE II. NORMAL MAP RESULTS COMPARISON

X (m)	-10.1	-30	-100
Normal Map			

Those results explain all of three variables X produced the same complete maps and normal maps exactly.

## VIII. CONCLUSION

The projection method has successfully reduced the polygons used for the 3DCG assets of Borobudur Temple virtual reality.

Cage distance toward the 3DCGs doesn't affect any change in complete maps and normal maps.

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# The Use of Computational Medium for Visualization and Simulation in Healthcare Architectural Design

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**Abstract**— The design of healthcare facilities involves the complex system in various spatial and temporal dimensions; it involves a wide range of functions, different kinds of users and activities, and various technical requirements. Understanding the complexity in healthcare facilities becomes important in order to ensure that the design could perform well to support healthcare services. This paper discusses the current development of computational tools in healthcare architectural design. The emergence of computational medium in architecture provides new possibilities in analyzing and understanding the complexities within the system of healthcare facilities. The computational medium could play an important role in the spatial analysis of healthcare design, particularly as the medium of representation, visualization and simulation. This paper illustrates the development of some visualization and simulation tools that could assist in understanding some aspects of spatial configuration of healthcare design, such as visibility and movement. The use of the tools could assist the analysis of spatial configuration of the healthcare facilities in order to optimize the performance of the spaces. The dynamic of computational medium provides a new dimension in understanding the complex system from multiple perspectives that can be used to provide feedback for future design of healthcare facilities.

**Keywords**—healthcare design, computational architecture, visualization, simulation

## I. INTRODUCTION

Designing healthcare facilities is not a simple task. The performance of healthcare facilities could be affected by the design. Healthcare design often involves complex functions, users and activities that require thorough understanding. To address the complexities in healthcare design, evidence-based design approach has emerged to support the decision-making in design [1]. This approach uses the best available research evidence as a basis of decision making in order to improve the outcomes of healthcare services. As a part of evidence-based design approach, thorough analysis of what is really going on in healthcare facilities becomes important. The understanding of how different elements of healthcare facilities – different functions, users and activities – interact to one another becomes important. Such complexities in healthcare design

have further consequences on the needs for architectural representation techniques beyond traditional media. The new medium of representation that could deal with the complexities is needed.

The emergence of computation in architecture opens up new possibilities of working medium on architecture as it has the ability to deal with many layers of spatial information and to represent dynamically changing condition [2]. The use of computational tools in architecture is not new; it was marked by the development of computer tools such as CAD, CAM and BIM that have been used extensively in architectural practice. Those developments consequently alter the design and production process in architecture [3]. But architectural software was commonly designed to accommodate the general needs on architectural field and could not address many particular problems in architectural design including in healthcare facilities design. To extend such limitation, the recent development has further promoted simpler software to be developed to address specific task which is not yet covered by common architectural computer tools [4] which becomes more familiar in architectural practices.

This trend is supported by the emergence of simpler programming languages, such as *Processing*<sup>1</sup>, that could simplify the development of software for specific purpose. This development extends the use of computer programming into other disciplines [5]. The development of *Grasshopper*<sup>2</sup> also supports the paradigm of parametric modeling in architecture which alters the representation of architecture - from purely geometrical appearances into its parametrical functions which allow us to analyze its performance computationally rather than merely representing it. Computation thereby now can be seen as a medium rather than merely as tools to fulfill some functions. Computational medium can provide the interactivity and the dynamic through its interface [6] which cannot be attained by analogue or traditional media.

<sup>1</sup> *Processing* is an open source programming language and environment initiated by Ben Fry and Casey Reas at MIT Media Lab.

<sup>2</sup> *Grasshopper* is a visual programming language editor tightly integrated with Rhino's 3-D modeling tools developed by David Rutten at Robert McNeel & Associates



The dynamic of the medium and its ability to deal with complex information has the potential to address the complexities in healthcare design. This paper provides an overview of some possibilities of developing computational medium for the purpose of healthcare design. This paper will begin with discussing current development of digital tools in architecture, particularly as a medium for visualization and simulation. Then we will illustrate some examples of our works in developing digital tools for visualization and simulation that could support healthcare facilities design and analysis.

## II. HEALTHCARE COMPLEX SYSTEM IN COMPUTATIONAL ARCHITECTURE

### A. Representation, Visualization and Complexities

Architecture design process highly depends on the medium of representation during the process. The conventional architectural drawings and representation has the limitation in coping with the realities since they tend to reduce the complexities [7]. This is a common problem in architectural design process, where such reduction may have implications on incomplete understanding of the realities. This becomes particularly crucial in the design process of healthcare facilities which tend to be very complex, involving a wide range of functions, users, activities, with various technical requirements.

The use of notation and diagram could bridge the gap between realities and representation in architectural practice by making the realities into set of codes that represent certain information relates to the realities itself [8]. But the more complex the system to be understood means the more information needed to be processed, which to some extent will exceed the capability of human in processing the information.

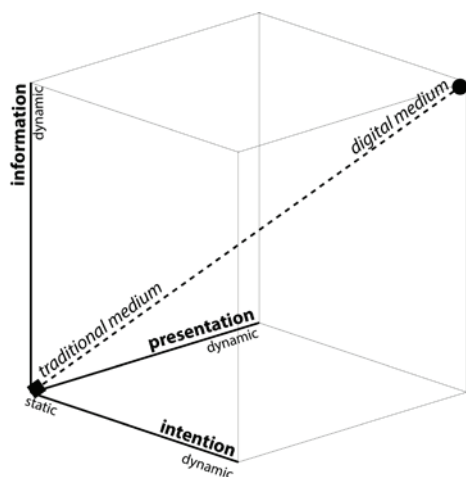


Fig. 1. The dynamic digital media provide new possibilities of representation in architecture (Source: Ishizaki, 2003)

The emergence of computational medium opens up the possibilities to process the complex realities into sets of information and representing it without reducing its complex information [9]. It also provides the three characteristics that inherit in digital media: dynamic changes of information, intention and capability of temporal presentation [6]. The

capability of computational medium to process such complexities in a dynamic interface allows us to encode user experience to build a more human-centered design environment [10]. This computational medium capability is very important because it opens up possibilities in dealing with the representation and visualization of healthcare facilities in order to understand what is exactly going on in it.

The advancement of computer allows them to bring greater degree of freedom in representation such as in space syntax [11]. Space syntax is a technique which relies heavily on computational tools in analyzing and representing the spatial characteristic within spatial configuration and relates it with the possible social behaviors. Space syntax analysis has been increasingly used in healthcare design to get positive outcomes such as better wayfinding around the hospital, higher visibility and potentially increasing care qualities [12,13,14]. It could also be used to predict the flows inside hospital to increase its performance [15], to assess the accessibility of hospital outdoor spaces [16] and to measure the user cost [17]. Another example of the use of computational tools in healthcare facilities design is the development of visibility index for nursing units [18]. The tool was used to analyze and visualize the areas which have the highest rate visibility index toward the patient beds in intensive care units. The results then can be used to locate the nursing units in areas with higher visibility index. By integrating spatial analysis visualization with other analysis, the visualization could relate the spatial configuration within the space with its spatial practice in highly programmed workspace such as inpatient ward [19].

The above examples illustrate the possibilities brought by the computational medium to comprehend various aspects of healthcare facility spaces. The representation and visualization of certain spatial aspects in healthcare facilities could provide better understanding of what is really going on in healthcare facilities, which tend to be complex and dynamic.

### B. Simulation

Computation can be used further as a new medium to open up more dynamic representational system to work with the complexities of healthcare facilities through simulation. Computation also has the ability to create the complexity itself [4], which can help us to mimic the realities and open up the possibilities to simulate the complex system of the healthcare facilities and analyzed even further.

Simulation can provide benefit to deal with the real world context by generating data in a proportional form that attained by replicating and manipulating and demonstrating its context [2]. The data gathered from simulation then can be used to provide feedback for further development in the real context. The capability of computational medium to comprehend with complexities of information provides huge possibilities in replicating and manipulating spatial complexities that occur in the real world. Simulation provides virtual context in order to see how the space and time really works or operate in reality. Such operation usually could not be represented in static medium. The use of simulation then can be used to addresses and demonstrates the performance of build environment in architecture.

There is a wide spectrum of the use of simulation in architectural context: the simulation of structural viability, energy and environment performance, lighting, egress performance, and user behavior [20]. Each simulation has different purposes and thus provides different kind of data related to its way to depict and operate the realities of the real world context.

In complex healthcare facilities such as hospital, the role of simulation can be vital. An example of the use of computer simulation is to analyze human movement in the hospital. Computer could be used to simulate the process of way finding and evacuation in the building [21]. This simulation could provide information on how to optimize the process of how the users can navigate through the hospital which is usually more confusing than other buildings due to its complexities. There was also a study on patient bed utilization based on agent-based simulation modeling to demonstrate the effect of certain rules to the utilization of beds [22]. Another simulation was developed to analyze the utilization of hospital resources [23]. Computer simulation could also be used to optimize movement flow in the hospital [24,25], which is important to achieve efficiency in healthcare service delivery. Another approach incorporated complex simulation model and 3D representation to simulate the operational scenarios inside a hospital to support its building design [26]. These examples of simulation studies suggest that simulation could play various roles in healthcare design in multiple scales and dimensions, ranging from the simulation of a particular event to complex operational systems.

When simulation is used to mimic the dynamic system of the real world context, adequate visualization technique is needed to represent the dynamic of the simulation [27]. Simulation and visualization are closely intertwined; the visualization provides the representation of the spatial context while the simulation provides information on how the space might really operate. Interactivity between the real world context, visualization and simulation therefore can provide the dynamic interface between the real and the virtual environment which might become the potential working medium in architecture, including for healthcare design process.

### III. DEVELOPMENT OF DIGITAL TOOLS FOR HEALTHCARE DESIGN AND ANALYSIS

The following section provides some example of our works in developing computational medium for various purposes of analyzing the spatial performance of healthcare facilities. There are three digital analytical tools that we will describe below: the tool to visualize the visibility of hospital ward, the interactive mapping tool based on spatial journey, and the tool for simulating human movement in the hospital. These tools are developed based on various programming language and open source library, and tailored for each specific purpose that could support design decision making in healthcare design process. Some of the tools are still in the ongoing process of development; however, the illustration of how they generally work could provide some understanding on the range of possible uses of computational medium in healthcare architectural design.

#### A. Visibility Visualization: Visual Analysis of Visibility

The purpose of the visualization is to assist in the analysis of visibility in hospital ward, which is an important aspect relating to the control of the patient under hospital care. We develop the visualization tool in *Processing* to provide various visualization modes of visibility within the configuration of space gathered from the plan of the building. The visualization is based on the logic of an *isovist* [28] and optic array of visual perception [29] to represent the visibility characteristics within a plan. The idea was then developed further to construct *visibility graph* [30] that represents general visibility measurement. This graph can be used to analyze the part of space which have lower and higher visibility level and this information can be used further as a feedback to the design.

The tool provides different modes of visibility visualization; it could use to dynamically check the single *isovist* appearance from one point of location to check the areas of spaces that are visible from there. It can also generate multiple *isovist* as a series or set to represent the interplay between multiple locations of point of view and provide *neighborhood graph* [30] which is a simple graph that shows the amount of visible areas across the whole plan.

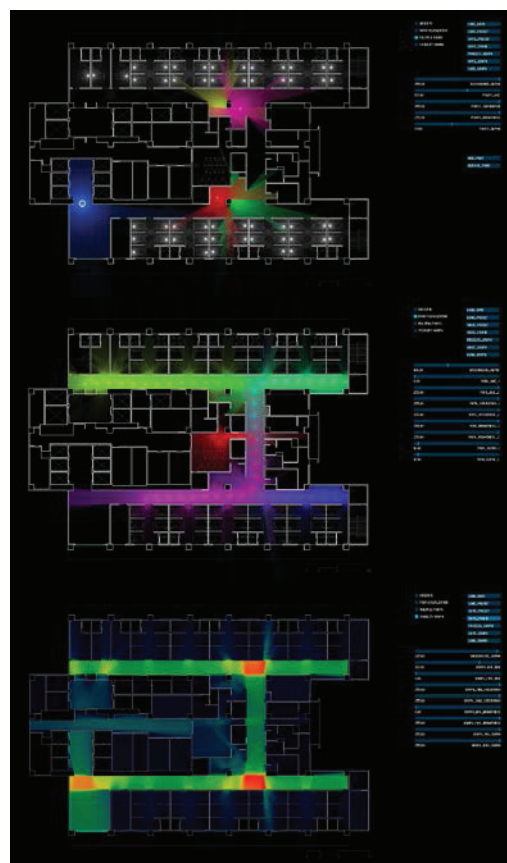


Fig. 2. Visibility visualization tools as a visual analytic tools to examine the visibility degree of spatial configuration from the building plan

Healthcare facilities have many issues concerning the visibility within the building. The visibility character of the building can affect the behavior and experience of its user [31].

It has something to do with the way finding process within hospital building which usually has a complex plan, and this can be vital in emergency situation. It may also affect the efficiency of the whole operational process of the hospital. Visibility also has an important role in patient care process in the care units. The visibility performance of the care units could affect the process of patient monitoring by the staffs. Those are some examples of issues related to visibility in healthcare facilities. The visualization tool that we have developed is an example of how the digital tool that could assist in the visualization of the visibility. This could be the potential medium that could support design decision making regarding the layouts and building element design that could affect the performance of space in terms of its visibility.

### B. Mapping Stories: Journey-based Interactive Mapping Tools

The second tool was developed to address the needs for mapping tools to represent the journey along the space in interactive way. This tool was initially developed in urban scale context to map the stories experienced by the users within an urban context, as a way to visualize the well-being qualities of urban environment. The visualization of the experience through stories become an alternative way to communicate the users' experience of architecture which might become more productive [7].

Developed in *Processing* with *Unfolding*<sup>3</sup> library, this tool provides the interactivity among the narratives of the stories in space and time representation. The user can interact with the narratives in multiple ways in various focus and scales. This tool provides an alternative way to map the narrative environment in digital medium which can be used to examine the particularity and generality of the operation of space in a dynamic way. It helps us to understand the complexities of spatial environment through its stories.

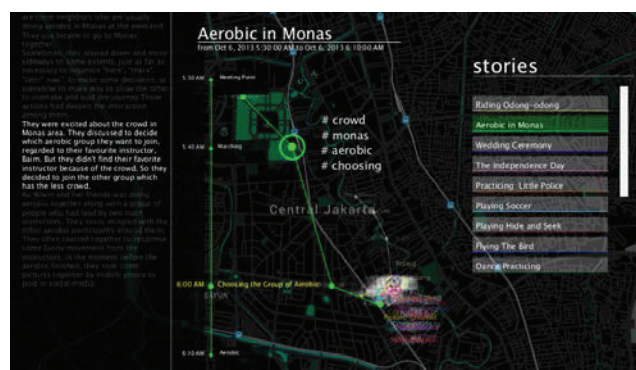


Fig. 3. Interactive mapping tool provides the dynamic and selective representation of operation of space in complex environment

Within the context of healthcare facilities, this tool has the potential to develop further in the scale of the building and building complex, in order to map the narrative of users' experience in the healthcare building complex. The

complexities of the healthcare facilities often result in the long and painful process that has to be experienced by the patient when moving from one part of the healthcare facilities to another. Nevertheless, the experience of patient needs to be considered as it may affect the outcome of the healthcare process. Mapping the experience of the patient through the stories could be an important step to understand thoroughly the point of view of the users. The dynamic nature of digital medium becomes very useful to represent how the space operates from the point of view of the users' experience, and to understand how the design of the building can affect the activities and *vice versa*.

### C. Virtual Environment for Hospital Flow Simulation

The purpose of the development of the third tool was created to address the complexity of human movement or flow within the hospital space. Human movement is one of the critical aspects of hospital service, since many of the services depend on the efficiency of movement from one care setting to another [24]. We develop a tool that provides a virtual context to perform discrete multi-agent-based flow simulation with *MASON*<sup>4</sup> simulation engine library. The tool is developed in *Java* IDE, using *Processing* and *Proscene*<sup>5</sup> to build its interface. It allows us to build and represent the virtual building from structured spatial data parsed from CAD drawing with the help of *Grasshopper*.

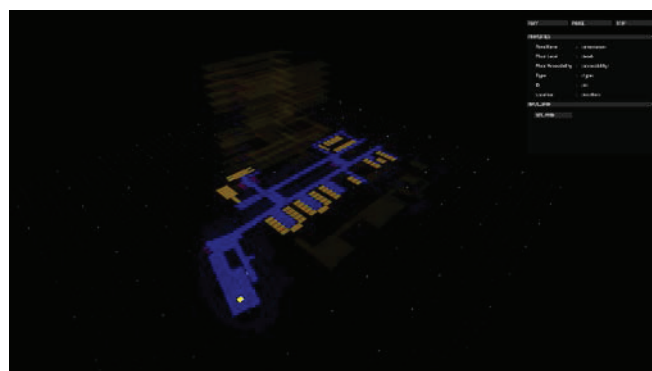


Fig. 4. Virtual environment built based on the topological connectivity and grid map.

The virtual environment is based on hierarchical world model which is composed by various scales of topological map [32]. The map is composed in such a way to allow us to perform spatial computation such as path finding algorithm and other spatial queries inside the models in order to run the simulation properly. This tool is currently in the process of development, and further works will be focused on the development of path finding algorithm and agents behavior to simulate the flow and movement of users in the virtual model.

<sup>4</sup> MASON is a fast discrete-event multiagent simulation library core in Java, designed by Sean Luke and team from George Mason University's Evolutionary Computation Laboratory and the GMU Center for Social Complexity

<sup>5</sup> Proscene is Processing library to create interactive scene developed by Jean Pierre Charalambos

<sup>3</sup> *Unfolding* is a Processing library for interactive maps developed by Till Nagel at Interaction Design Lab, University of Applied Sciences in Potsdam, Germany



The interface of the tools are created in interactive three dimensional representation in order to ease the navigation within the virtual building, the controlling and the monitoring of the simulation using the given control panels. The extensibility of the virtual environment also allows us to add other relevant visualization features which are important to gain better understanding of the hospital complex system. This virtual model development is still in progress and could be the first step in the development of other building simulation tools that are necessary to simulate how the space of the healthcare facilities might operate in reality.

#### IV. CONCLUSION

The capability of computational medium to process complex information and to represent it dynamically provides alternatives to the more traditional media which tend to be more static. Architecture design process should take advantages on such progress. The example of digital tools that we have developed suggests the important role of computational medium in contributing to the design process of built environment especially in complex environment such as healthcare facilities.

The emergence of computational medium in architecture provides new possibilities in analyzing and understanding the complexities within the system of healthcare facilities. The computational medium could play an important role in the spatial analysis of healthcare design, particularly as the medium of representation, visualization and simulation. The use of the digital tools could assist the analysis of spatial configuration of the healthcare facilities in order to optimize the performance of the spaces. Moreover, the development of computational medium allows us to understand better the complex system of how the healthcare spaces operate, since the simulation and visualization tools were developed based on such understanding of the spatial system. Therefore it could contribute to the deeper understanding of spatial configuration in relation to healthcare architecture.

The development of our computational tools was still in early progress and need further development to take advantage of the potential of the computational medium. The massive development in open source community in developing libraries provides great contribution in computational tools development. It could provide the core features to be developed further for specific purpose that could support healthcare facilities design. There is a huge potential for the development of computational tools to assist in the design process, to address various aspects of healthcare design through visualization and simulation. These will be the necessary tool that could support evidence-based design approach of healthcare architecture.

#### ACKNOWLEDGMENT

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# The use of 3D Solid in After Effect to produce 3DCG Character Animation

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*The solid equipment in After Effect can be used to develop a complex 3D object without the intervention from 3D program. The 3D object, for example, like space ship, wheel, car and many more object that can be created from flat 3D square shape. However, the ability of solid can also be developed into a more advance development, which is the creation of 3DCG character animation. In order to achieve this, the After Effect plug in named Duik, which is created for the purpose of making 2D character, will be used, with the combination of solid ability. The focus in this paper is about the effort and result to make a humanoid character that able to make movement like walking, jumping and running. The character then used to support a Motion Graphic project.*

**Keywords :** *After Effect, 3D Solid, link technique, Inverse Kinematic, 3D character animation.*

## I. INTRODUCTION

After Effect is the computer program that mostly use to produce motion graphic artwork. One of the equipment from this program is solid, which is the 2D (two dimensional) layer that used to create motion graphic elements. The equipment can be edited with After Effect tools to produce image, which has the same quality like image that produced by Photoshop or Illustrator.

The ability to produce image using solid make a benefit for After Effect user so they don't have to buy or going back and forth with another program to produce image, which can save more time and money. Another ability from solid, that the equipment can be transformed from 2D layer into 3D (three dimensional) layer, that used in one of the After Effect ability, which is creating 3D environment.

In After Effect 3D environment, the 3D solid layer has the shape of a flat rectangle, which has no volume in it. Some motion graphic designer used this equipment to produce simple 3D shape [8]. This technique, usually used more than one 3D solid which combined together to make a 3D form.

From the observation with some books about After Effect program [1][3] and opinion from one motion graphic designer [8], the solid equipment mostly used to create a 3D box object and it would take a long time to produce a more complex shape. Some of the usage with 3D solid is just to make flat drawing has a depth and when combined with After Effect camera movement and light, the drawing will look three dimensional [8]. The limitation with this technique, is when the camera turn to the side of this drawing, it will look flat.

The technique that recommended to use 3D object for element in After Effect is to import 3D object that made in 3D program like 3D Max. Here, there is a limitation with this technique that the After Effect user need to know how to use another program, buy the program and working back and forth. From this observation, the research sees potential ability from 3D solid to solve this kind of limitation, especially for beginner user. Students, in their first semester with After Effect, often find it hard to work with two program to produce motion graphic with 3D.

For start, an experiment was made to produce more basic shapes than a 3D box, which produce shapes like pyramid, hexagonal prism, cylinder and triangular prism. Here, the author sees the potential use from 3D solid to be developed into more complex shape, not just a basic shape. The next effort is to make the combination of 3D basic shapes to create a more complex shape. Some of the effort that made is to put pyramid 3D shape at the top of 3D box, pile 3D box shape into a ladder or pyramid shape and made simple car with 3D box and cylinder shape.

The next experiment is more complex, where the solid that used to made a character is not just a square flat solid but edited with After Effect mask tool. The purpose of this effort is to produce a head shape, which of course need more than just a flat square shape. The result from this experiment can be seen in Fig.1.

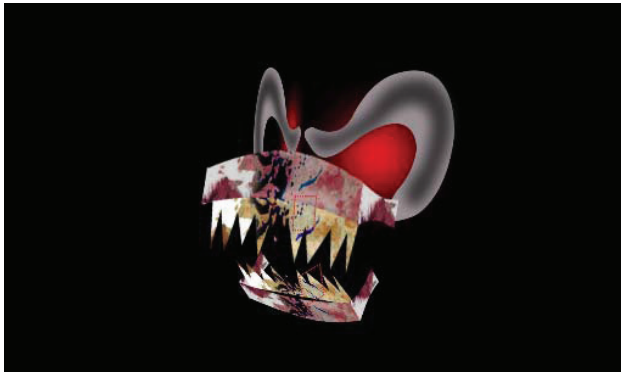


Fig. 1. Head shape from 3D solid

From the experiment with solid, that able to produce complex 3D head objects, another potential beneficial usage emerges, which is the creation of 3DCG character animation with 3D solid. To achieve this goal, the body part and the bones will be created using 3D solid, and for making character rigging, the third party plug in will be used.

The benefit from this 3DCG character animation made from 3D solid, is that the After Effect user, especially with the beginner with no experience with 3D animation program, can make a 3DCG character to be used in motion graphic artwork.

With the combination of the knowledge of producing 3D element and 3DCG character animation, this research intended for the After Effect user, especially the beginner, so they can produce a motion graphic artwork with 3D walkthrough and 3D character, without intervention with 3D program, so it is easier for them to learn. The other benefit from this technique, for the professional user, is they can produce 3D environment and character with just After Effect, so it can save time and money.

There is a limitation with this technique, which the 3D character that created is unlike the other creation of character that produced by 3D program like 3D Max, where 3D solid is unable to produce smooth polygon.

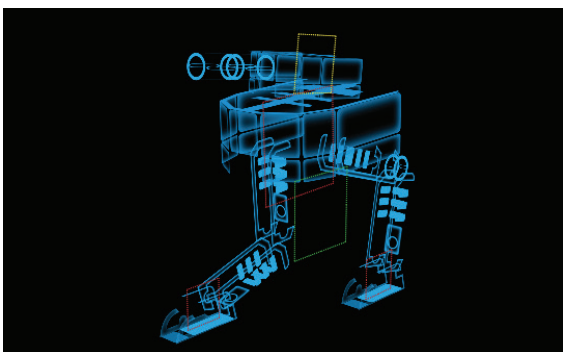


Fig.2. 3D character from 3D solid

Basically 3D solid is not intended to make complex 3D object or 3D character. The After Effect plug in that used is also not for 3D character but made to produce 2D character. Besides of this limitation, with the creativity of the creator, the character or 3D object can be used for motion graphic artwork with simplified look, just like sample at Fig.2.

Most of the motion graphic artwork is actually has a simplified look, where form the history of motion graphic, the usage of this type of artwork is for the movie title, which doesn't need a realistic look, like the artwork from Saul Bass [2]. Based on this, the character that needed for motion graphic artwork is actually simplified.

The focus in this research is to produce humanoid character that fit into a Motion Graphic work. The reason to make a humanoid character is the challenge, because the principal of rigging in humanoid character can be applied to all kind character, including non human character.

## II. RIGGING PRINCIPAL

Before making an experiment to rig 3D solid in After Effect, we need to discuss about the basic principal of making a rigging. In 3D digital animation industry, the term rigging is mentioned as the system to make a 3D character able to be moved [5].

Here, the principal is like adding a holder in a doll pelvis, so we can make the doll stand and with additional helper, like long wood, attached to the hand of the doll, we can animate the hand of the doll.

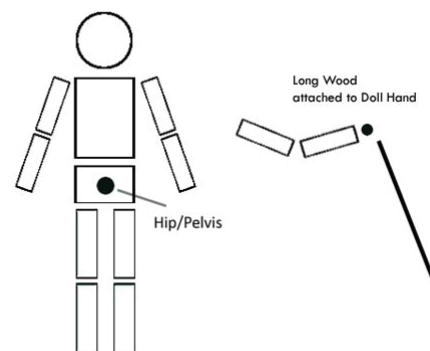


Fig.3. Sample of rigging principal with doll

In 3D digital animation, the doll is a 3D digital model, and the helper is a bones or joints. Bones or joints are equipments that provided in many 3D animation programs, like 3D Max, to help the animator animate the 3D digital model. To make a good rigging, we need to arrange the bones, so they can combined into a skeleton for 3D model [5]. Each bone then named as the body parts, like Thigh, Leg or Feet.

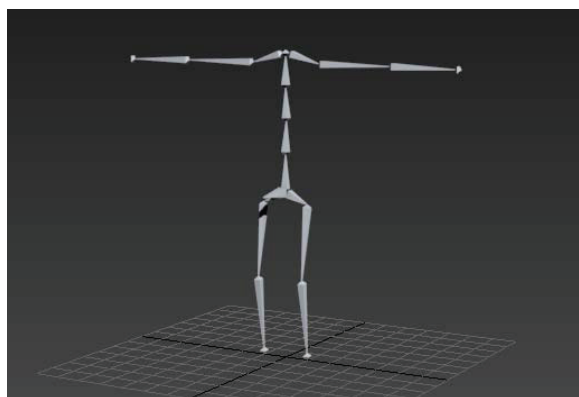


Fig.4. Bone arrangement

After all the bones are arranged, we need to link all the bones using hierarchical system [5], where as the center of the skeleton, the pelvis or hips is usually used, where all the bones are link into this bone [4].



Fig.5. Hierarchical system for bone

Besides make a link between bones, there are two terms that need to be mentioned, which is Forward Kinematic and Inverse kinematic. Forward Kinematic is a standard movement of the bone where we move the first joint to another joint to make animation [5].

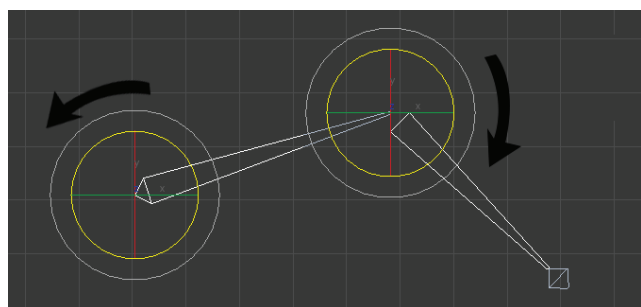


Fig.6. Forward Kinematic

Inverse Kinematic is the opposite where we put a main joint as a center of movement so when this center moves, the other will follow [5].

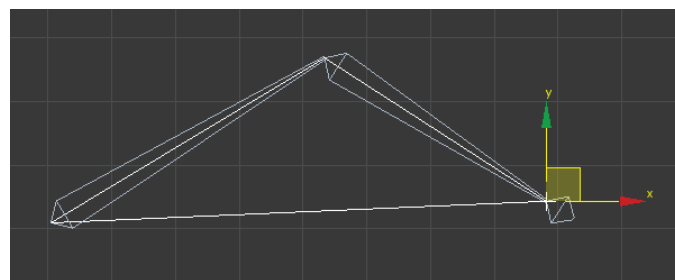


Fig.7. Inverse Kinematic

Based on this knowledge about rigging, the research will used this principal in After Effect. Again, the After Effect program doesn't have the specific tool to create 3D character rigging, so some tools will be used to replace what doesn't exist. Here, solid will be used as a substitute for bone, then the model also created with solid. To achieve Inverse Kinematic in After Effect, the plug in called Duik is used [7]. In order to make Duik works, it needs After Effect equipment called Null, which mostly used as a helper in linking works, which is available in After Effect.

### III. TECHNIQUE EXPERIMENT

To make the 3D solid as a bone of the character, some experiments were conducted. First, the 2D solid is shaped using the mask tool to produce the full feet, and we named this just like the named in human form rig principal, which is thigh, leg and feet. Because two legs were produced, we named this as left and right.



Fig.8. Bone from solid

After the bones made from solid were arranged, the plug in Duik is used to create Inverse Kinematic. The result can be seen on Fig.9.



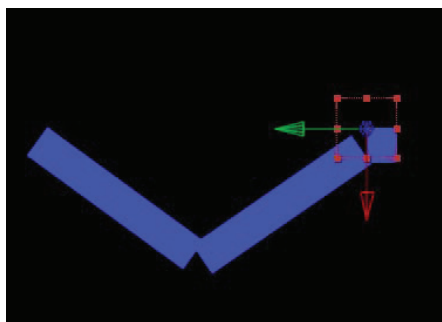


Fig.9. Duik plug in

The next step is the solids were turned into 3D and arranged so it looks like a 3D leg. Then the other bones, which is Pelvis, is created using Null and to control all bones, a Null which named All is created.

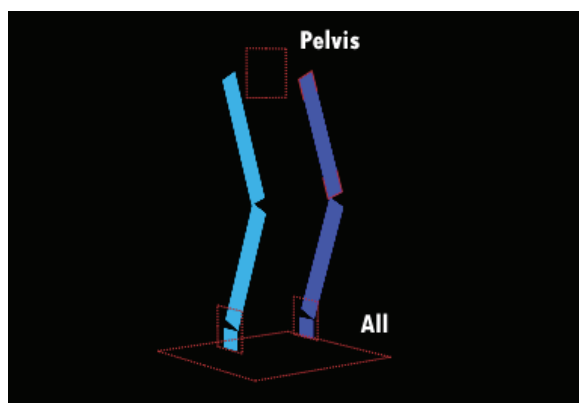


Fig.10. Bone in 3D and additional null

This experiment is success to mimic the principal of 3D animation rigging, where the Pelvis Null can be moved up and down while the Feet stay unmoved.

For the next step, the creation depends on the creator, which is the creation of backbone. For this, we can use solid of Null, and named the same like human form rig principal, which is Back-01, Back02 etc. The number of the Null or solid that used can be just one or more, which depends of the needs.

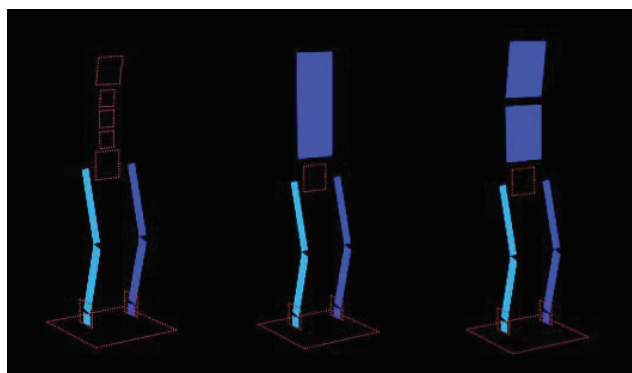


Fig.11. Alternative for backbone

After the creation of backbone, the next step is the creation of hand. Again, we have a freedom in creation where the Inverse Kinematic can be used for the hand rigging or not. If the Inverse Kinematic is used, the additional Null or solid need to be added at the tip of the hand, in order to make the hand able to rotate.

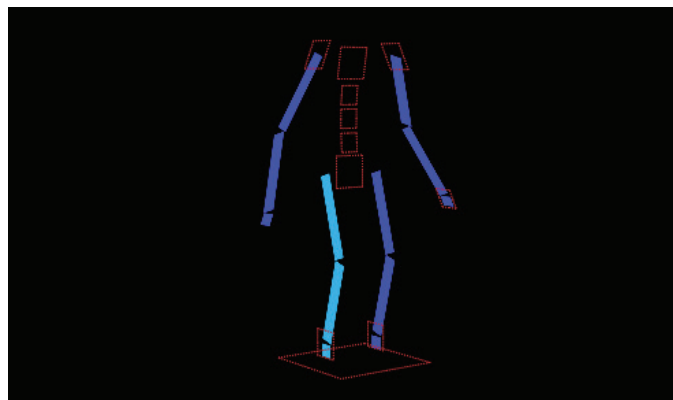


Fig.12. Rigging with hands

The last part of this is to put the 3D solids that made as a body part into the rigging. The 3D solids were made using the tools for solid which is mask and feather, to achieve science fiction look. The 3D solids then arranged to achieve the shape that needed.

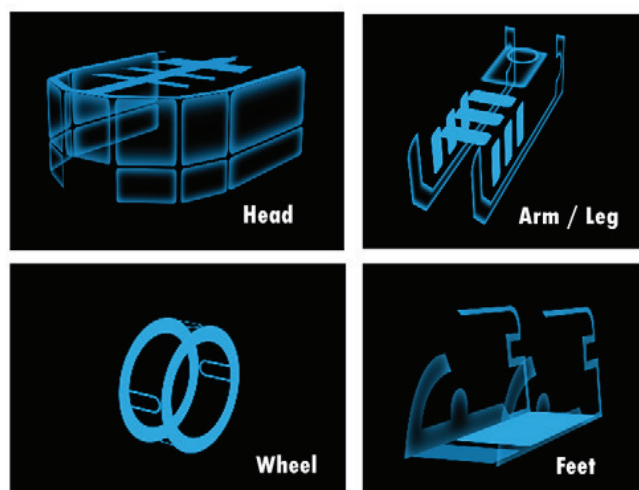


Fig.13. Body Parts

The next step is to linked all the body parts with the solid bones. Here, the head is just linked into top Back Null, then the wheel is linked with another Back Null, to create the body. For another part, which is arm and leg is used the last body part. The result is shown on Fig.14.

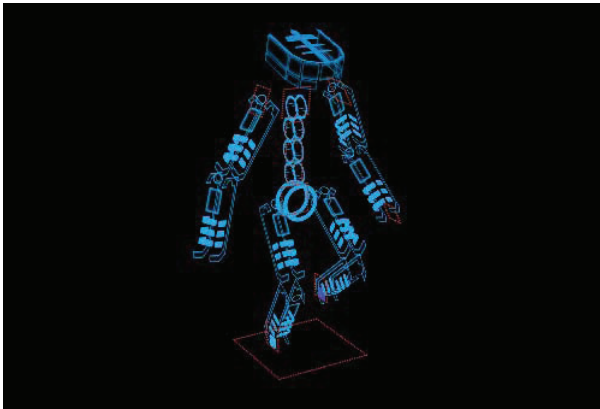


Fig.14. Humanoid character

After all the body parts were linked, the last step is make the animation with the humanoid character. First, the left feet is moved, then followed with right feet. In the end, it succeeds to make the walking pose.

The next effort is to make a simple walk cycle from this walking pose. In the end, the simple walk cycle was created, which proved that the rig can be used to made animation.

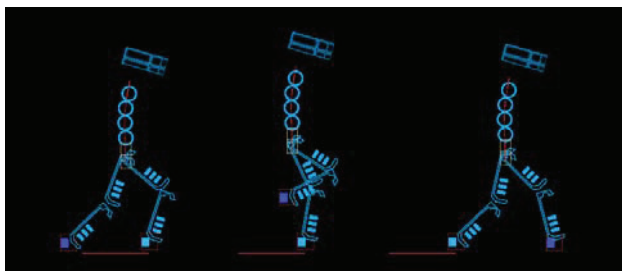


Fig.15. Simple walk cycle

By the end of the experiment, the humanoid character is able to walk, running and jumping.

#### IV. TECHNIQUE ANALYSIS

From the experiment, we can see that the basic principal of rigging can be put into implementation with equipment that not intended to make 3D rig. The solid in After Effect is basically made to create flat object, Null to help 2D animation and Duik plug in for the creation of 2D character.

There is a limitation of this technique that we are not able to create smooth polygon character and the movement of the character is limited due to that the inverse kinematic from Duik is intended for 2D animation, so when we try to move the inverse kinematic in z-depth, problem will occur.

Even though with some limitations, the result of the technique is the creation of robotic character that can be used

in Motion Graphic artwork with Science Fiction theme. Since most of the Motion Graphic artwork is more graphical work and not realistic, the character looks perfectly fine with science fiction background.

This technique is also able to help people, especially beginner, who like to produce 3D motion graphic but has no background in 3D animation.

#### V. CONCLUSIONS

With this experiment, it is concluded that creativity is the key to produce great artwork. The will to make an experiment with something unique, like trying the technique that usually been done with one equipment with different kind of equipment may give a useful result.

The other conclusion is that we need to maximizing the potential use of one equipment, where sometimes the equipment with little facility if used in a creative way will produce a result that never thought before, which can save more time and energy.

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# User Experience of SIPEBI as Indonesia Cultural Edutainment web portal

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**Abstract**— this is the third phase of research on creating Iconic Pusat Edukasi Budaya Indonesia (SIPEBI) as Indonesia cultural edutainment web portal. On this research we emphasized more to User Experience (uX) measurement based on Jeff Sauro usability metric, in this research we only use completion rate, usability problems, errors, page view/click and single usability metrics of SIPEBI. The method that we use is an explanatory with an experimental approach by measuring user experience based on usability metrics as integrated part of SIPEBI creation as an Indonesia educational web portal. Result of this research is based on single usability metrics in user experience overview it supposed to be redesign as the error, completion rate and satisfaction doesn't comply with standard of usability metrics.

**Keywords**—*User Experience, SIPEBI, usability metrics, edutainment, web portal.*

## I. INTRODUCTION

In the process of teaching and learning for Indonesian national plus or international schools, teachers are emphasized to give alternative way of teaching and assessments in addition to the main teaching and assessments on students' learning process. Generally, type of teaching and learning process use one way communication where teacher explain and student pay attention to the teacher. By the development of ICT, especially internet, it change into two way learning process where student explore more of their learning material, with the implementation of web portal using edutainment concept. This type of portal provides games based on students' lessons as well as quizzes, tests until the results of what they have learn in a form of passing certificate. Web Portal like [www.bcc.co.uk/bitesize/ks2](http://www.bcc.co.uk/bitesize/ks2), gives lessons on English, science and mathematics, while [www.ixl.com](http://www.ixl.com) provides alternative lessons for mathematics and English. Whereas for Social Sciences related to local and Indonesian culture, only provided in a portal by Indonesian Ministry of education that

is in <http://belajar.kemdiknas.go.id/> provided, containing resources on Indonesian cultures map but not in the form of edutainment content based on interactive games or material.

Edutainment concepts are learning concepts that is entertaining and fun. In edutainment, students learning process is not only by reading and listening teachers' lectures but they also try or experimented with multimedia content as well as interactive games without losing the lessons' contents. Besides, teachers and schools at primary level are emphasized to design and give lessons aiming on increasing the interests and interactivity of students. The conventional teaching and learning process can be implemented with teaching and learning concept of playing in the form of edutainment.

From the edutainment concept, students can explore lessons that given by teachers and learn more using the technology in self-directed learning concept. As an alternative assessment, the result of those lessons in the web portal can be printed out by the teacher as authentic students' work portfolio alongside with student's report card distribution.

### A. Research Question

So, based on the above introduction, the problems that will be used as the reference for problem Solving are as follow:

1. What is user experience on SIPEBI web portal?
2. How do we measure user experience on SIPEBI web portal?

### B. Research Limitation

The coverage of this research will only added interactivity design of SIPEBI web portal, containing third phase development of edutainment application for 2 Indonesian cultures that is Betawi and Aceh. Sub menu of the web portal will be history, culture and national heroes. Every content consists of narration, video, quiz and game. The target of this research's result is children ranging from the age of 6 to 9 or primary 1 to 3.

## II. LITERATURE REVIEW

Edutainment, according to Jiri N and Josef T [4] is a special form of entertainment that allows the participants to be educated like getting new information from various fields in our life. Edutainment consist of 2 syllables which are education and entertainment, when combined it will be education that gives entertainment. Based on the above opinions, edutainment can be defined as a learning process that's designed to fuse education with entertainment so that learning activities will be fun.

There are 3 assumption concepts that will be the foundation for edutainment concept. The first assumption declares that positive feelings can accelerate learning process while negative feelings slow down and obstruct learning process. The second assumption declares that if someone can use his sense of thinking potential and emotions accurately he'll make a leap in academic achievements that no one can think of. The third assumption declares that if every learners can be motivated accurately and are taught using the right way, in the way of respecting their way of learning, they all will achieve optimized learning result.

Application of those 3 assumptions in edutainment able to give a learning system that is designed interactively, open and fun, not scaring and two way learning environment. This concept places the students as the center of learning process that involves relationship between the student, teacher, learning process and learning environment throughout SIPEBI web portal.

User experience is the experience the product creates for the people who use it in the real world. User experience is about how product or service work on the outside when a person comes into contact with it, it is not inner working of product or services [2].

Usability is summed up as being a general quality of the appropriateness to a purpose of any particular artefact [1]. Usability metrics is a metric for usability evaluation that measure impact of good and bad usability to assess the quality of user experience [11]. Usability metrics that is use for usability evaluation are:

- **Completion Rates:** Often called the fundamental usability metric, or the gateway metric, completion rates are a simple measure of usability. It's typically recorded as binary metric (1=Task Success and 0= Task failure).
- **Usability Problems (UI Problems)** encountered (with or without severity ratings): Describe the problem and note

both how many and which users encountered it. Knowing the probability a user will encounter a problem at each phase of development can become a key metric for measuring usability activity impact and ROI. Knowing which user encountered it allows us to better predict sample sizes, problem discovery rates and what problems are found by only a single user.

- **Task Time:** Total task duration is the de facto measure of efficiency and productivity. Record how long it takes a user to complete a task in seconds and or minutes. Start task times when users finish reading task scenarios and end the time when users have finished all actions.
- **Task Level Satisfaction:** After users attempt a task, have they answer a few or just a single question about how difficult the task was. Task level satisfaction metrics will immediately flag a difficult task, especially when compared to a database of other tasks.
- **Test Level Satisfaction:** At the conclusion of the usability test, have participants answer a few questions about their impression of the overall ease of use. For general software, hardware and mobile devices consider the System Usability Scale (SUS), for websites use the SUPR-Q.
- **Errors:** Record any unintended action, slip, mistake or omission a user makes while attempting a task. Record each instance of an error along with a description. We can later add severity ratings to errors or classify them into categories. Errors provide excellent diagnostic information and, if possible, should be mapped to UI problems.
- **Expectation:** Users have an expectation about how difficult a task should be based on subtle cues in the task-scenario. Asking users how difficult they expect a task to be and comparing it to actual task difficulty ratings (from the same or different users) can be useful in diagnosing problem areas.
- **Page Views/Clicks:** For websites and web-applications, these fundamental tracking metrics might be the only thing you have access to without conducting your own studies. Clicks have been shown to correlate highly with time-on-task which is probably a better measure of efficiency. The first click can be highly indicative of a task success or failure.
- **Conversion:** Measuring whether users can sign-up or purchase a product is a measure of effectiveness. Conversion rates are a special kind of completion rate and are the essential metric in e-Commerce. Conversion rates are also binary measures (1=converted, 0=not converted) and can be captured at all phases of the sales process from landing page, registration, checkout and purchase. It is often the combination of usability problems, errors and time that lead to lower conversion rates in shopping carts.
- **Single Usability Metric (SUM):** There are times when it



is easier to describe the usability of a system or task by combining metrics into a single score, for example, when comparing competing products or reporting on corporate dashboards. SUM is a standardized average of measures of effectiveness, efficiency of satisfaction and is typically composed of 3 metrics: completion rates, task-level satisfaction and task time

According to Goni [3], web portal is web site that were used as bridge that provides wide variety of resources, service, task and link to other website. Based on his research there will be two kinds of web portal that is horizontal portals and vertical portals. Whereas Horizontal portals is a type of portal that offered by internet service provider or search engine usually with general purposes such as yahoo or google. Whereas vertical portal is used for specific interest or field such as those portal for medical information.

TABLE I. LITERATURE REVIEW

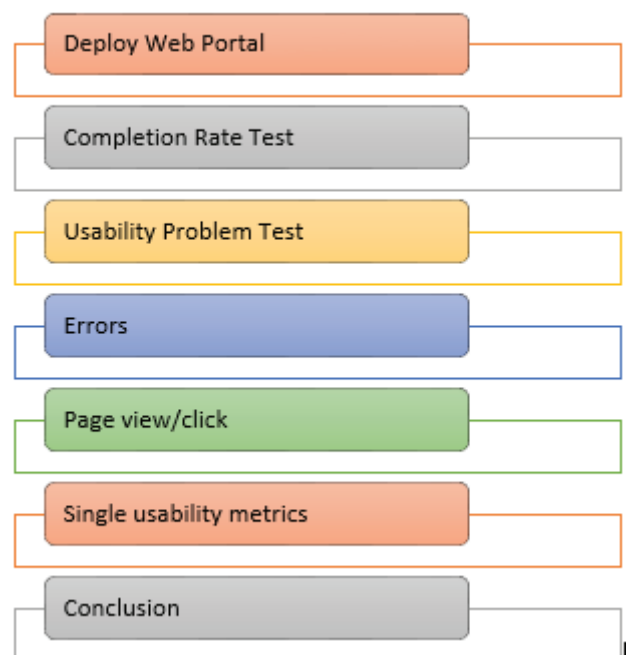
No.	Title and author	Result	Adoption
1	Willyanto[10] <i>Perancangan Aplikasi E-Education Berbasis Web Dengan Menggunakan Bahasa PHP</i>	E-Education System must be supported by the resource with qualities so that learning teaching process will become effective. They use web based application using PHP Programming Language	Reference on building e-education application with PHP language.
2	Ifan Kurniawan[2] <i>Pemanfaatan E-Education untuk meningkatkan Kualitas Belajar</i>	utilizing e-education as a transport in learning in the field of computer is used in order to help students in finishing problems especially in the field of computer and lecture notes can be downloaded by students freely so that it can increase knowledge and insight of the students	the concept and reference how e-education can increase learning qualities
3	Oka A.S., Widya C and Ilman Z[7] <i>Perancangan sistem edutainment berbasis web di sekolah menengah atas negeri 1 curup kabupaten rejang lebong</i>	A design of an edutainment system for interactive learning that creates student's interest to study. This system combines the element of education with entertainment to erase the feeling of boredom in the students towards the past learning way. This system is designed basing on web so it will ease up the user and utilize system networks available at SMA Negeri 1 Curup.	Reference to make an edutainment system based on web with PHP and MySQL.
4	Sidiq Wahidi[8] <i>Pembelajaran bahasa Arab berbasis edutainment (model ustadz Mohamad Nuaim pada kelas X di MAN Wonokromo</i>	Capturing the edutainment concept practiced by learning arabian language ustadz Mohamad Nuaim version that covers happiness of taught participants, way of thinking, their personal experiences, ability of	Reference on edutainment concept emphasizing in fun student's learning process.

	<i>Pleret Bantul)</i>	teachers in teaching, learning atmosphere, creative media, edutainment in learning and evaluation model	
5.	Zufri. T, Saputra. D, Tjhin. Santo [15] "Desain Portal Edutainment Budaya Indonesia sebagai sarana self-directed learning siswa di tingkat sekolah dasar"	Phase 1 of creating cultural edutainment web portal without implementation on quiz, game or certificate. Software using Flash, PHP.	Design and creation of cultural edutainment web portal.
6.	Saputra. D, Tjhin. Santo, Zufri. T [8] "SIPEBI: An overview of cultural edutainment in web portal as a medium for students' self-directed learning and alternative's assessment"	Phase 2 of creating cultural edutainment web portal added implementation on quiz, game or certificate. Software using Flash, PHP.	Second phase design and creation of cultural edutainment web portal.

While in this third phase we add more on interactive design by giving a usability testing on internal test.

### III. RESEARCH METHODOLOGY

The methodologies used in this research are experimental methods that will measure usability user experience on SIPEBI web portal. The research methods are divided into 7 stages: Deploy Web portal, completion rate test, Usability problem test , errors, page view/click, single usability metrics and conclusion. Figure 1 shows these stages:



This is results of usability test on user experience that done internally by researcher in using SIPEBI. It will be divide into divided into interactive design, Design Portal, usability measurement and conclusion.

Base on Dr. Mark Ingham [6], Interactive design are divided into 13 components. In this research we use 3 component that is applied to this research. The first is feel experience that based on layout and components inside the portal that give feeling of interactivity to user that is Touch screen, button and switch. The second is define interactions that what area of human feel that touch by interactivity that is touch, hear and see. The third is positive emotions is the goal of this research and interactivity consist of happy, joy and fun. Interactivity design are shown by figure 2. Below.

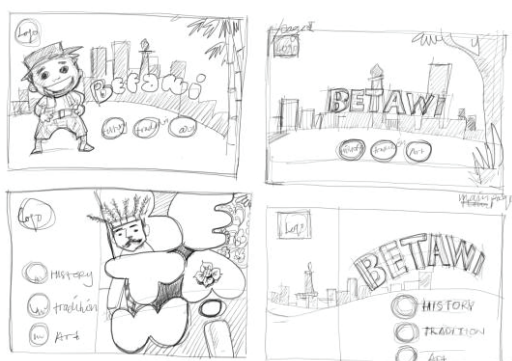
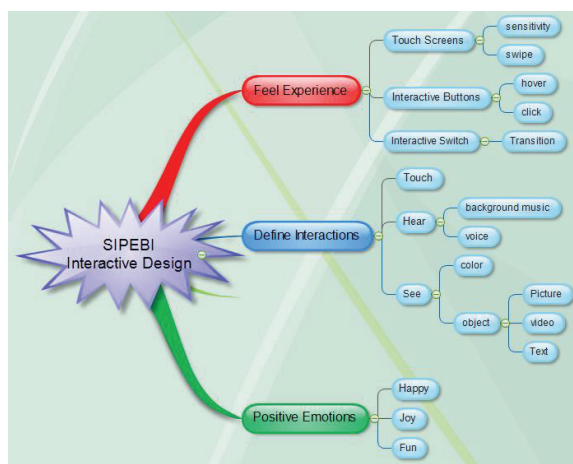


Fig. 2 Interactivity Design

Design for the portal will be shown using unified modeling language (UML) use case and activity diagram for menu and action inside the portal as shown in Figure 3 below.

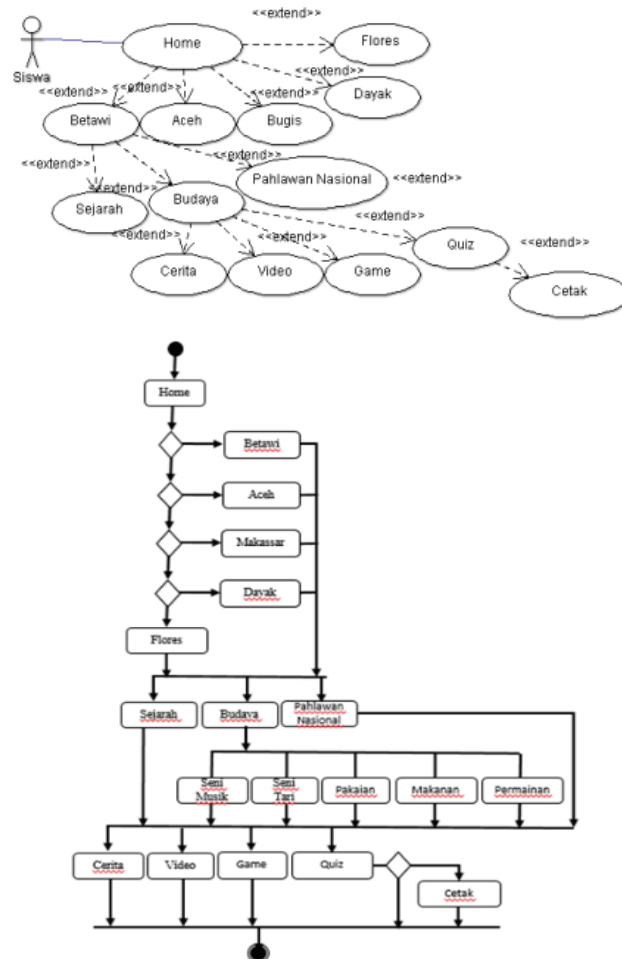


Fig. 3 SIPEBI use case and activity diagram

Fig. 3 explain the stages of using the portal. Students as users will open the homepage from iconic web portal. The homepage provides a button in the form of icon animation that contains Betawi culture, Aceh culture, Makassar/Bugis culture, Dayak culture and Flores culture. After clicking one of the icons, an animation of the origin of the selected culture will appear and another history, culture and national hero buttons from the selected culture will also appear. If the history button is clicked, an animation story that narrates the history will appear and narration, video, games and quiz menu will be flashed. If the quiz menu is selected, a series of questions that will be answered by the students will appear and by the end of the last question, the total score will be displayed and there is an option to print the score. If the culture is selected, introductory narration animation will appear and another set of music art, dance art, traditional clothes, houses, foods and drinks buttons will appear. After the buttons are chosen, a similar menu as the history button will be displayed.



Fig. 4 SIPEBI Display

Every picture in this page, as in Fig 2, is a moving animation that will display names from each tribe when magnified. The next menu will be displayed once clicked. When the page appears for the first time like shown in fig. 2 there would be an animation of betawi village appearances that was covered by metropolitan city, then there is the traditional house of betawi. After that there is the character si pitung that was running from his house and sees the background with narration and background music. After that, 3 arranged and animated buttons appeared that is history, culture and national heroes. The third picture in fig.2 is a print out of certificate as an alternate assessment after they've done the quiz or game, It will included passing score and level of quiz or game they have passed.

### C. Usability Testing on User Experience

#### • Usability problem test

In this test we specified design and layout user interface problem as button, link, option and check box button with black box testing as follow:

TABLE II. USABILITY PROBLEMS

No	Design	Criteria	Result
1	Button	When it hover there supposed to be highlight on the button when it press and click it supposed to be emboss and go to link directly	Good and according to the design
2	Link	There supposed to be link to correct url address	Good and according to the design
3	Check box	It supposed to give user selection more than one user	Good and according to the design
4	Option	User supposed to select one out of the option given by web portal	Good and according to the design

#### • Single usability metrics(SUM)

In this metrics we use SUM calculator suggested and created by Jeff Sauro that measured completion rate, errors, task-level satisfaction and test level satisfaction with result as shown in the figure below:

Task	SUM			Completion	Satisfaction	Time	Errors	Graph Low	Graph High
	Low	High	High						
Task 1	55.8%	76.0%	87.8%	86.7%	60.0%	71.1%	65.8%	20.2%	11.8%
Task 2	24.8%	41.6%	60.3%	53.6%	29.7%	37.6%	49.1%	16.8%	18.7%
Task 3	44.9%	64.1%	78.0%	86.7%	41.6%	67.9%	46.0%	19.2%	13.9%
Task 4	50.7%	70.7%	84.9%	75.5%	55.5%	69.1%	71.1%	20.0%	14.3%
Task 5	49.7%	69.0%	81.9%	86.7%	51.8%	75.2%	46.0%	19.3%	12.9%
Overall SUM	45.2%	64.3%	78.6%						

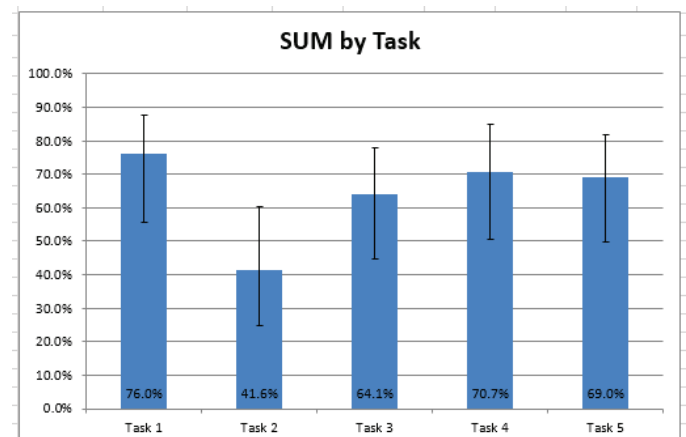


Fig. 5 Single Usability Metrics

Grouping of task from 1 to 5 are representing task of usage on 5 different pages. That is Betawi, history, culture, game and quiz. Where we test completion rate, satisfaction, error and time and sum it up using Jeff Sauro SUM Calculator. The result says that task 1 has the highest SUM percentage of 76%, followed with task 4 70.7%, task 5 69%, task 3 64.1% and task 2 41.6%. With this result task 1, task 4, task 5 and task 3 have good result of usability test (> 60%) which mean the design can be retain. As Task 2 that represent history page have to be redesign as it get low and poor result of usability test (under 60%).

Application testing system for web is based Krishen, Kota are divided into 6 type which are testing of application usage, testing unit, testing code, HTML, Load testing, user acceptance test and security test. In this research, the conducted test will be:

1. Testing between browsers online by using browsershots.org that states the fastest load time by using Google Chrome for  $\pm 15$  seconds meanwhile Mozilla Firefox and Opera  $\pm 25$  seconds.
2. HTML code test by using online tester on www.validator.w3.org states that the code HTML 5.0 is suitable with the WWW standard.
3. PHP code test with simple test application from simpletest.org states that the PHP code was made without problems.
4. Compatibility test towards browser and performance application based on HTML 5.0 resulting in optimized application and works well if browser Google Chrome is used.
5. Loading time testing online at loadimpact.com states that the experiments from various location load time application is more or less 15 seconds.
6. Unit testing is using blackbox testing like shown in table 3

TABLE III. BLACKBOX TEST

No	Tests	Criteria	Condition after test
1	main page	System shows page according to the loading time, if browser doesn't have or updated flash player, will be directed to install that plugin.	Good and according to the design
2	betawi page	System shows page according to the loading time, if browser doesn't have or updated flash player, will be directed to install that plugin	Good and according to the design
3	history page	System shows page according to the loading time, if browser doesn't have or updated flash player, will be directed to install that plugin	Good and according to the design
4	Culture page	System shows page according to the loading time, if browser doesn't have or updated flash player, will be directed to install that plugin	Good and according to the design
5	Game page	System shows page according to the loading time, if browser doesn't have or updated flash player, will be directed to install that plugin	Good and according to the design
6	Quiz page	Application shows page according to the loading time, if browser doesn't have or updated flash player, will be directed to install that plugin	Good and according to the design
7	printing quiz results	Portal shows pop up menu where students' name, class and school name will be written on before printing result.	Good and according to the design

#### D. Conclusion

1. This research is fourth phase research on Creation of SIPEBI as a cultural edutainment web portal.
2. This research overview user experience using usability metrics to SIPEBI web Portal.
3. This research aim to emphasize of usability metrics measurement of user experience on student accessing SIPEBI.
4. In this research user experience usability metrics is using Single usability metric and usability problems that created by Jeff Sauro.
5. The result it supposed to be redesign since the error are 55.6% higher than 50 %, while satisfaction are 47.7 % below 50% and completion rate is 77.8% below 78% rate..

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# Comparative Aesthetic Study between Three-Dimensional (3D) Stop-Motion Animation and 3D Computer Graphic Animation

Towards Physicality and Tactility, Perfection and Imperfection

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## Abstract

This essay provides a comparative study on aesthetic between 3D stop-motion animation and 3D Computer graphic animation. These two animation forms produced in different pipelines and outcomes. Highlighting key aesthetic principles of animation and fueled by statements that written by Power who underlines the importance of expressiveness in animation and engagement of viewer's emotion, author draws two clusters for comparing these two animation practices. The first cluster explores physicality and tactility; and the second cluster discusses perfection and imperfection of both animation practices. This essay aimed to contribute insight on comparative study of aesthetic between diverse animation forms from technical, visual and craft perspectives that have not yet explored by academic or practicing animators.

**Keywords:** 3D animation, stop motion, computer animation, aesthetic, comparative study.

## I. INTRODUCTION

The motivation to analyze aesthetics of three-dimensional (3D) stop-motion animations and (3D) computer graphic animation as comparative subjects in this essay has driven by two reasons. Firstly, it was triggered by the fact that 3D stop motion animation is a one of traditional form of animation that still can survived while 3D computer graphic animation coming as a new media of storytelling. Secondly, several researches of animation and cinema often include 3D computer graphic animation as comparison to contrast the distinctive characteristics and aesthetics of 3D stop-motion. The mentions of this comparative are found in research publications [1], [2], [3], [4], [5], [6], [7].

Whereas the discussion of 3D stop-motion often include 3D computer graphic animation as subject of comparison, the research regarding 3D computer graphic animation - for instance - in [8] and [9], Manovich and Power give less effort in defending its distinctive feature in a comparative way toward stop-motion. These difference of

perspectives led author to a quest of aesthetic as well as the survival key of both animation techniques, knowing the standard of aesthetic between these two technique animations were established in different context and led by different history [5], [7]. This introductory study gives insight on aesthetic analysis from distinctive perspectives of technical, visual and craft in the context of 3D animation.

## II. UNDERSTANDING THE STANDARD OF AESTHETIC IN ANIMATION

### A. Stop Motion

Stop-motion once being important composite technique for making visual effect in several movies such as *King Kong* (1933) and *The Lost World* (1925). Stop-motion animation as technique for visual effect in film was slowly disappearing as it replaced by computer generated imagery puppets, as example: the digital dinosaur creature in *Jurassic Park* [2]. Thus, this change has brought stop-motion return into its aesthetic core as a tactile handcraft storytelling as evidenced by *ParaNorman* (2012). It confirmed that is the handcraft storytelling which made stop-motion survived over a century [1], [6].



Figure 1. Stop motion animation in *King Kong* (1933) [10]



Figure 2. Stop motion animation in *The Lost World* (1925) [11]



Figure 3. Digital dinosaur in *Jurassic Park* (1993)[12]

In [2], Scholar Jane Shadbolt argue that the visual world that have re-arranged in miniature through frame-by frame processes of considering “scale, perspective, construction, materials, sets and character performance” is being “the basis of stop-motion aesthetic”. Shadbolt also noted that this physical process of stop-motion animation provides “a unique form of fantasy that is difficult to analyse because it provides an atmosphere of a dream world rather than a fake reality” [2]. Shadbolt believe that the stop-motion strengths are actually its ‘otherworldliness’, the ‘otherness’ and its “constant visual and spiritual tussle with the qualities of that, which is animate or inanimate” [2]. This might be one of the reasons why some horror genre animation which involving otherworldly creatures like *Corpse Bride* (2005) and *Frankenweenie* (2012) was done in stop motion.

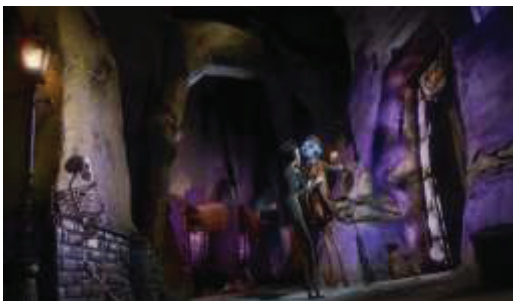


Figure 4. Creature from land of the dead in *Corpse Bride* (2005)[13]



Figure 5. Living sea monkey in *Frankenweenie* (2012)[14]

### B. Computer Graphic Animation

This otherworldliness and handcraft feel in storytelling is contrast with aesthetic goal of 3D computer graphic animation. Standard of computer animation aesthetic in 1990s is ‘smoothness’ and ‘complexity’ in 1980-1991 [8]. Manovich firmly state, “In considering the mechanisms of professional distinction in the field of computer animation, aesthetic standards function like the technical standards” [8:24]. The example of smoothness and complexity standard at that time can be seen on the 3D computer graphic animation effects by Industrial Light and Magic in the movies *Young Sherlock Holmes* (1985) where the knight from the stained glass is turning alive.



Figure 6. Smoothness and complexity in *Young Sherlock Holmes* (1985)[15]

However, in [16], Manovich explained that post 1990s, the technological development in 3D computer graphic animation has set the goal of producing realistic animation, which implicitly says that the aesthetic standard of 3D computer graphic animation has shifted from aiming ‘smoothness and complexity’ to achieve realism (or in 1990s -2000s was overly labeled as ‘virtual realism’).

While in the past the development of 3D computer graphic animation was driven by mimesis and realism intention, 3D computer graphic animation now aiming towards naturalist representation. The example of this tendency is *Avatar* (2009) which being a synthesis between the real and the virtual [9]. The agenda of heightened realism in 3D computer graphic animation thus slowly shifted into naturalistic directions (in term of gesture, character expression, and etcetera). This naturalism is aiming to make the narrative in 3D computer graphic animation became ‘believable’ to the viewer [9]. Thus, even though “Believability is distinct from truth” [9:37], the intention of 3D computer graphic animation to be ‘believable’

is contrast with the ‘otherworldliness’ and the ‘otherness’ that being offered as special feature of 3D stop-motion animation. Power argues that if the representation of entities is believable in the context of narrative, thus the viewer will credit through giving emotional response [9]. Thus, this believability is essential for 3D computer graphic animation.

### III. COMPARING AESTHETIC

In order to compare the aesthetic between 3D computer graphic animation and 3D stop-motion animation, a specific similarity of characteristic regarding these two types of animation are needed to be found since there is no universality of aesthetic. According to Power, traditionally, animation has been “one of the most expressive of the visual arts” [9:109]. Power also suggests that “expressive arts need to be experienced emotionally if they are to be properly understood” [9:113]. Thus, expressive animation is closely relates with an intention to engage viewers’ emotion. Both 3D stop-motion and 3D computer graphic animation is form of expressions and are expressive arts. In order to explain expressivity in each context and the way viewers’ emotion involve and response the form of expression that chosen with both techniques, this essay narrowed down the aesthetic discussions between 3D stop motion and 3D computer graphic animation into two focused clusters.

First cluster explored physicality and tactility in both animations, and second cluster explored the impact of perfection and imperfection of the animation outcomes. Frequent debates of physicality, tactility, perfection and imperfection are found in several academic researches such as in [1],[9],[6] as well as in computer graphic virtual forums - such as in *forum cgsociety* website. These findings have convinced author that ideas of physicality, tactility, perfection and imperfection are worthy to discuss aesthetic in the context of animation.

### IV. ANALYSIS OF AESTHETIC ELEMENTS

#### A. The First Cluster: Physicality and Tactility

The charm of stop-motion animation lies in its handmade animator’s physical touch in the sets and creatures [6]. The 3D stop-motion performed its expressiveness through physical manipulation in its process [17]. Sharp wrote that the key to puppet’s emotive power is “contained within the physical manipulation of their body parts rather than in the expressiveness of their features” [17:64].

The expressiveness of 3D stop-motion animation relies on its visual tactility – the sense of physicality and touch. The discussions of tactile visualization of 3D stop-motion have been explored in several academic publications such as in [1],[3],[6],[5]. Marks suggest that the viewer must engage with the cinematic experience in the film through haptic visualization [18]. According to Vasseleu, tactile sensation can be a “metaphor for conveyance into the interior of the subject, particularly the capacity to arouse emotion” [3:143]. Vasseleu

continues “in touching, we enter into the fold of psychophysical interaction with others” [3:143]. The ‘sense of touch’ that captured from real material and texture is an expressive language of stop-motion which distinct its characteristic with 3D computer graphic animation.

Furthermore, the use of handmade process as well as the physical touch of the artists into the real object addressed viewers’ sense of touch through vision [1]. The imperfection of stop-motion because of its ‘handmade feel’ can connect the viewer into the material reality in the world they lived in [1]. Human physical intervention and the craft and delicacy in transforming set in the frame contribute handmade feels in stop-motion animation and offered the audience richer materiality and textures that “beg to be touched” [6:137]. Similarly, in [1], Souza also argue that materiality and texture being the key of the ‘sense of touch’ – the haptic look of stop-motion animation. Souza convinces “Viewers are both able to be touch and be touched by movies, by their textures and tangible qualities” [1:6].

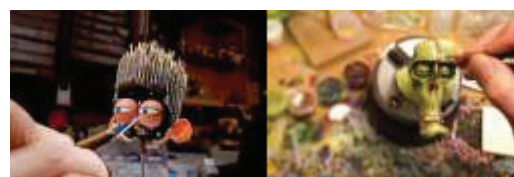


Figure 7. Physical touch for 3d printed puppet in *ParaNorman* (Images courtesy of Chris Mueller 2012, online archive)[19]

As example, *ParaNorman* (2012) facial expression is printed one by one, and its facial features were physically manipulated by hand. Facial expressions in some characters even have to be hand painted – or in other words: physically manipulated.

According to Pat Power, the issues of “realism and naturalism” as well as ideas of mimesis and art as “imitation of reality” are considered more important in 3D computer graphic animation and technology rather than “aesthetic and artistic convention” [9]. The aesthetic appeal of expressive work usually shown in artist’s physical footage such as fingerprints, strokes of another “embodied gestures” as artifact in animation construction, whereas 3D computer generated animation is usually “indexically dehumanized through absence of such qualities” [9]. Power suggests that term ‘naturalism’ best reflect the “technological drive towards verisimilitude in 3D animation” [9]. Three-dimensional computer animation technique builds its ‘physicality’ by its verisimilitude, aiming to make a believable object and scenes. Whereas the tactility in 3D computer graphic animation is also pursued by the use of various computer generated materials and textures. Interestingly, some studios including Pixar are still creating their physical marquette figures of character prior process the animation using computer software in order to achieve natural gesture [20]. This confirmed that visual ‘physicality’ is considered as important feature in 3D computer graphic animation.



In regard of a quest of realism, Disney *Pinocchio* (1940) is way ahead into realism far before the introduction of 3D computer graphic animation [9]. The intention to visualize animation as real as possible has been evidence in the process of making *Pinocchio*.



Figure 8. The movement and shape in some scenes in *Pinocchio* (1940) were based on real object.[21]



Figure 9. Realism in movement of *Pinocchio* (1940) [21]

Ironically, in regard its verisimilitude intention, “the more real the imitation the more fraudulent it becomes” [9:109]. Unlike stop-motion, the challenge in three-dimensional computer animation is to make a believable object. The ‘lack of gravity’ being a common issue that occur in the outcome of 3D computer graphic animation [22]. In order to animate a believable object, the timing and weight have to consider “the spacing of the poses” instead the poses themselves [22:117]. Thus, in 3D computer graphic animation, the weight of the object became a tangible effect of timing. Tai concludes that in computer animation there is still found a struggle to work with interpolated frames [22]. In this case, Tai gave example of *Shrek*. Tai write that *Shrek* demonstrates “the struggle with digital kinetics” [22:111].



Figure 10. ‘Lack of Gravity’ issue in *Shrek* (2001) [23]

### B. Imperfection and Perfection

In seeing stop-motion animation, viewers’ emotion engages in the imperfection of physical capture gap between movement and stillness. This sense of humanness and

imperfection reduce the distance between the film and the viewer. Moreover this gap gives space to the viewers to ‘communicate’ with the animation. In 3D stop-motion case, the imperfection in the film – such as imperfect material or texture made closer the relationship between the viewer and the film [2],[14],[1]. Thus, the imperfection is regarded as the charm of 3D stop-motion animation [2], [1].

In the case of 3D computer graphic animation, the imperfections are not associated with charm, instead it considered as failure and flaw. The concept of ‘uncanny valley’ borrowed from Masahiro Mori’s robotics research in 1970 in Japan is precise to define this kind of phenomenon when animation looks “very realistic but not quite real” [9]. The technical flaw – even a bit, made the brain “registers the subtle mismatch resulting in loss of emotional engagement or even repulsion” [9:40-41]. Power gave some example of these ‘uncanny valley’ in *The Polar Express* (2004) and *Final Fantasy: The Spirits Within* (2001) [9].



Figure 11. The ‘uncanny valley’ in *The Polar Express* (2009) [25]



Figure 12. The ‘uncanny valley’ in *Final Fantasy: The Spirits Within* (2000) [26]

However, imperfection is not always counted as a ‘charm’ in 3D stop-motion if it related with some technical issue. It is proved by the early development of stop-motion animation, which was hard to retain audience on “emotional level” on long duration, due to low/lack quality of the picture/motion/[5]. The intervention of technology of 3D printing and digital rig removal that was introduced in *ParaNorman* (2012) [27] contributes significant impact in the making and outcome of 3D stop-motion animation.



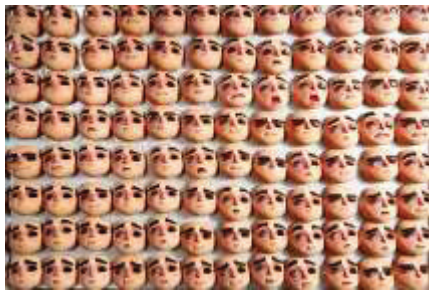


Figure 13. 3D printing for *ParaNorman* (Images courtesy of Sciretta 2012, online archive) [26]

Animation '*ParaNorman*' (2012) is a great example of a proportional combination between handcraft and technology in animation industry. In making *ParaNorman*, *Laika* studio using computer 3D generated model to transform the sketch prior creating the marquettes that will be finished manually one by one with hand [27]. In this case, technology is not installed for chasing perfection and realistic representation; instead it helps to realize the magic of handcraft in storytelling.

## V. CASE STUDY ANALYSIS

In this chapter, four films will be analyzed as case studies based on findings that already discussed before in those two clusters. The first two films are *Coraline* (2009) and *Fantastic Mr. Fox* (2009), both of them are produced in 3D stop-motion using puppets with different characteristic of materials. The next two films are *The Adventure of Tintin* (2011) and *Up* (2009), that have been done with 3D computer graphic animation technique, but each of them have different visual style.

### 1. *Coraline*

Prior production of *ParaNorman*(2012), *Laika* studio already uses rapid prototyping technology for facial expression when they make *Coraline* (2009). According to Dunlop the 3D model for facial feature were carefully remade base on its traditional sculptured model to maintain the detail of the imperfection of the original sculpture, including wrinkles, mole, and freckles [29].

'Handmade feel is not only can be experienced by audience through remodel result of the imperfect original sculpture but also through the physical touch from the artist during finishing process.

The 'sense of touch' in this film can be seen from the real material for the costume and hair of the puppets, as well as other real material from the set and props. The detail of parts inside model's mouth helps to bring the emotions of the characters closer to the viewer, especially when it comes to close up scenes of the characters.

Even though there is an intervention of technology in *Coraline* (2009), the imperfection of its visualization still shown through occurrences of slightly jagged transition of their characters' movement, it is seen from the gap between each frame of facial expression.



Figure 14. Finishing process with physical touch in *Coraline* (2009) *ParaNorman* (Images courtesy of McLean,online archive) [30]

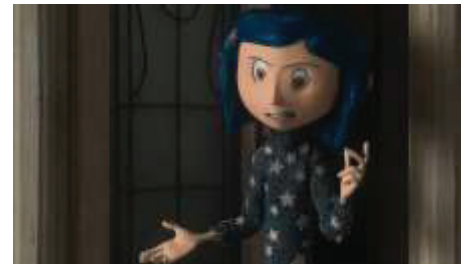


Figure 15. Real material of hair and fabric in *Coraline* (2009) [31]

### 2. *Fantastic Mr. Fox* (2009)

*Fantastic Mr. Fox* was screened at the same year as *Coraline* (2009). It also uses puppets for its animation, but it has more traditional look compared to *Coraline* (2009). The distinctive characteristic that author sensed in this film is the handmade fur texture of the puppets. Since most of characters in this story are animals, the charm of furry handmade texture can be seen in most of the scenes during the movie show.

In some close up scenes, viewers can feel the physicality of materials through details of facial feature of the characters, such as whiskers, eyelashes and even tears. The sense of handmade touch in this film also can be felt from the use of traditional technique that utilized touchable material for the effects. It has shown in the scene where the human try to explode fox's den. Touch-ability and tactility of the object can be seen from a scene that shows the smoke from explosion. Instead of using real smoke, the smoke in scene is made by some kind of cotton material that can be touched.

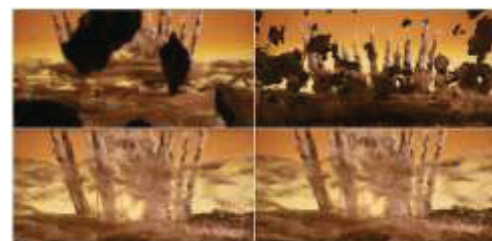


Figure 16. Touchable material for special effects in *Fantastic Mr. Fox* (2009)[32]

Imperfection also can be seen from the inconsistency of the fur position from the character in this film. But refer to

Power's statement in his article [9], the footage of artist touch in the fur material could be categorized as the aesthetic appeal of the film.



Figure 17. footage of artist touch in *Fantastic Mr. Fox* (2009) [32]

### 3. The Adventure of Tintin

*The Adventure of Tintin* is a good example to show how the aesthetic standard is shifted from smoothness and complexity into a realistic result. By aiming realistic visual, *the Adventure of Tintin* not only build its physicality by creating computer generated material and textures, but it also try to imitate other elements as real as possible, such as the proportion and details of real human, environment, even movement from real actor. This imitation has been done with motion capture technology. The example of this imitation is shown in the scene where Tintin lost in the middle of the sea.



Figure18. believable computer generated material and textures in *The Adventure of Tintin* (2011) [33]

*The Adventures of Tintin* shows how technologies in computer graphics animation have been rapidly developed for its ability to create virtual imitation that getting closer to real world. Overall, the virtual imitation to the real world in this film is looks much better compare to other two films that have similar visual style: *Final Fantasy* (2001) and *The Polar Express* (2004). However, those two film were also mentioned by Power as an example of uncanny valley phenomenon, which actually also can be felt in *The Adventure of Tintin*. Even though motion capture technology had been applied to bring the real movement from real actor to the virtual main character in this film, some scenes still fell odd as it has to do with issues of timing, spacing and poses. This imperfection shows in the scene where Ben Salaad tries to take a sit position.



Figure 19. Odd pose in *The Adventure of Tintin* (2011) [33]

### 4. Up

Up is an example of 3D computer graphic animation that not aiming realistic visual style. By looking at stylized character in the film, viewer instantly aware that they are seeing a world that different with the world where they are lived in. Unlike *The Adventure of Tintin* which aiming realistic look, there is no uncanny valley in 'Up' film. Anything does not looking real in this film such as stylized proportion of character and some exaggerated movements which is not considered as subtle mismatch.

To express its 'Physicality', this film shows complex and believable virtual elements such as material, visual effects and the natural gesture that achieved by creating physical Marquette before creating the virtual model just like what Power ever mention in [22].

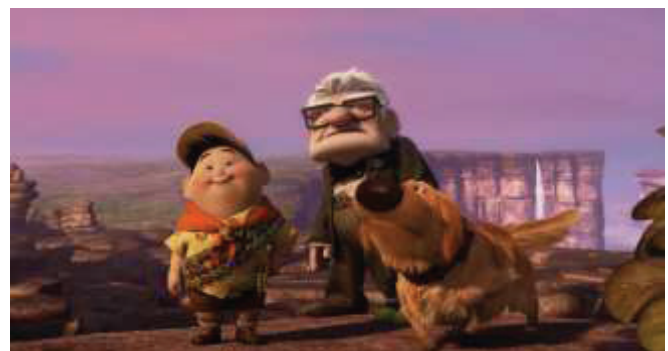


Figure 20 believable virtual material and natural gesture in *Up* (2009) [34]

## VI. CONCLUSION

There is no universality of aesthetic that can easily compare and contrast 3D stop motion and 3D computer graphic animation because the development of these two techniques is having different goal and aim. The classic premise that animation is one of the most powerful expressive art forms have helped this essay to divide discussion into two related clusters which explored expressiveness of both animation techniques.

Both 3D stop-motion animation and 3D computer graphic animation expressed physicality and tactility, however physicality in 3D stop motion is related to real touch, material

and texture, while the 3D computer graphic animation expressed its physicality and tactility virtually, through realist, verisimilitude, naturalist and believable objects and narrative. Meanwhile, the occurring perfection and imperfection is perceived differently. Whereas the aesthetic of 3D stop-motion is performed through its delicacy of handcraft storytelling and its imperfection adored as it 'charm', the aesthetic of 3D computer graphic animation relied on 'believable' computer-generated storytelling and technical perfection which pursue naturalistic against its plasticity to immerse viewer's emotion.

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# **Embedded Systems and Communication**



# Developing A Wireless Touch Screen Switch Panel Connected With Zigbee

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**Abstract**—In this research, a wireless touch screen switch panel has been developed. The device is connected to the light bulbs through ZigBee communication. The wireless touch screen switch panel can turn on/off or dim all the lights in the room. Besides, there are two user profiles available to control the lights directly based on the preferences (i.e. turn on/off, dim the lights) have been made and InstaOn/Off button to turn on or turn off all the lights in one button. The device can handle all the operations in a reliable way and real-time by keep updated the device to the current state of the lights when the customers try to turn on/off, dim, InstaOn/Off, or pick a user profile, even when the device is unsynchronized because of the connection or the electricity is down, the device will also inform the customers directly. The device is fairly power efficient by using a Sleep Mode whenever the device is being idle for more than 15 seconds with estimation battery life up to 33.29 days on daily use. With flash memory feature offered by the device, all the user profiles made will not be deleted and reset to be default whenever the battery is changed or even when the device needs to be reset.

**Keywords**—wireless; ZigBee; touch screen; switch panel

## I. INTRODUCTION

Switch is commonly well known and important for people nowadays. An electrical switch is any device used to interrupt the flow of electrons in a circuit. Switches are essentially binary devices: they are either completely on ("closed") or completely off ("open") [1]. Most of the light switch turns on and off the light by flipping the switch that is on a wall somewhere [2]. But along with technology growth, some manufacturers tried to make wireless switches that are more energy efficient, flexible, and user friendly by adding some features. One of features they are offering is a dimming feature on the switches. Customers can set the light's brightness intensity. This feature helps customers to save energy cost and longer bulbs life [3]. However, most manufacturers put the dimmers inside the switch panels. It will cause the switch panels become warm when dimmers get overheated. Thus, when overheating keeps going on, especially when the wattage of the load gets above 300 watts, the heat from the switch panels will be too noticeable [4]. It will make customers feel uncomfortable yet dangerous for the customers when the customers have no idea what is actually happened with their dimmers [5]. Besides, most of wireless

dimmer switches also require dimmer resetting whenever the customers change the bulbs.

Another additional feature offered by some manufacturers is a RF remote control in addition to the switch panel on the wall as its main controller. However, the remote controllers are not controlling the lights directly. The remote controllers still have to communicate with the main controller. Both the main controllers on the wall and the RF remote controllers have a button and options of lighting action limit (i.e. turning off/on the lights or preset lights). It is not convenient enough since customers need to put another addition switch panel and a new faceplate when they need to place another light in the room. However, customers should prepare external power supplies to power up the additional switches if the main controller cannot support anymore.

Mostly, one switch button can only handle one light that is close to it. It is because the switch is connected with the light directly through cables. The switches cannot be moved easily or swapped one another, not to mention when the customer wants to add another light bulb, traditionally adding new locations for light switch control, room configurations or energy savings was costly and destructive due to the need to pull new wire through walls and ceilings to the desired locations [6]. If there are more lights that have to be controlled, there will be more switch buttons have to be used by customers and customers might be confused, even more if they are in a rush. Therefore, some customers give labels on each switch button to avoid something bad happened like Costa Coffee in Bangalore should put Post-It labels on their light panel to get to figure out what switch does what [7].

Most of wireless dimmer switches utilizes simple radio frequency (RF). RF communication has a range limit to deliver the signal. Therefore, most of wireless dimmer switches need RF repeaters to expand the range [8][9][10].

## II. SYSTEM OVERVIEW

In this wireless touch screen switch panel connected with ZigBee, customers do not need any cables to connect switch panel to the wall. Since the wireless touch screen switch panel utilizes batteries, it can be placed anywhere in the room or customers can place it on a wall switch mount. It will be more flexible and handy for customers to set up and use the switch

panel. By adding a sleep mode feature in this switch panel, the switch panel could be expected to have a longer battery life compared with no sleep mode feature on the switch panel. The wireless touch screen switch panel can handle several lights and detect which lights are still on or off. This switch panel also have dimmer feature. There are three levels brightness intensity available for customers to choose.

A special feature offered by this wireless touch screen switch panel is there are some light profiles available for customers. Customers can set which lights to turn on/off and the lights' dimmer settings in a profile. Customers can also edit or remove the light profile in the future. Customers also do not have to reset the dimmer if they have to change the bulbs. Besides, there is a memory feature that allows customers to keep the user profiles that were set before. Therefore, customers do not have to remake the 4 user profiles in case there should be a reset needed on the device in the future. There are also some addition features that are Insta-On/Off and refresh option in this device. Insta-on/off allows customers to instantly turn on/off all the lights from the main menu. Therefore, the customers do not need to turn off the lights one by one or waste a user profile for turning off/on all the lights.

In case there will be another device developed and used at the same time or a network issue between the device and lights which will cause the device is not synchronized with one or any lights' current states, the device will recognize and update the display on the next button touched by the customer. There is also a refresh button in the main page can be used to resynchronize the device with the lights manually. Therefore, the customers will recognize if in the future the network connection or electricity is down. In short, by using this wireless touch screen switch panel, customers could control the lights yet keep saving the energy and longer the bulbs life in a handy and flexible way.

### III. PROTOTYPE DEVELOPMENT

Silicon Labs C8051F340 Microcontroller, Success Electronic Co., LTD S95361 TFT LCD Touch Display Module, and ZigBee ETRX357 built in EVB-TouchTFT400\_v1.0 development (see Fig. 1) board connected with ZigBee ETRX2 and a Power Source were used to build the prototype.



Fig. 1. EVB-TouchTFT400\_v1.0 development board

#### A. Managing Menus and Features on Success Electronic Co., LTD S95361 TFT LCD Touch Display Module

Success Electronic Co., LTD S95361 TFT LCD displays any images by converting a JPEG or JPG picture to a 16-bit TrueColor C array and save it in a global constant. In this research, another program was used to convert every image to be able to be displayed on the LCD. Whenever an image will

be displayed, the system sets the address coordinates, calls its C array global constant, and takes it through asynchronous 16-bit parallel communication. Since the display image method is based on coordinate, it is important to clear the display by rewriting the background color every time the system changes page to avoid images (i.e. buttons) collision.



Fig. 2. (a) Main Menu page, (b) User Profile 0 page, (c) User Profile 1 page (d) User Profile 2 page (e) User Profile Edit page

There are two main pages that are **Main Menu** and **User Profile** in the system (Fig. 2). **Main Menu** page contains four light switch buttons that are used for light indicators too, either the light is off (black), full brightness (bright green), or dimmed (light green) in the middle of the page. There are lower brightness button on the left in every light switch button and higher brightness button on every its right side. There are also Insta-On/Off button on the right top of the page to instantly turn on/off all the lights, Refresh button on the left bottom of the page and User Profile button on the right bottom of the page. Refresh button is used to resynchronize the system with the lights' current state. User Profile button is used to direct the customers to User Profile page. **User Profile** page contains four pages depends on how many user profiles had been created by customers. If there is no user profile made by the customers before, system will direct the customers to User Profile 0 page.

If there is a user profile made by the customers before, system will direct the customers to User Profile 1 page. If there are two user profiles made by the customers before, system will direct the customers to User Profile 2 page. The fourth User Profile page is User Profile Edit page which is used to edit User Profiles preferences from the customers.

#### B. Coordinating LCD Display with Touch Screen

Touch screen feature has been built in the Success Electronic Co., LTD S95361 TFT LCD Touch Display Module. Firstly, to make the touch screen working properly, it is important to know the LCD's coordinate patterns. One LCD's coordinate patterns to another's can be different. By using the coordinate patterns, any button's coordinate range can be located (Fig. 3).



Fig. 3. Button “Z” coordinate range

### C. Coordinating Menus and Features on LCD Display with Light Bulbs Connected with ZigBee

In order to be able to control the light bulbs, the LCD switch panel should be connected to ZigBee. There were two connections that had to be established, LCD to ZigBee connected with the microcontroller in EVB-TouchTFT400\_v1.0 development board and ZigBee connected with the microcontroller in EVB-TouchTFT400\_v1.0 development board to ZigBee attached to the lamp controller.

The connection between the LCD and ZigBee can be established by hardware through the microcontroller. The connection can be tested by sending some commands shown in Table 1 to UART terminal through UART0.

To make ZigBee ETRX357 on the device be able to communicate with ZigBee ETRX357 attached to each lamp controller, all ZigBee ETRX357 should be in the same PAN (Personal Area Network). ZigBee ETRX2 is the PAN Coordinator. Therefore, some commands shown in Table 2 were sent to both ZigBee ETRX357 on the device, while for ZigBee ETRX2 attached to each lamp controller the commands were sent through UART terminal by attaching one by one every ZigBee on a converter.

TABLE I. ZIGBEE COMMANDS TO CHECK THE CONNECTION AND ESTABLISH ALL ZIGBEE ETRX357 CONNECTION TO ZIGBEE ETRX2 PAN

Commands	Function
ATI	To display product identification information
AT+N	To display network information
AT+PANSCAN	To scan all the available PAN
AT+JPAN:11,2829 or AT+JPAN:11,CDB7FD25DAEE177C	To join ZigBee ETRX2 PAN

Value “11” and “2829” in **AT+JPAN:11,2829** (see in TABLE I.) are gotten from **AT+PANSCAN** reply which is **+PANSCAN=11,2829,CDB7FD25DAEE177C**. “11” means Coordinator’s channel, “2829” means Coordinator’s PID, and “CDB7FD25DAEE177C” means Coordinator’s EPID. To join PAN, Coordinator’s channel and PID/EPID are needed to be sent in AT+JPAN command.

The connection between Zigbee on the device and the ZigBee attached to every lamp controller was established by sending ZigBee’s address and commands through UART0

programming on microcontroller (See TABLE II.). Each lamp controller is connected with a ZigBee and a dimmer. A lamp controller can handle 1/2/4 channels, depends on light bulbs’ wattage. A maximum wattage the dimmer can handle is 200W. If the dimmer has reached 200W, customers have to add another dimmer and lamp controller to avoid overheat on the dimmer. In this research, a lamp controller handled one bulb. Therefore, there were four lamp controllers with four ZigBee addresses used.

TABLE II. ZIGBEE COMMANDS TO CHECK THE CONNECTION AND CONTROL THE LIGHT BULBS.

Commands	Function
ATI	To display product identification information
AT+N	To display network information
AT+UCAST: (ZIGBEE DESTINATION ADDRESS), (COMMAND)	To transmit a unicast command

### D. Managing Sleep Mode in Microcontroller

If the customers do not perform any touch to the LCD for more than 15 seconds, the system will go on a Sleep Mode until there is a button pressed from the customers. A sleep mode on the system includes a sleep mode on LCD and ZigBee and an idle mode with a transition to low frequency system clock on the microcontroller. Whenever the customers press a Reset button, the system will re-initialize the microcontroller, LCD, ZigBee and all the variables and direct the customers to the Main Menu page.

### E. Managing System’s Synchronization

To manage the system’s synchronization, the microcontroller will always send bulbs’ state request commands to the lamp controllers every time it sends commands to turn on/off or dim the bulbs. If the lamp controllers do not respond the request commands from the microcontroller, the microcontroller will receive NACK response. The system will display red buttons on Main Menu page and activate a buzzer for 100ms. If the lamp controllers do respond the request commands from the microcontroller, the microcontroller will process the responses and update the display on Main Menu page based on the responses.

## IV. EXPERIMENTAL RESULTS AND DISCUSSIONS

### A. Device Analysis

#### 1) Microcontroller and LCD Touch Screen

On this research conducted, Success Electronic Co., LTD S95361 TFT LCD Display Module is chosen as the interface because it supports full color TFT 262k colors and comes with a handy size. Besides, it has built in touch screen which is a good feature to support this research. Silicon Labs C8051F340 is chosen as the microcontroller because it provides fast clock speed so it can handle the LCD, ZigBee and other peripherals smoothly. Besides, it has sufficient RAM and flash memory to support programming. All the components are built in EVB-TouchTFT400\_v1.0 development board except



ZigBee ETRX2. It makes the device becomes more handy since it only contains essential peripherals and more secure since less wires used.

Every time customers do any valid-touch, the LCD will display the menus smoothly, since the background color is only rewritten when the system should move to another page. The buttons in every page cannot be larger or optimized with a convenient touch by any fingers even though it works well with any stylus. It is because the larger buttons the more memory needed to store its C array. The flash memory is limited and there is no any other internal or external storage that can be used to store the images.

The background color used cannot be other than white since the background color of every images are white and all the images are extended as JPEG or JPG which will not support transparent background. This will make bad appearance on the display if the background color is other than white. Besides, it will not be possible to make a full screen picture as the background since a full screen picture will need more than 65K memory which is greater than the memory available, unless the picture is displayed repeatedly, but like what was mentioned before, it will make bad appearance on the display since there will be so many white color popped around the buttons.

The display is presented as full color to make the device is more informative towards the customers than buttons, slider, or monotone color. Therefore, by presenting the lights based on its current state, the customers would know which state the lights are in at the moment. Besides, by making the display full color, the device will be more attractive, instead of the monotone black and white color or grayscale color, etc.

Touch screen is utilized and chosen as its input method to ease the customers to use the device, increase the speed of task, and reduce the device's size. Compared to other input methods (i.e. buttons) in this research, there will be needed quite several amounts of buttons to run the device, even though indeed the buttons can have double tasks but it will require more time for the customers to memorize which buttons can do what tasks and it will become more harder if there is no LCD display to show the menu, less informative, and the customers will keep pressing the buttons without knowing what is the real state of the lights. Even though there is an LCD display, it will be such a waste. Why it should use buttons while the LCD display and device's size can be optimized by using touch screen?

## 2) ZigBee Connection

In this ZigBee Connection Examination, some coverage measurements from the wireless dimmer switch panel to a lamp controller were held (TABLE III.). From TABLE III, it can be seen that the wireless dimmer switch panel can control the lamp controller through a wall within 12 meter. But after 20 meter with so many obstacles, the wireless dimmer switch cannot control the lamp controller anymore. However, with mesh topology ZigBee has, it is possible for ZigBee to cover any lights even in a big room, since every light will have its own lamp controller which will be a ZigBee node to amplify the signal.

TABLE III. COVERAGE MEASUREMENTS FROM THE WIRELESS DIMMER SWITCH PANEL TO A LAMP CONTROLLER WERE HELD.

Distance (meter)	Obstacle	Result
7	None	OK
12	A wall, Outside the room	OK
20	A wall, Outside the room, Stalls, Exhibition's properties, etc	Out of Range

## 3) Dimmer

A dimmer feature can only work if the lamp controller and the lamp are dimmable. If it keeps dimmed while lamp controller and the lamp are not dimmable, the lamp controller will just ignore the dim value sent by the device and the lamp will flicker.

To make the lamps dimmed smoothly, a command should be sent to the lamp controller to enable a smooth transition. Therefore, while changing brightness level, no matter how much the level gap, it will require a fixed transition time.

## B. Reliable Aspect Examination

While doing the examination, it was shown that the device is reliable. Every input made is processed and worked as what it should be. The examinations given to the menus and buttons on LCD display, the connection between Zigbee on the device and ZigBee attached to each lamp controller, flash memory on the microcontroller, and system's synchronization.

## C. Real-time Aspect Examination

While doing the Reliable Examinations, it was shown that the device is real-time. Every commands sent through ZigBee to control the lights are executed directly with slight delay. This is caused by the system is always sending request commands to the lamp controller to keep both the system and the bulbs synchronized. The lights current state will always be updated automatically by the system.

## D. Device's Current Consumption

With a 5V voltage input, the operational current of EVB-TouchTFT400\_v1.0 development board is 69-70mA when it runs displaying the menus and when transmitting commands to ZigBee ETRX357 attached to each lamp controller, the load current consumed is 71-73mA. But, when ZigBee ETR357 on EVB-TouchTFT400\_v1.0 development board is waiting to receive any replies from ZigBee ETRX357 attached to each lamp controller, the load current consumption is around 66-67mA for a few seconds. This is caused by after ZigBee ETRX357 on EVB-TouchTFT400\_v1.0 development board transmitting a command to ask the light status from ZigBee ETRX357 attached to each lamp controller, the microcontroller becomes idle for a few seconds until ZigBee ETRX357 on EVB-TouchTFT400\_v1.0 development board receives the replies and the microcontroller processes it. In the Sleep Mode after the device went idle for 15 seconds, the device consumes 2mA. Shown in TABLE IV, by using device's transmitting, receiving, idle mode, and sleep mode current consumption data



got from the examinations above, there are some estimations of device's battery life.

TABLE IV. ESTIMATIONS OF DEVICE'S BATTERY LIFE.

Categories	Conditions	Current Consumption	Time Used in 1 day (hour)	Battery Life
Sleep	LCD, Microcontroller, and ZigBee are on Sleep Mode	73mA for 0.0042 hour and 2mA for 23.9958 hours	15 seconds / 0.0042 hour	41.41 days
No Sleep	Receiving Commands	67mA	24 hours	1.24 day
	Idle	70mA	24 hours	1.19 day
	Transmitting Commands	73mA	24 hours	1.14 day
Mix	In a day, in a studio apartment, turning on/off bedroom's light twice (1x on, 1x off), lower dimming bedroom's light twice, turning on/off bathroom's light twelve times (6x on, 6x off), turning on/off balcony's light twice (1x on, 1x off), turning on/off kitchen's light twice (1x on, 1x off), pressing instaOn/instaOff button twice (1x on, 1x off), and pressing user profile buttons one each. The total buttons pressed in a day are 24 buttons.	73mA for 0.17 hour and 2mA for 23.83 hours	600 seconds / 0.17 hour	33.29 days
Note: <ul style="list-style-type: none"> <li>• A button takes maximum 25 seconds to load the update.</li> <li>• The calculation on Mix category column can be varied depends on people's habit and daily use.</li> <li>• The estimation is using 2000mAh rechargeable Eneloop battery</li> </ul>				

## V. CONCLUSION

In this work, a wireless touch screen switch panel connected with ZigBee has been developed. This wireless touch screen switch panel could control the lights in a room either a small room or a big room or even some rooms at once. It has been shown reliable and worked in a real-time, while considering mostly lighting controller in the market still need wires and less flexibilities for customers to set up and use the switch panel. From the examinations, it was shown that the device could handle every operations it provides (i.e. turning

on/off the lights, lower/higher dimming the lights, user profiles, and flash memory) in a reliable way. Besides, the device also kept updated to the current state of the lights, even if the device was not synchronized with the lights because there was another device controlling the lights at the same time or the connection or electricity down. The device could always catch up the light bulbs current state by sending commands through ZigBee to get current lights' state and update the display right after the information received by the device. From the current consumption examinations, it was shown that the device was also fairly power efficient because the system entered a Sleep Mode if the device is idle for 15 seconds. All the user profiles made still had the preferences made before whenever the battery was changed or even when the device needed to be reset.

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# ZLeAp: Application for Wireless Sensor Network (Zigbee) Learning Tool

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**Abstract**— ZLeAp is a Wireless Sensor Network (WSN) learning aid application based on ZigBee. This application is intended to assist academics in the study of ZigBee devices, especially in terms of the formation of message delivery route. This application shows the real route generated from the hardware unlike the other simulation tools which generate the route based on specific algorithm and pre-generated conditions. ZLeAp provides seven learning scenarios. The scenarios are three routing learning scenarios, two scenarios for the effect of transmission power, and two timing constraints scenarios. It is known that ZigBee devices are smart devices that are trying to choose the best route with the lowest cost and the routes are able to change dynamically. The experiments show that the shorter distance between devices doesn't always produce lower cost compared to the longer ones. The transmission power plays a significant role in routing but the routing results are not always the same as the theoretical route. Network resolving time depends on network size and beacon periods. During the design of WSN this time value should be anticipated.

**Keywords** : Learning aids, Wireless Sensor Network, ZigBee, data transmission, route visualization.

## I. INTRODUCTION

The high penetration of internet today makes the internet inseparable from human daily activities. Internet connection can be found at almost all places; especially in big cities. Based on this phenomenon, experts invent a concept known as the Internet of Things (IOT). The term IOT was first expressed by Kevin Ashton in 1999 [1]. Computers in the IOT framework are expected to automatically collect information in its own way so as if all the items are connected to the computer, to see, hear, and feel the world.

The implementation of IOT typically uses wireless communications, where devices are connected in a wireless communication network to form a system known as the Wireless Sensor Network (WSN). Research and development was conducted to create standard Wireless Sensor and Control Network to simplify the process of data collection where ZigBee is one of the devices that complies IEEE 802.15.4. ZigBee is growing rapidly because ZigBee device is one of WSN devices which is flexible and inexpensive [2]. The reliability of ZigBee in forming the WSN has been tested in previous studies in Universitas Multimedia Nusantara, titled:

Remote control and monitoring system based on ZigBee [3] and the development of remote monitoring and controlling applications using friendly ARM mini 2440 for ZigBee-based building management systems [4]. Both applications are focusing on the implementation of ZigBee networks and their implementation for remote monitoring systems.

The WSN concept is still growing with a lot of new protocols, standards and features. WSN also comes with so many possible applications. This makes the learning for WSN difficult especially in Indonesia where the use of this technology is uncommon. The authors feel the need for a WSN learning tool. Using this tool, the academia can be further understood with the concept of WSN. This tool also gives support for implementing WSN in an easier way. The learning tools available now are only covering the ideal circumstances only. These learning tools are usually in the form of simulation software. This simulation software only represents the ideal situation and often creates a problem because of the differences between theory and implementation. Simulation may be expanded to reach a better result but the development of the simulation will require a lot of effort.

There are some ZigBee simulations which are available for learning tools. Dimitri Marandin created ZigBee/IEEE 802.15.4 learning Simulation. The simulation uses NS-2 network simulation tools for implementing ZigBee [5]. Petr Jurcik and Anis Koubâa also developed IEEE 802.15.4 / ZigBee OPNET Simulation Model [6]. The simulation is based on the implementation of ZigBee IEEE 802.15.4 simulation model. This model is implemented in discrete event simulator and claimed to be more precise than the same model implemented in Network Simulator 2 (NS-2). The timing parameters and the CSMA/CA mechanism are more precise than implementation in NS-2 which introduced more overhead. The background noise, propagation delay, radio interferences and bit error rate are using default wireless models from OPNET. Non beacon-enabled mode, unslotted CSMA/CA MAC protocol and PAN management are not supported in this model. Another simulation is developed with NS-2 simulation software [7]. The paper titled Simulation and experimental analysis of a ZigBee sensor network with fault detection and reconfiguration mechanism uses separate methods for implementing ZigBee. NS-2 model is used to explore the new

scenario and then the hardware implementation using Texas Instrument CC2430 development kit was used to test the scenario.

In order to simplify the learning process, this work proposes the learning tools that combine the use of both hardware and software. The application software will assist the beginner to setup the devices and visualize how ZigBee work. The data submissions from the devices are mapped based on the responses from ZigBee device itself. The focus on ZLeAp Software is the visualization of ZigBee data transmission route which tracked from the messages delivery and reception from one node to another node in the same channel. The feature of the mesh network captured in the visualization will help the ZigBee beginner to better understand the system. Another WSN parameter which is difficult to simulate is the effect of transmission power to the range of the data transmission and mesh network. The time needed to form the complete network and time needed to reroute in the network are also difficult to simulate. ZLeAp provides the way to present how one device can be connected to another using visualization for the beginner to easily understand how WSN work. Using real devices as one part of learning tools will provide real working environment and more precise result without adding more complication for novice users.

## II. RESEARCH METHODOLOGY

### A. System Design

The hardware for ZLeAp consists of six Telegesis ETRX2 ZigBee Modules. One module dedicated for the coordinator and five for the WSN nodes. The coordinator is connected to the PC running ZLeAp application software through Future Technology Devices International (FTDI) basic converter chip. Another modules are dynamic, each have their own power supply. The hardware diagram of this system is shown in figure 1.

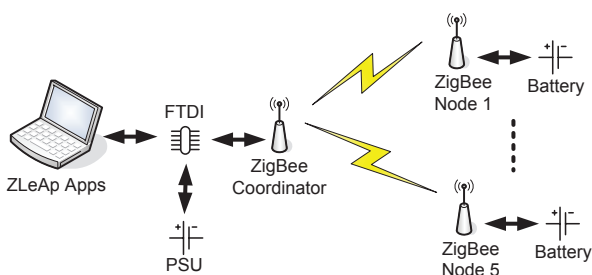


Fig. 1. ZLeAp System Diagram

ZLeAp application software is installed in the PC connected to ZigBee coordinator. All device settings and data transmitted in this system are generated, transmitted, captured and stored in this application. The User interface is shown in figure 2. Single page approach is implemented in the user interface to simplify the data entry process. When all of the hardware connections are done, user can detect the connection

to ZigBee coordinator through the FTDI Chip. Using a single click, the application will detect the computer communication ports available and connected with ZigBee coordinator device. If necessary, user can change the connection parameters. The connection is initiated after the connect button is pressed. If the connection is successful then all of the feature buttons are enabled. These buttons are the prebuilt ZLeAp commands that can be used to send commands directly to the ZigBee device.

The feature buttons and its functions are as follows:

1. Obtain device identity information consisting of device type, software version of the device, and the device addresses or EUI64 (identity device according to the IEEE 802.15.4 standard).
2. Obtain information about the network. This contains information about whether the device is a part of the PAN (Personal Area Network) or the device is not part of the PAN.
3. Inform the existence of devices in a PAN.
4. Perform search devices that are connected to them.
5. Delete the existing PAN configuration on the device.
6. Make a Personal Area Network.
7. Knowing the amount of transmit power levels.
8. Adjust the amount of transmit power levels.

Using the command buttons on the upper left of ZLeAp application, the user can input the data into ZLeAp database which will be useful for node visualization. The ZLeAp database structure can be seen in figure 3. The database consists of a table that contains the user information such as node name, ID and the coordinate (location) of the node. This data have to be entered before visualizing the data communication route between devices. The data contained in the database can be modified by the user as needed.

Description of the column names used in the database are as follows:

1. Name, for storing the device name desired by the user.
2. EUI64, for storing the address of the device in accordance with the IEEE 802.15.4 standard
3. Network Id, for storing the address of the device in a PAN. This address will be obtained when a device becomes part of a PAN.
4. Lat, for storing device position to be displayed on the map based on the y-axis (latitude).
5. Long, for storing the position of the device to be displayed on the map based on the x-axis (longitude).
6. View, for storing node status, whether the node will be displayed on the map.

User can use the bottom left menu to visualize the route. In this section the user prompted to click the load button to enter data from the database to the combo box according to the route. The user can select the sending node and the destination node. The sending node is usually a ZigBee coordinator connected to this application, while the receiving node is a ZigBee node destination device.

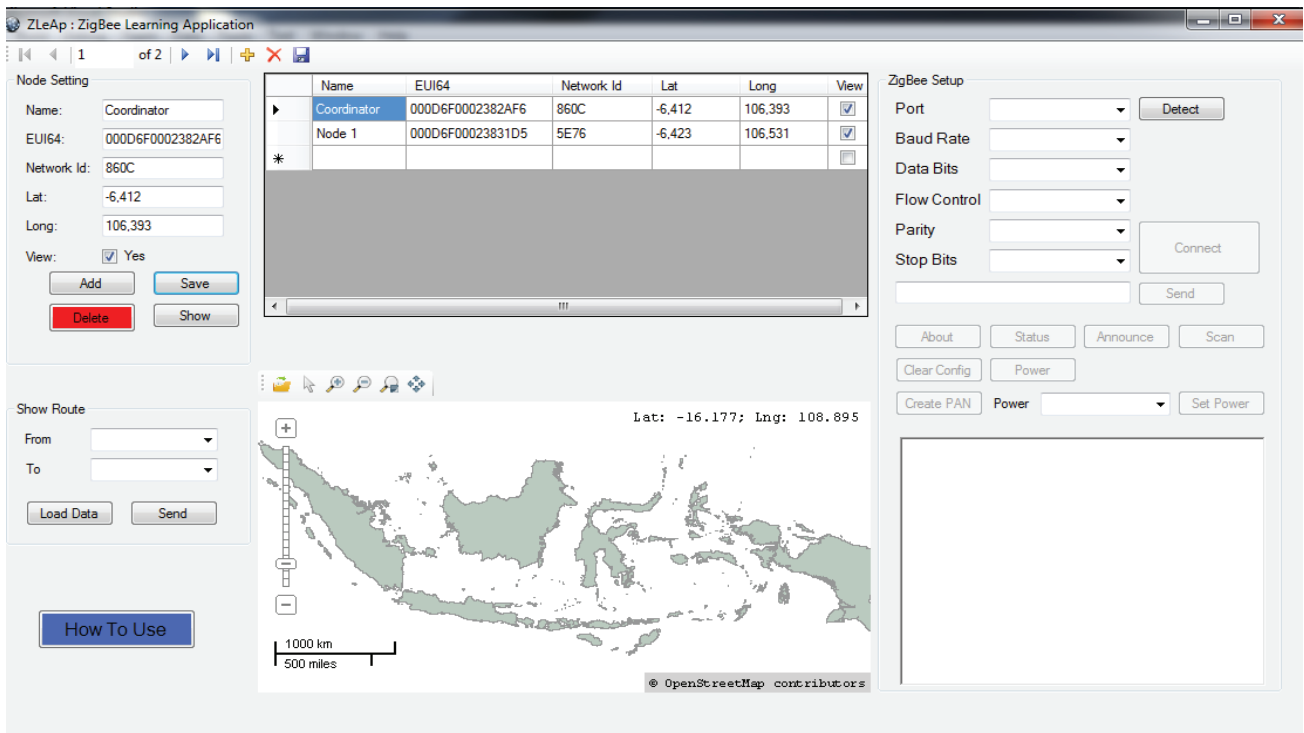


Fig. 2. ZLeAp User Interface

Results of these visualizations will be shown on the map which is located in the bottom middle of ZLeAp application. The background map can be changed in accordance with the user location and detail. This map feature is also equipped with menus for change the map, zoom in, zoom out, zoom extend, and pan the map. The map can be uploaded by user and use common shapefile (shp) format.

### B. Methods

As a learning tool ZLeAp has many activities and trials. These trials are tested to see whether these applications can really help learning about WSN especially the visualization of traffic. The experiments are as follows:

1. Viewing network formed by a set of ZigBee who are in the same PAN.
2. Investigating the changes in the network when there is a node which fails to work or turned off at an existing PAN.
3. Investigating the changes in the network that are formed when there is a new device added to the existing PAN.
4. Investigating the effect of adjusting the transmission power to overall power usage.
5. Testing the effect of adjusting transmission power to the range or distance of the transmission and the RSSI (Received signal strength indication) Level.
6. Measuring the time required by the ZigBee device to execute various commands using provided command buttons.
7. Measuring the time required to transmit a message between ZigBee devices until ACK / NACK obtained from the receiving device.

Improvements to the application have been made if there are parts that do not work as expected in the initial design. The application is considered to be complete if all functions are working properly, no error is found and meet the desired specifications with acceptable tolerance limits.

Name: NodeInfo					
Column Name	Data Type	Length	Allow Nulls	Unique	Primary Key
Name	nvarchar	50	No	Yes	No
EUI64	nvarchar	25	No	Yes	Yes
Network Id	nvarchar	5	Yes	No	No
Lat	float	8	Yes	No	No
Long	float	8	Yes	No	No
View	bit	1	Yes	No	No

Fig. 3. ZLeAp Database Structure

### III. TEST RESULTS AND ANALYSIS

Testing is done by monitor all nodes through FTDI Chip bridge connection to check all trial scenarios that had been prepared beforehand. Only one FTDI chip needed later on for the learning purposes.

Scenarios are developed to become the key activity for learning purposes. Without proper scenarios the learning of WSN would certainly be difficult because the way WSN work and behave is not easily captured. These scenarios are tested to know whether these scenarios can be useful as a learning tool. The constrained resources that WSN have can be captured



within these scenarios to give better understanding of the WSN.

The first experiments carried out using the five ZigBee devices already connected one to another. The second experiment conducted by disabling one of the nodes that were previously used in the first experiment. These four ZigBee devices and the routes of data transfer can be compared if the shutdown node is an edge node and if the shutdown node is the middle node. The third experiment is done by adding two new ZigBee devices to the previous network. The total employed ZigBee will become six again and can be compared with the initial six device network.

The visualization of the network for the first scenario can be either direct or indirect connection. Direct connection means that all nodes are directly connected with the coordinator like which is shown in figure 4. Indirect connection means that the node can be connected to the coordinator using the help of other nodes as relay as shown in figure 5.

If the sender and the receiver are connected like in figure 6, the possible pathways used by ZigBee device will be one of the listed paths. If later on the ZigBee begins to transmit the data, the selected line will change its colors to red. Besides the differently colored path, the user will be given the information about the time required by the sending node to get a response from the recipient node this pop-up message also contains information if the message is not received by other devices.

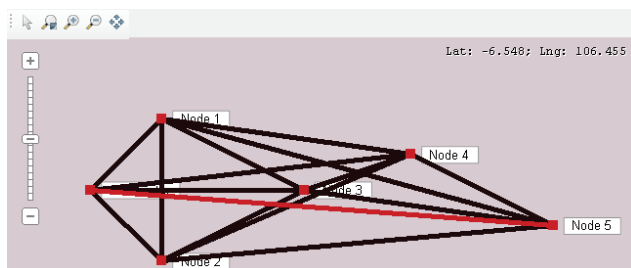


Fig. 4. Direct Connection Visualization

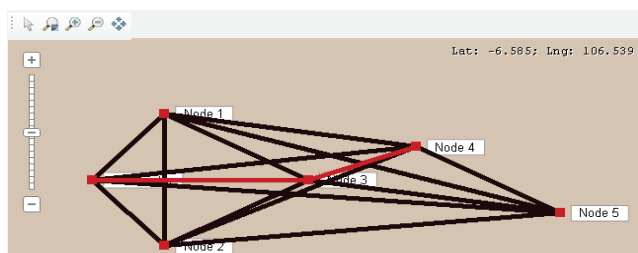


Fig. 5. Indirect Connection Visualization

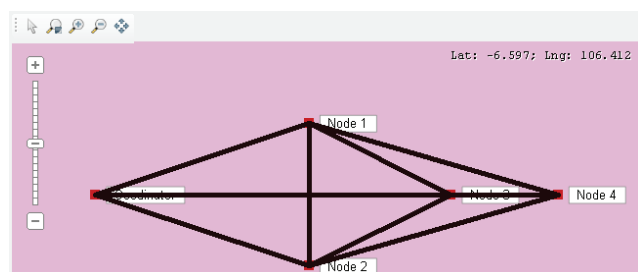


Fig. 6. Possible Route of Communication

Zigbee is designed to calculate and select route based on the lowest cost calculation and node availability. The lowest cost calculations not always generated by the shortest distance. Figure 4 and 5 also shows that the greater distance is not always produce greater cost. The lowest cost calculation will consider the signal strength received by the nodes, the quality of data link, and the factors which are generated by the physical data communication layer of ZigBee. These values are generated by the radio data hardware and given to the application which is the higher data communication layer. Further details on how this is done in the visualization process can be seen in the flowchart of sending data in figure 7.

During the first trial up to the third data trial, if the sending node fails to send a message to the receiving node then the user will get a pop-up message that contains a notification that the message delivery is failed. If the user believes that the destination node is the active node, the user can retry to send the message directly, or wait a while until the ZigBee device and network make auto adjustments. These adjustments are done among the nodes using beacons transmission between devices. If the destination node is non-active, the user can check and try to activate it before trying to send another message.

The fourth experiment uses a single ZigBee device which transmits a signal with specific power settings arrangement. The actual current being measured directly at the device as the indication for device power usage. Changing the setting is done by using ZLeAp application feature. The power or the current can be measured using separate power meter or ampere meter. The result shows the current needed by the device in order to work properly. Measurement is also being done when the ZigBee device is not connected to the network (PAN) which means the device is not transmitting (idle). The test results are shown in Table 1.

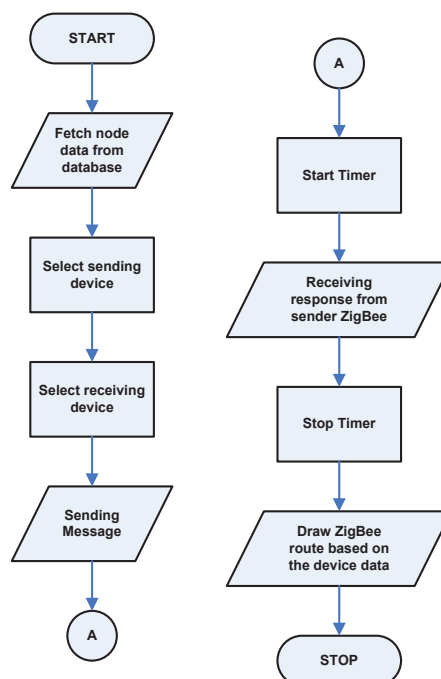


Fig. 7. Data Transmission and visualization Flowchart

TABLE 1. THE EFFECT OF TRANSMIT POWER AGAINST POWER CONSUMPTION

Condition	Current Usage (mA)
Transmit Power -43dB to 3 dB	37
Transmit Power 4 dB (boost mode)	38
Not registered to PAN	9

The fifth experiment use two identical ZigBee devices which the transmit signals power settings and power source are equal. The transmit power is varied from low to high. The results of the experiments are shown in Table 2. The tests were conducted in a laboratory room where there are other user in the same frequency used by ZigBee. The tests are not conducted in open space and there will be possibility of signal reflectance. These tests are intended to represent ZigBee on its normal usage environment.

TABLE 2. THE EFFECT OF TRANSMIT POWER AND DISTANCE TO THE RSSI LEVEL

Tx Power	Distance (in cm) and RSSI level (in dB)					
	100 cm	200 cm	300 cm	400cm	500cm	600cm
-43 dB	-95	-88	-	-	-	-
-20 dB	-75	-81	-94	-90	-90	-85
-3 dB	-61	-64	-76	-69	-67	-77
3 dB	-56	-72	-54	-60	-57	-65
4 dB	-54	-50	-50	-61	-60	-67

The sixth trial using a single ZigBee device which the time required to run the applications is displayed in a pop-up message to be recorded. Each command will takes different time to run and can be seen directly on the pop-up message. This application is able to provide information on the time required to execute a command in units of milliseconds. Only a scan command are not equipped with this feature since the result will not be accurate.

The seventh experiment produces results similar to the sixth trial. Based on the average of the five time test it is known that to get a response ACK (message received by the destination node) or NACK (the message is not successfully received by the destination node) based on this type of network, the node have to wait for 0.059 seconds in average. The experiment results can be seen in Table 3.

Based on overall experiments conducted, it can be said that the application was made according to the expectations and we can conclude that these applications can help the beginner in learning WSN especially in the visualization of communication between ZigBee devices.

TABLE 3. THE TIME REQUIRED TO OBTAIN ACK / NACK

Trial Number	Time Required (in seconds)
1	0.067
2	0.056
3	0.060
4	0.055
5	0.059
Average	0.059

#### IV. CONCLUSION

ZLeAp application can become one of the tools for learning Wireless Sensor Network (WSN) especially ZigBee. ZLeAp allows users to perform many observations which are used by ZigBee devices in the delivery of real data. ZLeAp can provide simplified real experience on using ZigBee instead of simulations. The application is equipped with the feature to visualize the ZigBee route. The experiment shows that the delivery of data that have been conducted not just follows the shortest path but according to the lowest cost calculation. The scenarios were carried out in the form of experiment are suitable to be used for the guide in learning WSN. With this learning tool, academics who will be working with ZigBee can be able to have a better understanding about the devices in real circumstances and real time, especially in the route formation of the data transmission.

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# Improving Performance of Intrusion Detection System Using OpenCL Based General-purpose Computing on Graphic Processing Unit (GPGPU)

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**Abstract**—With the increased connectivity of computer devices including mobile devices to the Internet, the volume as well as the type of information that moved through organization network perimeter are also growing significantly. Consequently, this has heightened information security threats to organizations that rely on the Internet to do their businesses. On the other hand, Intrusion Detection System (IDS) being used today to detect these threats is limited by a single threaded application, limiting its capability to cope with the growing network traffic. This research introduced a parallel intrusion detection system based on GPGPU and Open Computing Language (OpenCL), that processes incoming packets concurrently, thus increasing system capacity in a high throughput environment. The experiment result shows that performance of GPU-based design is improved on the average of 58.73x against a single-thread central processing unit (CPU) implementation, and on the average of 13.53x against a multi-thread implementation. At the same time, GPGPU-based system has a performance gain of 29.92 compared with CPU-based system implementation.

**Keywords**—Intrusion Detection System, Graphic Processing Unit, GPGPU, Parallel Computing, OpenCL.

## I. INTRODUCTION

With the rapid growth of number of computing and network devices that are connected to the Internet, the need of high speed network becomes obvious. This situation also increased the information security threats faced by the organization, thus the required security monitoring system, such as IDS also need to cope with the rising network traffic volume and threats. Hence, conventional IDS that relies on the single-threaded application has become obsolete, since IDS may miss many of the malicious packets flowing through the network. With a higher traffic rate, conventional CPU-based IDS system becomes less viable solution to this problem.

Conventional IDS can be categorized as Single Instruction Multiple Data (SIMD) system, in which all the data is processed using a single instruction set. These instructions are pattern rules in IDS, created and modified from time to time by network administrator to detect possible security intrusion. Hence, as the number of possible intrusions increases, the pattern rules need to be processed by the system also increase. Modern GPUs are powerful SIMD Engine, and they perform same instructions across multiple streams of data. Graphical processing, which inherently a SIMD operation (e.g. a single

instruction can be used to blur multiple pixels) has long enjoyed the power of GPU for many years now. Thus, given the same instructions, GPU can process a lot more data in a single clock cycle than CPU. Figure 1 shows simplified SIMD engine processing multiple data.

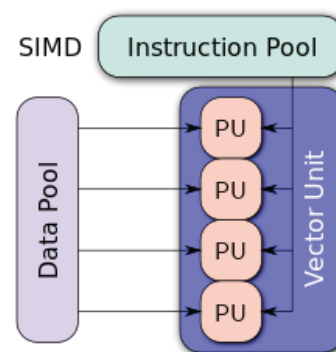


Fig. 1. SIMD Diagram (simplified) [1]

GPU has been used to perform other non-graphical related operations, such as IDS [2], firewall [3], cryptography [4], hashing [5], and data compression [6]. Vasiliadis et al [2] showed that it is possible for GPU to perform pattern matching operations, as the pattern rules can be seen as the image filter (a series of instructions) and the packets can be seen as the pixels (data). In his research, Vasiliadis used Nvidia GPU [7] to implement IDS. This platform along with its Compute Unified Device Architecture (CUDA) programming API [8] is indeed a mature GPGPU development environment. However, we argue that by implementing OpenCL [9], which is an open and cross-platform, can provide more advantages, especially to a rising number of different computing devices, based on multiple architecture such as x86, ARM, GPU, and co-processor.

Following are the organization of the paper: Section II summarizes the related works, Section III discusses our system architecture, Section IV and V describe our experiment setup and experiment results respectively, Section VI presents the discussion of our experiment results and VII concludes our research.

## II. RELATED WORKS

IDS monitors possible intrusions by matching the incoming packets with the rules stored in IDS databases. Thus, matching string patterns in the IDS is highly CPU-intensive tasks [10]. GPU originally designed for processing graphical related computing has been used to offload the pattern-matching computation from CPU, releasing CPU to perform other more sequential computation [11], [12], [13]. Multi-pattern string matching algorithm such as Aho-Corasick [14], Wu-Manber [15] and Commentz-Walter [16] has been introduced to achieve a higher overall performance of the matching computation. Vasiliadis et al [2] showed that using Aho-Coarsick algorithm, GPU is able to increase performance up to 3.2x CPU speed. However, he also showed that GPU is only effective when the packet is larger than 100 bytes.

Schatz et al [17] also showed that Cmatch, a CUDA based string matching that run on Nvidia GPU, performance improvement up to 35x, compared with equivalent CPU implementation of the software. In addition, Smith et al [18] showed a detail analysis of how SIMD suitable for signature matching at packet level. The implementation was done on Nvidia G80 GPU and it was shown that GPU outperforms CPU at the time by 9x. Narasiman et al [19] showed that GPU performance can be improved by about 17% using high number of threads executing the same code into fixed sized batches, called warps, reducing the IO waits between tasks.

In his recent research, Vasiliadis et al [20] also showed that using hybrid architecture, a combination of CPU and GPU, with stateful packet processing could provide multi-gigabit forwarding rate and could potentially achieve 16.2 speedup compared with GPU implementation with the same application. Nevertheless, almost all of the implementation of GPU is using Nvidia CUDA for string matching for packet inspection processing. In this paper, we propose a GPU-based implementation of Bro [21], an open source IDS, based on OpenCL using naive algorithm to detect malicious web query traffic.

## III. SYSTEM ARCHITECTURE

The system comprises of several components from multiple software, including core system, which is based on C++ and other supporting system. Packets are pre-parsed packets as they are received and passed to the GPU. Bro [21] was chosen due to its ability to handle high load of network traffic and allow custom algorithms to be implemented in various detection schemes [22]. Parsing results are then passed to the core utilizing pipe, an inter process communication (IPC). The OpenCL codes are implemented in the GPU core to process packets received from the CPU. Once the core completed its tasks, the results are then sent to the reporting system. Fig 2 shows the overall system architecture. Bro and core subsystem is hosted in CPU-based system, and OpenCL subsystem runs on the GPU-based system.

### A. Core Subsystem

Core subsystem encompasses tasks to initialize Bro subsystem and to request OpenCL subsystem to process the newly received packets. The core also handles sending the results to the reporting subsystem for further analysis. To

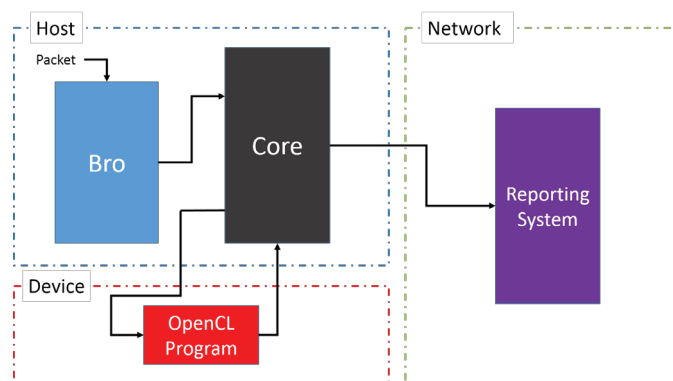


Fig. 2. Accelerated IDS architecture

ensure maximum utilization, each incoming packet is handled by different thread by the core subsystem. In addition, the subsystem also ensures that pipe created between the core subsystem and Bro is non-blocking mode. Similarly, reporting subsystem uses new thread for each request received sent by core subsystem.

### B. Bro Subsystem

This subsystem implements Bro [21] to capture incoming packets and performs pre-process based on the given criteria. The meta-data and data of the packet are then converted to a preferred format before being sent to the core subsystem. Incoming packets are parsed and further processed using pre-defined Bro script, which essentially define the filtering method format used. The result is then sent through pipe to the core subsystem for further processing.

### C. OpenCL Subsystem

OpenCL subsystem runs inside GPU performing string search and pattern matching algorithm. Input strings are parsed into multiple chunks of strings, simultaneously matched with the substring. The matching algorithm used in this research is a naive algorithm, in which the input string is compared with a target substring character-by-character. If one of the character does not match it then returns false, if it does match it will continue to loop. The loop will stop when it has performed the full length of the pattern then it returns true. Figure 3 shows OpenCL string search process flow.

### D. Reporting Subsystem

The reporting subsystem has 2 unique functions: reporting and controlling. The reporting function validates the result from Bro subsystem to the control data on the host. The result is stored if it is valid and compiled before presented as a report. The other function is to control the entire test process by checking whether the system is ready for running. Figure 4 summarizes the overall system process flow.

## IV. EXPERIMENT SETUP

### A. Hardware Specification

For our research, we use the following CPU specification:

- Processor: AMD FX-8120 Eight-Core Processor



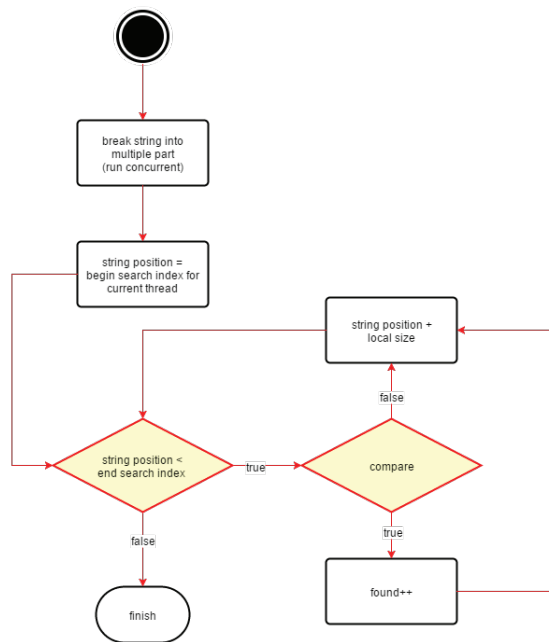


Fig. 3. OpenCL String Search process (detail)

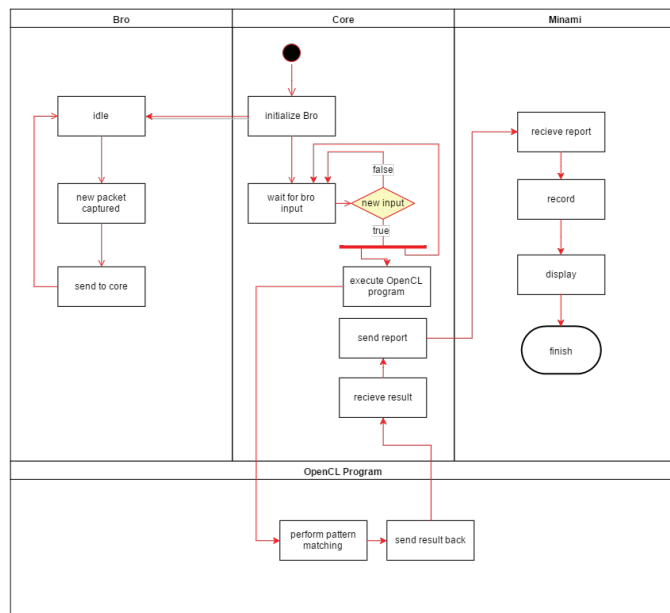


Fig. 4. Overview of the system process flow

- System Memory: 2 x 4 GB DDR3 667 MHz

and the specification of GPU is as follow:

- Processor: AMD Radeon R9-270x
- Compute Unit: 20
- Memory Capacity: 2048 GB
- Memory Bandwidth 179.2 GB/s

### B. Network Architecture

Figure 5 shows the overall network connecting testing servers (sending and receiving servers), IDS and reporting

server. The network comprise of two dedicated subnets. One subnet is dedicated for testing purpose, while the other is for monitoring, reporting and control. The testing subnet is used to transport testing data between sending server and receiving server. When the IDS receives the marked data (i.e. data that matched the rule) it then sends report via reporting channel/subnet.

Since Bro is a passive IDS network infrastructure, it is configured to tap the testing subnet between the client and server computers, allowing the IDS to obtain all data passed between client and server computers. The IDS has two interfaces, one is connected to the tap (dedicated for capturing packets) and the other one is connected to the reporting subsystem (dedicated to send intercepted packet).

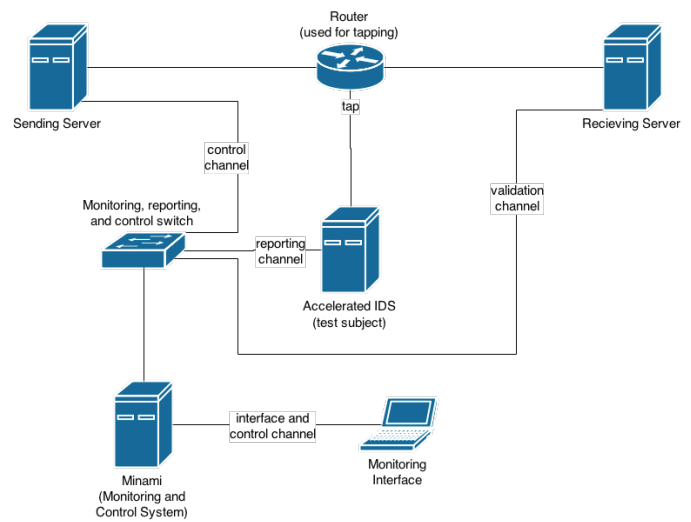


Fig. 5. Network architecture diagram

The receiving server is also connected to the second subnet and this subnet is used for data validation. When testing is complete, reporting subsystem validates both data from IDS and receiving server. If both data is valid, i.e. the same, it means the test has been conducted successfully and no data is dropped. The processing time is then calculated for performance measurement.

The reporting subsystem is connected to the host (server that runs IDS) through the second subnet (monitoring, reporting and control subnet) to ensure that the traffic sent by the client and server does not interfere with the control and reporting traffic. Thus, each of the server is equipped with 2 networking interface cards, and each network card is dedicated to each of the subnet.

### C. Rules Execution in CPU and GPU

Rules in IDS are basically strings to be matched with the incoming string. For CPU version, the string matching is performed in a iterative manner depending on number of rules to be matched. On the contrary, GPU, depending on number of concurrent threads supported, runs the string matching on a number of threads concurrently while others are queued. Modern GPU can easily supports thousand of threads for optimum utilization. Thus, handling threads properly is a

critical factor to provide optimized results. Figure 6 and 7 show pseudo code for CPU and GPU respectively.

```
foreach rule in ruleSet
    foreach searchPos in searchArea
        if rule == string
            rule.violationCount++
```

Fig. 6. CPU pseudo code string search

```
foreach searchPos in searchArea
    if rule == string
        rule.violationCount++
```

Fig. 7. GPU pseudo code string search

## V. EXPERIMENT RESULT

### A. Initial Experiment

Our initial experiment focuses on getting Bro to run and making sure that OpenCL code runs in multi-threading capable environment. Once the packets have been captured and sent to core subsystem, then to OpenCL subsystem, string matching can be performed immediately. Initial experiment result is summarized in figure 8. The figure compares CPU, Threaded CPU and GPU performance in terms of number of rules per seconds that it can handle respectively.

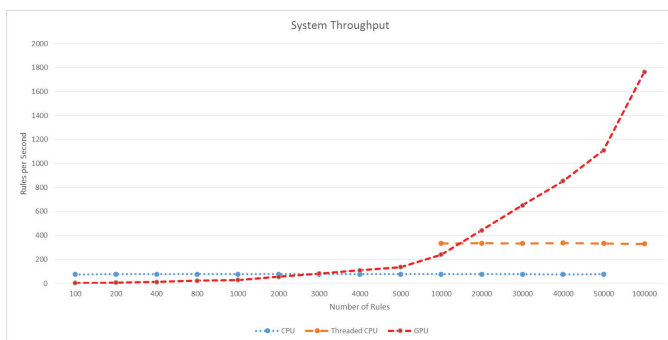


Fig. 8. Performance Comparison (rules per sec)

It is obvious from the figure 8 that GPU starts to show its advantage over single-thread CPU when the number of rules processed more than 3000. On the other hand, GPU overtakes CPU (multi-thread enabled) at around 15000 rules. In addition, we can also observe that performance of CPU (either single-thread or multi-thread) stays “flat” with the number of rules to processed increased, while GPU performance continue to increase as the number of rules increased. The fact that GPU is capable to handle more rules as the number of rules to be processed increased provides a good indication for our research.

### B. Optimizing GPU

During the experiment, it was found that the initialization overhead is about 36 seconds, which is a huge disadvantage for small number of rules to be processed. This overhead is due to OpenCL kernel construction, which called multiple times, to provide multi-threaded dispatcher function. These codes

did not actually improve performance but degraded it instead. With some modification and optimization, the performance was improved by a factor of 11.2 and the reduction of overhead time was about 93%. The optimized code now has a new overhead of about 2 seconds. Figure 9 shows the performance before and after the optimization.

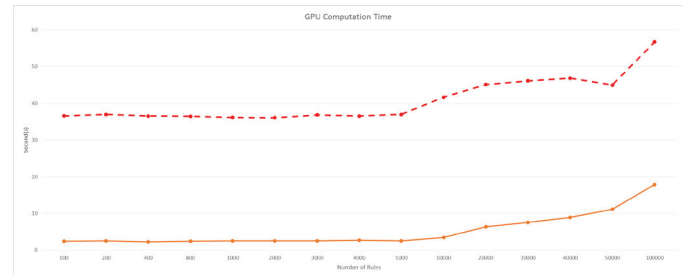


Fig. 9. Performance Comparison - Before (red; dotted) vs After GPU Optimization (orange; solid)

Once the GPU is optimized, the system throughput is recalculated to obtain the final results. Table I and figure 10 shows performance comparison in terms of computation time and system throughput respectively for CPU (single and multi-thread mode) and GPU (before and after optimization).

TABLE I. PERFORMANCE COMPARISON CPU VS GPU - COMPUTATION TIME (SEC)

No. of Rules	CPU	Threaded CPU	GPU	Optimized GPU
100	1.34	N/A	36.59	2.49
200	2.65	N/A	36.96	2.53
400	5.26	N/A	36.55	2.31
800	10.49	N/A	36.48	2.48
1,000	13.07	N/A	36.17	2.53
2,000	26.19	N/A	36.09	2.57
3,000	39.08	N/A	36.84	2.55
4,000	52.35	N/A	36.57	2.69
5,000	65.12	N/A	36.98	2.58
10,000	131.25	29.97	41.66	3.49
20,000	260.90	59.71	45.11	6.36
30,000	390.61	90.10	46.13	7.61
40,000	531.94	119.05	46.87	8.90
50,000	651.97	150.23	45.00	11.11
100,000	N/A	303.20	56.71	17.90

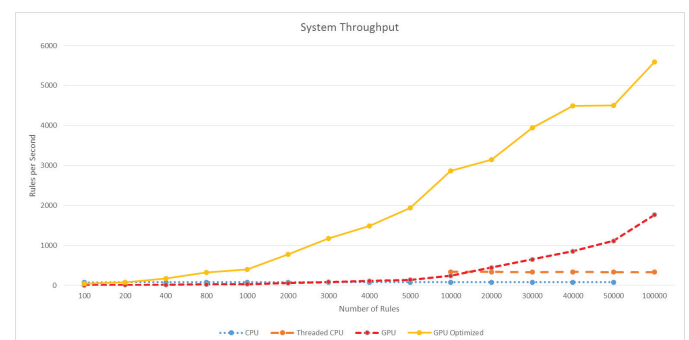


Fig. 10. System throughput (rules per sec)

Looking at the figure 10, it is clear the GPU(optimized) has a performance gain over CPU (multi-thread) in terms of rules per sec by a factor of 9 at the 10,000 rules and by a factor of 19 at the 100,000 rules.

## VI. DISCUSSION

Even though GPU is designed to speed up computation time, GPU will perform worst than CPU when the number of rules to be processed below certain threshold; in our case the threshold is 3000 rules. This confirms that GPU is only effective with more data to process and CPU should be used instead for low number of rules to be processed. Our implementation uses OpenCL and OpenCL code should be implemented correctly to reduce overhead in initializing the GPU process. Furthermore OpenCL optimization may improve the overall processing time. In addition, computation speed up obviously can be improved by using a faster string match algorithm (current implementation uses naive algorithm). Table II summarizes the performance gain comparison in terms of Average Computation Time, Average Rules Per Second.

TABLE II. PERFORMANCE GAIN COMPARISON - CPU VS GPU

Metric (Average)	CPU	GPU	Performance Gain
Computation time (sec)	155.87	5.21	29.92x
Rules per second	76.20	2,061.56	27.05x

## VII. CONCLUSION

Design of GPU based on OpenCL for speeding string matching process inside IDS has been presented. A proof of concept IDS system based on GPU has been tested and results are promising. At 50,000 rules, after optimization, GPU-based system improved on the average of 58.73x against CPU-based (single thread) system and 13.53x against CPU-based (multi-thread) system. Performance gain for computation time of GPU over CPU is a factor 29.92 and a factor of 27.05 for processing rules speed (rules per second).

Our current limitation include using naive algorithm in our experiment, further improvement is expected when faster string matching algorithm is used such as using Aho-Corasick [20]. Another area of improvement may include further OpenCL code optimization and balancing loads between CPU and GPU to maximize performance of the overall system.

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# UTAR NoC: Adaptive Network on Chip Architecture Platform

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**Abstract** - Network-on-Chip (NoC) has been proposed as a solution for the communication challenges of Multi-Processor System-on-chip (MPSoC) design in nanoscale technologies and it has better reusability and scalability. However along with the advantages of any communication parameter follow its disadvantages. Most state-of-the-art NoC architecture and their design flows is optimized for a single application, and no single NoC can provide optimal performance across a wide range of applications. In this research, a reconfigurable and adaptable Network-on-Chip architecture is proposed. Adaptive routing components are designed to enable the router to select a path with less congestion. Parameterize file is designed to enable the NoC to be reconfigured and scalable.

**Keywords** – Network on Chip, MPSoC, RTL, Platform, Adaptive Routing.

## 1. Introduction

Increasing the speed of the System-on-Chip (SoC) clock and packing functionalities in a single die are traditional ways to improve processor performance. Both of these techniques are readily aided by the ever relentless development in processing technology down the Moore's Law curve where system clock speed breached the microwave frequencies and gate packing density is doubled every 1.5 years or so [1]. However, power losses at ultrahigh frequencies in CMOS outweighed the power saving benefit CMOS brought to IC implementation which was significantly obvious at lower frequencies. Multi-processor System-on-Chip (MPSoC) has come out as the way forward in the pursuit of processing performance improvement.

An MPSoC may well contain several hundreds or thousands of processors, including microcontrollers, various on-chip memory modules, hardware accelerating units, and peripheral control devices. The communication architecture of MPSoC plays a major role in defining the area, performance and energy consumption [2]. The traditional communication architecture such as bus, switch matrix and arbiter are no longer suitable to support inter-processor communication and sharing of resources. They cause severe on-chip synchronization errors, unpredictable delays, and high power consumption [3].

The Network-on-Chip (NoC) has emerged as a promising alternative to classical bus-based and point-to-point (P2P) communication architecture [4] [5] [6]. NoC communication paradigm was adapted the most from the terminologies and methods in the computer networking area. The advantages of NoC are numerous and obvious. It offers better scalability, performance and power consumption [2]. Despite of all the NoC advantages, prior work shown most state-of-the-art NoC architecture and their design flows is optimized for a single application [7], and no single NoC architecture has been found to provide optimal performance across a range of applications [8].

In this research, an MPSoC with parameterized NoC implementation is proposed. The purpose of the research is to implement NoC architecture that is reconfigurable and adaptable for a large class of applications. Mesh and Torus have been selected as topologies in the proposed system. Mesh topology has been considered more by designer due to its simplicity. The main problem for mesh is its long diameter that has negative effect on communication latency. Torus topology was proposed to reduce the latency of mesh while maintaining its simplicity. Adaptive and deterministic XY routing is applied in the proposed system. A NoC traffic pattern generator based on real applications has been developed as a tool for verification, evaluation, architectural exploration and benchmarking. A NoC traffic pattern generator is an essential tool for NoC performance evaluation and architecture design. The traffic pattern used is based on research work at the Hong Kong University [9]. The implementation for NoC traffic pattern generator and the verification platform for UTAR NoC are not covered in this paper.

## 2. Literature Review

In the NoC-based System on Chip, the components of the chip are divided into multiple Processing Blocks (PBs). One PB can contain one or a group of components that forms a subsystem inside this PB. All of the PBs are interconnected via routers. A router can be connected to one or more neighbour routers depending on the topology of the network [10]. Figure 2.1 Shows example of an Mesh NoC topology.



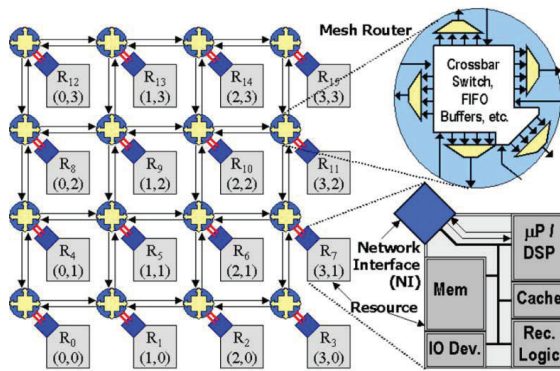


Figure 2.1 Mesh NoC Topology [10].

With its architecture constructed based on multiple routers and the packet switched data sharing method, NoC has become the solution of choice for the problems that are faced by traditional interconnects [11]. The design of NoC can be divided in various aspects such as the topology, routing, flow control, and router microarchitecture. Topology determines the physical layout and connections between nodes and channels in the network. Topology design has an important role in determining the routing strategy and the application mapping [2]. Topology design starts with decision on the basic typical network topology to be implemented for example, tree, ring, star, or mesh topology. Optimization and additional feature are then implemented to improve these basic topologies such that new and more complex interconnects are formed. For example, the Quarc NoC architecture is an improved ring NoC topology [12]. Floor-planning and layout of the NoC architecture need to be considered as well [13].

Routing algorithm determines the path through the network that a message will take to reach its destination. A routing algorithm's ability to balance traffic has a direct impact on the throughput and performance of the network. Flow control determines how resources are allocated to messages as they travel through the network. Another challenge come from the communication design aspect, such as the routing algorithm, congestion control, energy and power management, as well as the reliability and fault tolerance [2]. All these design aspects have become the focus of researchers. Many researchers studied routing algorithm [14] to improve the quality of service (QoS) [15] or to improve power management [16] [17].

Router microarchitecture comprises the following components: input buffer, router state, routing logic, allocators and a crossbar. Developing efficient channels is largely a circuit design problem. Router performance, cost and efficiency primarily depend on its microarchitecture [18]. Input-queued routers have emerged as the architecture of choice in current NoC research. Flits that cannot be

forwarded immediately are temporarily held in FIFO buffers at the router's input port until they can proceed to next hop. Figure 2.2 illustrates a typical NoC router microarchitecture.

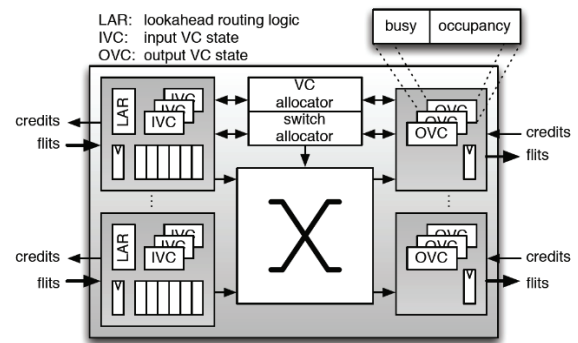


Figure 2.2 Typical Router microarchitecture overview [18].

Application modelling and optimization is another challenge in a NoC-based MPSoC. Every application has different communication traffic pattern, even for the same application, different application mappings will significantly affect the network traffic. A good understanding of the traffic patterns and system requirements helps in determining the optimal network topology, this has a huge impact on design costs, power, and performance [19]. Accurate application modeling and mapping help to define the communication paradigm design decisions. NoC are usually design for a specific application [20]. An example of previous work is an NoC architecture designed for video encoder application [21]. Another previous work is an NoC designed for image and signal processing applications [22]. Other previous works show that no single NoC can provide optimal performance across a wide range of applications [23].

NoC architecture design and application modeling validation and evaluation are other challenges. Power consumption, die size and other performance and physical characteristic metrics need to be determined as early as possible. Latency or system throughput of NoC architecture are the main performance metrics that should be considered [2]. Other researchers provide analytical power models for early power consumption investigation [24] [25]. Simulation time and accuracy are the tradeoff in designing simulation model. Virtual prototyping platform for NoC system is built to improve accuracy of characteristic prediction and also for early software-hardware co-verification [26].

The mesh and torus topologies are adopted for the proposed NoC architecture. They are chosen due to their simplicities. Adaptive and deterministic routing algorithms are implemented in the proposed system. The focus of the adaptive routing algorithm is to achieve minimum number of hops in path selection and balance all of the flits over all possible paths. To evaluate the performance of the NoC

architecture, an NoC traffic pattern generator based on real application is made as a benchmark program. The NoC traffic pattern generator UVC is implemented using UVM. The implementation of the NoC traffic pattern generator UVC is not presented in this paper. Throughput and average latency of the whole system in running all of the applications with traffic pattern generator is measured. Another NoC system is built to get comparison results. The second NoC is generated from CONNECT, an NoC generator tool from a Carnegie Mellon University project [27].

### 3. Router Microarchitecture

In this chapter, the design of UTAR NoC architecture is presented. The UTAR NoC is composed of a number of UTAR NoC Routers. The number of the router depends on the size of the network itself. Figure 3.1 shows the overview of UTAR NoC router. The UTAR NoC router have 5 ports connections which are the North, East, South, West and PB connections. There are 8 pins for each port of the routers. **flit\_in** pins is for the incoming flit from neighbour router or PB to the router. **EN\_flit\_in** pins is for the enable signal of the incoming flit to the router. **flit\_out** pins is for the outgoing flit from the router to the next neighbour router. **EN\_flit\_out** pins is for enable signal of the outgoing flit to next router the incoming flit to the router. **credit\_in** pins is for incoming credit from neighbour router or PB to the router. **EN\_credit\_in** is for the enable signal of the incoming credit to the router. **credit\_out** pins is for outgoing credit from the router or PB to the neighbour router. **EN\_credit\_out** pin is for the enable signal of the outgoing flit from the router.

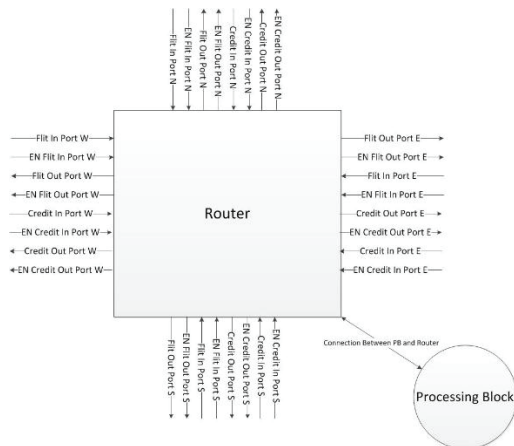


Figure 3.1 Overview UTAR NoC Router

The size for all of the pins are parameterized. In this research, 75 bits length are used for flit\_in and flit\_out pin, 2 bits length for credit\_in and credit\_out pins, and 1 bit length for all of the enable signal. The proposed router has standard fields for the flits as shown in Figure 3.2. The “valid\_bit” field defines the validity of a flit. This field will be set as one when sending a new flit. The “is\_tail” field determines whether the flit is a

tail flit or not. A large packet can be broke down into several flits, and a tail flit is the last flit of this group. The Destination field provides the information of the flit destination address. The width of this field may vary depending on the size of the network. The Virtual channel field indicates which Virtual Channel (VC) is to be used to send out the flit. The Source field provide the information of the flits sender address. The last field is the data field.

valid_bit	is_tail	destination	virtual channel	source	data
1-bit	1-bit	8-bit	1-bit	8-bit	56-bit

Figure 3.2 UTAR NoC flit fields

The signal that connect to each router can be grouped into two categories of ports, which are Send ports and Receive ports. The Send port is used to send flits and received credits, while the Receive port is used to receive flits and send credits. Figure 3.3 shows the timing diagram of the router while transmitting flits and receiving credits on the send ports. The EN\_flit\_out pin is pulled high by router every time it send out a flit. The bit number 75 of the flit\_out pin (valid\_bit) needs to be driven high when the EN\_flit\_out pin is high to indicate that the flit to be sent is valid as can be seen in the timing diagram at the second clock cycle.

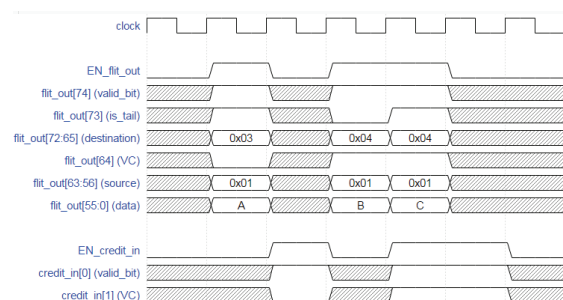
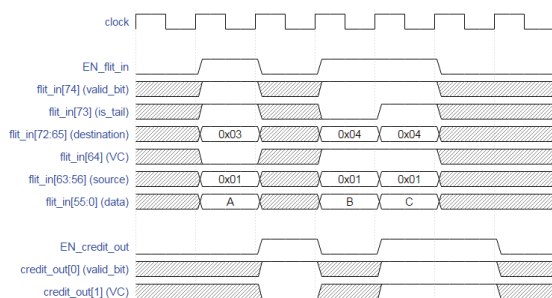


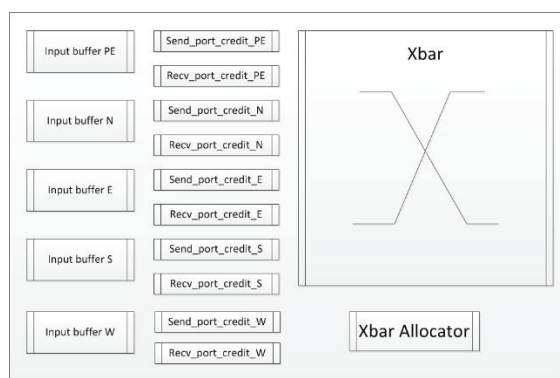
Figure 3.3 Transmit flit and receive credit timing diagram

The router will send the flit through the network using the VC 0 by pulling down the flit\_out[64] (VC) pin. At the fourth and fifth clock cycles, the router sends two more flits with different destination from the first flit and set the VC as 1. A flit can be considered as a tail flit if the flit\_out[73] pin is set high. The receiving router will drives a same number of credits with the amount of received flits. The EN\_credit\_in is pulled high by the receiving router to indicate there is a credit incoming. At the third clock cycle of the timing diagram in Figure 3.3, the receiving router drives a credit by pulling the credit\_in[1] pin high. The credit indicates that the flit that was sent by the router is leaving the buffer inside the receiving router. Pin credit\_in[0] (VC) is low at this cycle refer to the VC index of the sent flit at the second clock cycle. At the fifth and sixth clock cycles, the receiving router sends another two credits.



**Figure 3.4 Receive flit and transmit credit timing diagram**

Figure 3.4 shows the timing diagram for receiving flits and sending credits on the receive port. The sending router drives the EN\_flit\_in pin and flit\_in[74] (valid\_bit) high every time there is a new flit. The content of the flits is obtained from flit\_in pins. The router sends a credit back to the sending router every time the sent flit is leaving the router. It is done by pulling high the EN\_credit\_out pin and credit\_out[1] pin. The credit\_out[0] pin value follows the value of the VC field of the received flit.



**Figure 3.5 UTAR Router Microarchitecture**

Figure 3.5 shows the microarchitecture of the UTAR NoC router. The router has five input ports and output ports corresponding to the four neighbouring directions and the local processing element (PE) port. The major component which constitute the router are input buffer, route computation logic, virtual channel allocator, switch allocator, credit mechanism, and crossbar switch. UTAR NoC router is input-buffered, in which packets are stored in buffer only at the input ports. The buffers are responsible for storing flits when they enter the router, and housing them throughout the duration in the router. The route computation logic determines all of the path from the source of the flit to its destination. The allocators (VC and crossbar) determine which flits are selected to proceed to the next stage where they traverse the crossbar. The Credit mechanism takes its role in the flow control protocol. Finally the crossbar switch is responsible for physically moving flits from the input port to the output port.

#### 4. Routing Algorithm Logic

The Routing algorithm decides which path a message will take through the network to reach its destination. The goal of the routing algorithm is to distribute traffic evenly among the paths supplied by the network topology, so as to avoid hotspots and minimize contention, improving network latency and throughput. All of these performance goals must be achieved while adhering to tight constraints on implementation complexity. Routing circuitry can stretch critical path delay and add to a router's area footprint. While energy overhead or routing circuitry is typically low, the specific route chosen affects hop count directly, and substantially affects energy consumption [28].

Routing algorithm are generally divided into three classes; deterministic, oblivious, and adaptive. While numerous routing algorithm have been proposed, the most commonly used routing algorithm in NoC is dimension-ordered routing (DOR) due to its simplicity. DOR is an example of a deterministic routing algorithm, in which all messages from node A to B will always traverse the same path. Another class of routing algorithm is the oblivious, where messages traverse different paths from A to B, but the path is selected without regard to network congestion. A more sophisticated routing algorithm is obviously the adaptive, in which the path a messages takes from A to B depends on network congestion situation.

Adaptive routing can be restricted to taking minimal route between source and the destination. An alternative option is to employ misrouting, which allows a packets to be routed in a non-productive direction resulting in non-minimal paths. When misrouting is permitted, livelock becomes a concern. Without mechanism to guarantee forward progress, livelock can occurs as a packet is continuously misrouted so it will never reach its destination.

Adaptive routing algorithm need mechanism to track network congestion levels, and update the route. Many congestion sensitive mechanism have been proposed, with the simplest being tapping into information that is already captured and used by the flow control protocol, such as buffer occupancy or credits [29] [30]. In this research minimal adaptive routing is implemented, due to its performance to balance the flits in all possible paths, free of deadlock and minimize power consumption by maintaining minimum hop. Figure 4.1 shows all possible minimal routes that a message can take from node (0,0) to node (2,3).

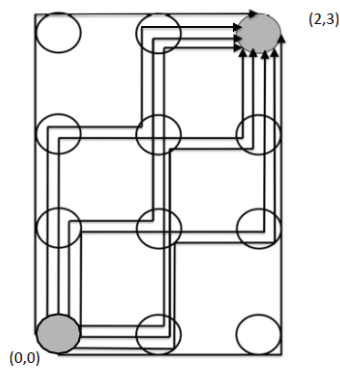


Figure 4.1 All possible path with adaptive routing

### 5. Test Scenario

To get the comparison result, another NoC system is built. The second NoC is generated from CONNECT. In this research, six applications from the MCSL traffic suite are used for the network architecture study and benchmark. The applications are RS 32 bit encoder and decoder, Newton-Euler dynamic control calculation for the 6-degrees-of-freedom Stanford manipulator (ROBOT), chemical program performing multi-electron integral derivatives (SPEC95 Fpppp), fast fourier transform with 1024 inputs of complex numbers, and random sparse matrix solver for electronic circuit simulations.

All of these applications is run with 100%, 50% and 20% processing time. The purpose of this scenario is to simulate the behaviour of the NoC with faster processor which mean the task finish faster and the data rate goes to the network is much more compare with the slower processor. To scale down the processing time of each task from RTP, scale down tool is built based on C program. Full code for the scale down tools are available upon request.

In this research implemented three configuration for the network size; 2x2, 4x4, and 8x8 network. For the topology, torus and mesh are selected. All of the application is run for UTAR NoC and CONNECT NoC. They both have the same configuration and scenario.

### 6. Result and Analysis

Figure 6.1 shows the graphs of the network throughput for mesh 2x2 topology with Fast Fourier Transform (FFT). CONNECT NoC, UTAR NoC with adaptive and deterministic routing are compared. All of the graph is normalized to the result from CONNECT NoC. The graphs shows that UTAR NOC with adaptive routing have a slightly advantages compare to the other two. This is expected, due to the topology of the network itself. Because of the network mesh 2x2 do not have many possible path.

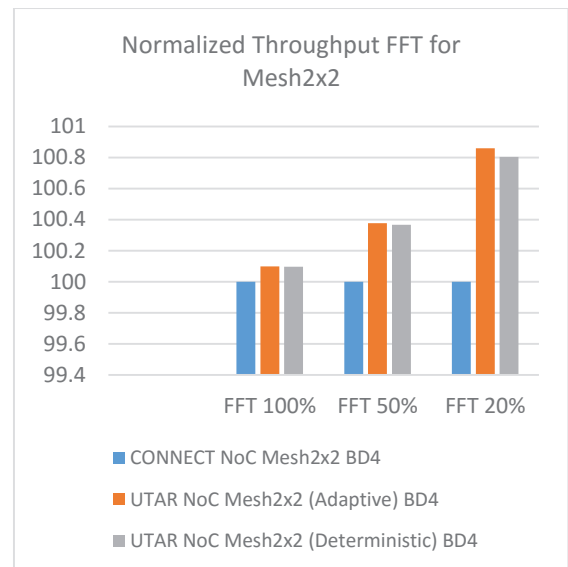


Figure 6.1 Normalized Throughput FFT Mesh2x2

Figure 6.2 shows the possible path from Mesh 4x4 and Mesh 2x2. For example node 0 in Mesh 4x4 topology wants to send a packet to node 15, in this network it has more possible path to choose to send the packet from node 0 to node 16. Meanwhile in Mesh 2x2, to send a packet from Node 0 to Node 3 it only have 2 possible path. This shows that adaptive routing is not make a big difference in a smaller network

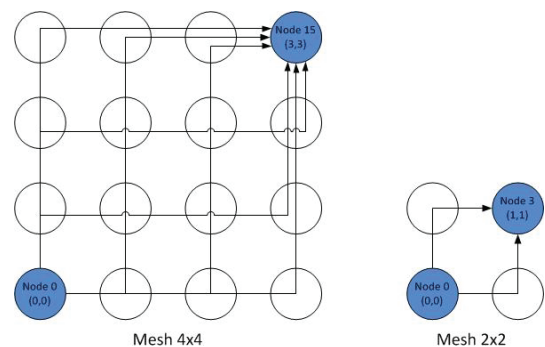
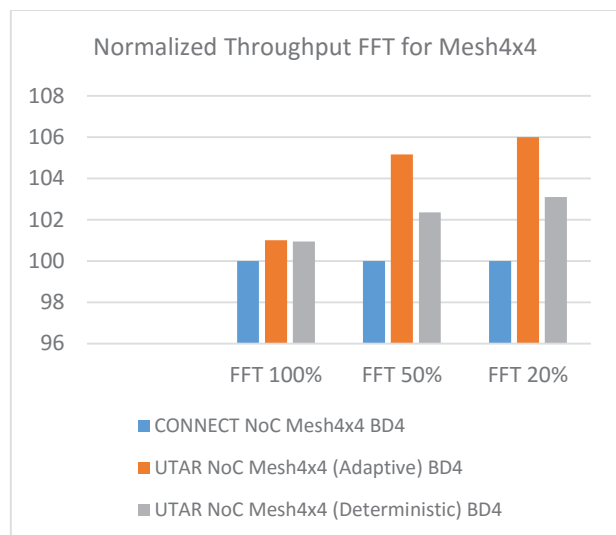


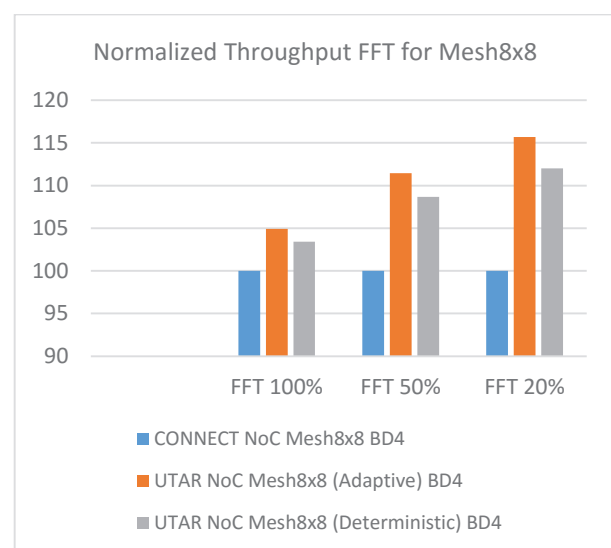
Figure 6.2 Example of possible paths in a different network size

Figure 6.3 and Figure 6.4 shows the throughput for mesh 4x4 and mesh 8x8. The chart shows that the throughput of the UTAR NoC with adaptive routing algorithm is higher from the rest. The throughput is even higher when the processing time for FFT task is reduced. The increase happen due to the faster processing time, means more packets or flit that travels inside the network, makes the network more congested. This where adaptive routing took part, since the network is congested, the adaptive routing balance all of the packets or flit to all possible path.





**Figure 6.3 Normalized Throughput FFT for Mesh4x4**

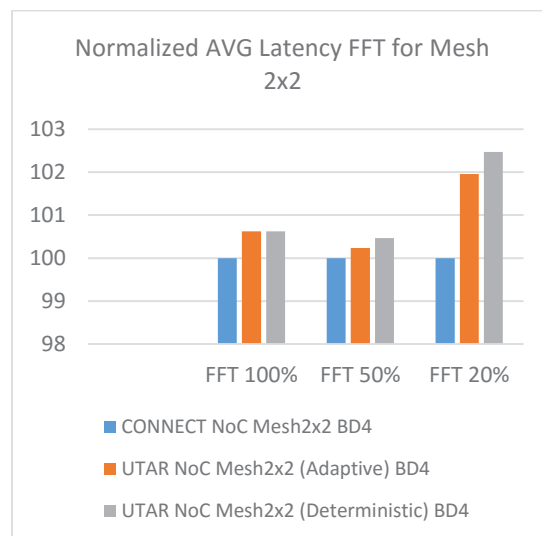


**Figure 6.4 Normalized Throughput FFT for Mesh8x8**

The average latency result for mesh 2x2 with FFT as the application is shown in the Figure 6.5. The average latency result from UTAR NoC with adaptive is higher compare the other. The reason is due to the limitation of possible path, so most of the flits is stacking on the same path makes the latency higher.

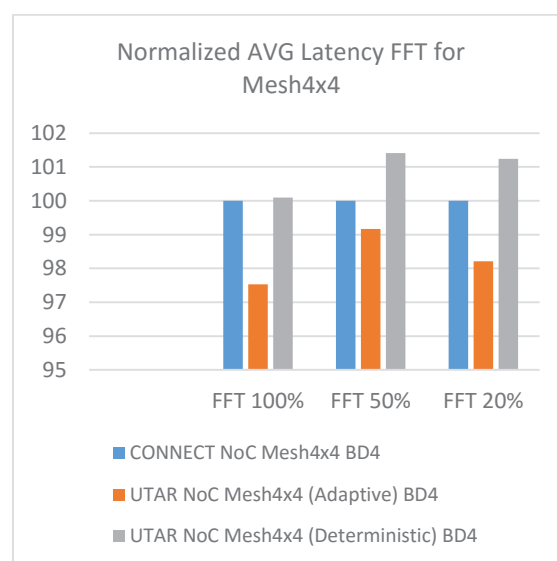
For an ideal network, it should support both high bandwidth and low latency, there often exist a trade-off between these two parameters. A network that supports high bandwidth tends to keep the network resources busy, often causing contention for the resources. Contention occurs when two or more messages want to use the same shared resource in the network. One of these messages will have to wait for that resources to become free, thus increasing the latency of the

messages. By reducing the bandwidth demands, latency would be also lowered.



**Figure 6.5 Normalized AVG Latency FFT for Mesh 2x2**

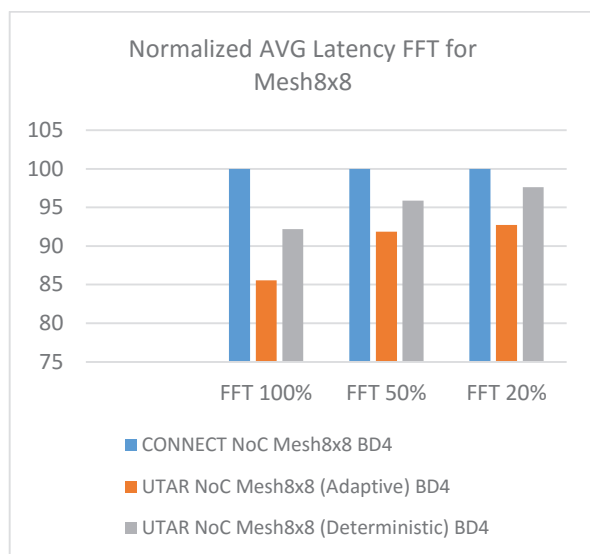
Meanwhile in Figure 6.6 and 6.7 shows the result average latency for FFT with 4x4, and 8x8 mesh topologies. Once again the UTAR NoC with adaptive routing shows better result than the others.



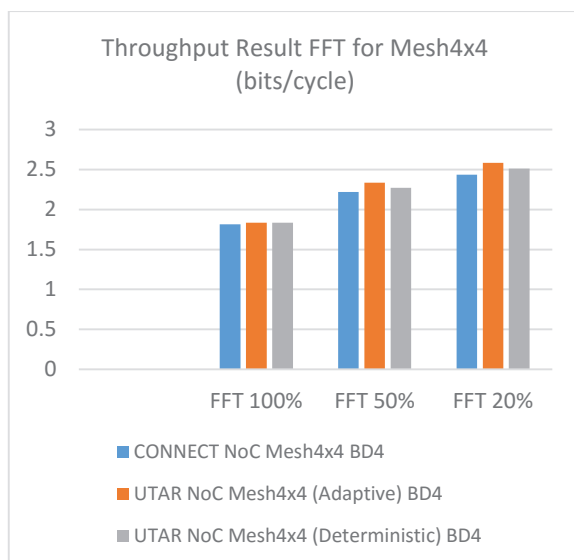
**Figure 6.6 Normalized AVG Latency FFT for Mesh 4x4**

However, the throughput result shown an improvement when processing time is decreased, while the average latency of the system is getting worse when the processing time is decreased. This shows that the volume of the data inside the network is a trade-off between higher throughput and lower average latency. This trade-off is shown in Figure 6.8 and Figure 6.9. Figure 6.8 and Figure 6.9 are the *normal* (Not Normalized to Connect NoC result) results of throughput and

average latency for mesh 4x4 topology with FFT as the application. This trade-off not only applied in this result, the rest of the results also shows the same graph characteristic.

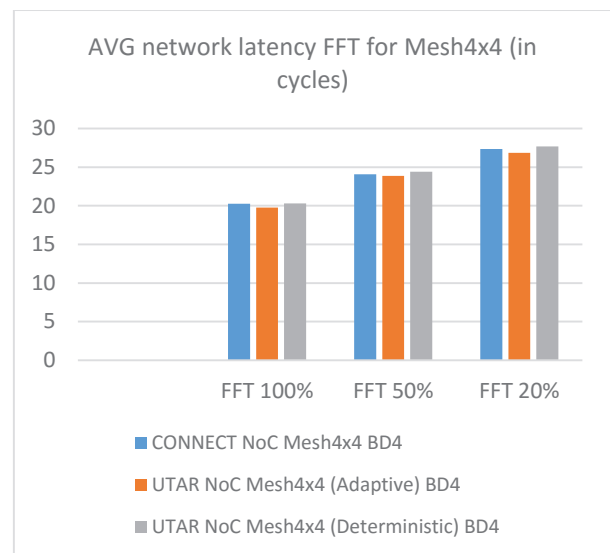


**Figure 6.7 Normalized AVG Latency FFT for Mesh 8x8**



**Figure 6.8 Throughput Result FFT for Mesh 4x4 (bits/cycle)**

All of the result above are from simulation with FFT as the application. The rest of the simulation with other application are available upon request. And all of them share the same characteristic.



**Figure 6.9 AVG network latency FFT for Mesh 4x4 (in cycles)**

## 7. Conclusion and Recommendation

The test are conducted to evaluate the performance of proposed NoC, exposed the characteristic of the NoC, and it could be concluded that:

- The communication architecture in UTAR NoC platform with adaptive routing algorithm offers a better performance in term of throughput for a large class of application. Better throughput means that UTAR NoC platform with adaptive routing use all of the resources efficiently and it also means that it has better resources allocation.
- The study from network architecture conclude that the UTAR NoC platform can be used as an early network exploration tools to get the optimum performance for a purpose application.

From conclusion, some futures works should be considered:

- Further study on development of allocator resources algorithm in the router architecture could be improved. The purpose of this effort is to push the performance even greater.
- Current NoC router interconnect implements wide parallel interface to links all of the routers. A network with lower number of parallel interface is a recommendation for future work. Decoding and encoding techniques are required to map the flits into a narrow data path. In the limit this can be a single serial data-clock stream connecting processor cores

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# A Scalable and Configurable Multiprocessor System-on-Chip (MPSoC) Virtual Platform for Hardware and Software Co-design and Co-verification

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**Abstract**— This paper defines a scalable and configurable Multiprocessor System-on-Chip virtual platform for hardware and software co-design and co-verification in Electronic System Level (ESL) design. It includes the integration of an Instruction Set Simulator (ISS) to the virtual platform, Transaction Level Modeling (TLM), IP (Intellectual Property) block design in high level of abstraction, and hardware and software partitioning. The virtual platform has been tested to develop and successfully tested to develop and run an AES-128 encryption software. The architecture of the virtual platform consist of multiple ARM Cortex-M0 processor, bus-based and Mesh NoC (Network-on-Chip) architecture, and IP (peripherals) to support the system. Lotus-G displays its capability to fill the gap between hardware and software team in ESL design and verification flow. It provides the software team with a platform which enables them to start software development and testing early before the RTL platform is ready. The virtual platform also gives the hardware team a golden reference model that acts as the functional specification reference during hardware design and verification.

**Keywords**—MPSoC virtual platform; SystemC with TLM; hardware and software co-design and co-verification; high level modeling

## I. Introduction

Today state-of-art technology brings computing closer to every aspect of human's life more than we could ever imagine before. It is the Multiprocessor System-on-Chip that becomes the essential component that makes it happen. A single MPSoC basically consists of several processors with memory and peripherals that all connected by a certain interconnect architecture to make them work together as a complete system. The architecture and configuration of the system such as computing power, processing speed, interconnect architecture, memory capacity and others will be based on the application designated to it [1].

Mission critical application will require more computing power and more processing speed in order to finish the required task precisely and in time, while other type of application like a monitoring system might want to use lesser

computing power to be more energy efficient and so cut down operating cost. The addition of more processors and other components into the chip makes the design and verification task even more challenging and complicated. At the same time there is tight time to market requirements and sky rocketing production cost to contend with.

Before multiprocessor system-on-chip (MPSoC) architectures become so complex, hardware and software of the electronic system are designed sequentially. In other words, the software engineers do not begin developing the software, device drivers, and inter-processor communication protocol stacks until they have a very solid hardware prototype to use. Nowadays such scenario is no longer feasible given the long design lead-time, resulting in unacceptable delay on the deliverables to the market [1].

Today technology provides engineer with ability to abstract the whole system in a higher level. The abstraction is developed in into a software platform called the virtual platform. This virtual platform is to mimic the functionality of the real system according to the specification document. The virtual platform will allow hardware engineer to explore any possible architectures for the system to find the most suitable one for the designated software. On the other hand software engineer will be able to develop the software more early before the RTL (Register Transfer Level) platform and FPGA prototypes are available and perform testing and debugging of the software on the virtual platform. The methodology today to develop such platform is called Electronic System Level (ESL) methodology. It begins with system specification and ends with the complete Multiprocessor System-on-Chip (MPSoC) or SoC virtual platform. It can be achieved using SystemC and Transaction Level Modeling (TLM) to build the virtual platform.

## II. Design and Implementation

Hardware and software co-design can be defined as the simultaneous consideration of both hardware and software to implement desired function within the design process. Successful co-design goes closely associated with co-verification, which is verification of both software and



hardware at the same time and in what degree it suites the desired function. This is where the virtual platform will become one complete solution for hardware and software co-design and co-verification.

The virtual platform presented in this paper is designed to be scalable and configurable, addition and removal of any components in the virtual platform can be made on-the-fly and at most minimum effort including changing the interconnect architecture, attaching and dispatching the processor, ROM, RAM, and other peripherals, reconfiguring components in the platform i.e. memory size, remapping component's address, and modifying the system architecture. This is achieved by building the platform and peripherals in high abstraction level using SystemC and TLM. However for simplicity of presentation, the scalability and configurability of the virtual platform presented in this paper is limited to certain levels.

In this paper, the virtual platform is built to accommodate Functional view, Programmers View (PV) and Programmers View + Timing (PV+T) abstraction levels and therefore it is coded in TLM-LT (Loosely Timed) coding style [2]. This gives the virtual platform capability to be used for algorithm development, software development and implementation, software performance and architecture analysis, hardware performance and architecture analysis, and hardware functional verification [3]. Determining the right virtual platform abstraction level is critical, targeting the pain that exists in the design and verification flow. It is not necessary to build the virtual platform in all abstraction level since the effort to keep all of it synchronized is painful.

The key features of the virtual platform is to be functional accurate, register accurate, instruction set accurate, transaction level communication, and high simulation speed. It utilizes time quantum and temporal decoupling features from the TLM-LT coding style [4]. In comparison with RTL platform, aspect like timing is not modeled in detail in PV virtual platform. It may not be implemented in the model at all, to allow high speed simulation. Interrupt function can be modeled in high level using `tlm_analysis_port`, to allow the interrupt signal to be propagated directly without having the need to wait for the end of its quantum [5].

The virtual platform is implemented in SystemC-2.3.1 with TLM-2.0. It is also integrated with an ISS from Open Virtual Platform (OVP) [6]. The system architecture that is proposed for the virtual platform is DMM (Distributed Memory Machines) which incorporates NoC mesh topology as the interconnect architecture between each processing elements [7]. The virtual platform is designated to allow hardware and software co-design and co-verification of an AES-128 application. Such virtual platform is certain to the extent of its architecture, components, functionality, specification and features; named Lotus-G.

Lotus-G virtual platform consist of four OVP's ARM Cortex-M0 processor model with OVP's Intel StrataFlash(R) Embedded Memory (P30) flash model configured with size of 512Kb as the ROM, OVP's TLM memory model as the RAM, and OVP's bus model as the interconnect. In addition to that, high level peripheral models are developed to support the system, Host Device, AHB to Parallel Port, AHB to NoC Bridge, NoC mesh topology, DMA (Direct

Memory Access), SPI (Serial Peripheral Interface), and AES wrapper for Texas Instrument's AES-128 model.

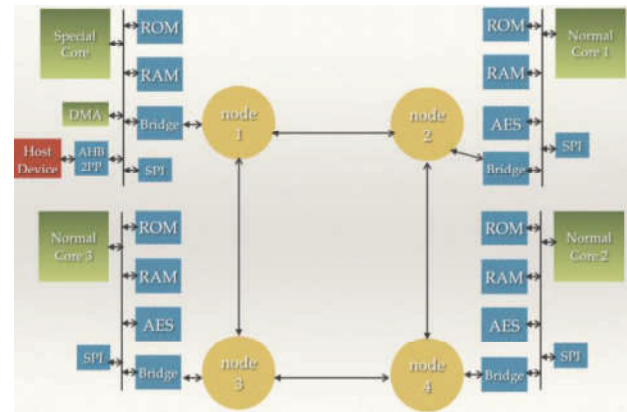


Fig. 1 Lotus-G System Architecture

Fig. 1 shows Lotus-G default system architecture. There are four ARM Cortex-M0 processors that are divided into two usages, special and normal. The special core has a task to receive and process an input (plain text), divide and transfer the input to normal cores, wait for normal cores to finish their job, receive the output (cipher text) back, and finally transmit the output to the outside world via host device. On the other hand, normal cores will have to receive and process the input that is allocated to them by the special core and send the result (cipher text) back to special core upon completion. The system is developed to target coarse-grained communication mechanism [7].

In general both usages are equipped with ROM, RAM, Bridge and SPI. The ROM stores software binary image file, RAM comes from OVP's TLM Memory model. Bridge is the AHB2NOC\_BRIDGE which task is to handle transaction conversion from bus to NoC and vice versa, the Bridge is connected to a Node which when combine together with the other nodes in the system will present the functional high level model of NoC mesh topology. The Node consist of address mapping table, router, and adapter, last but not least is the SPI to provide debugging capability in RTL platform. In this level, the software can be debugged by using GDB (GNU Debugger) which is fully supported by OVP ISS tool [8]. Therefore the SPI model is limited to only register accurate and address mapping, and does not represent the true functionality. However, this model is still added to the virtual platform to give software developer absolutely same architecture with the real RTL platform.

Special core environment is supplied with AHB2PP (AHB to Parallel Port), DMA, and Host Device (outside world). The AHB2PP handles input from and to the Host Device. The Host Device acts as the outside world to the system. It drives input (plain text) to the system via AHB2PP and later receives the output from the system via AHB2PP. To maximize special core performance, data transfer between AHB2PP and Bridge is taken care by DMA. This DMA has four channels and consist of DMA transfer module and DMA controller module.

AES model is added to normal core environment, composed of Texas Instrument's AES-128 model that performs

encryption process and AES wrapper module. The AES wrapper module controls and sets procedure for the encryption process.

The OVP simulator tool technology provides interfaces to simulate SystemC with TLM virtual platform and model. Separately OVP has their own technology to define the virtual platform and Application Programming Interfaces (APIs) to build peripheral models [9]. But OVP fast simulator tool is not limited to that development flow. It can also be used to simulate virtual platform and model that are developed purely using SystemC with TLM. Developing the virtual platform and peripheral models using SystemC with TLM will boost its compatibility to other 3rd party simulator tools and other 3rd party high level model vendors.

### III. Hardware and Software Partitioning and Integration

In ESL design, hardware and software partitioning and integration is an important issue [10]. It is crucial to efficiently partition the system specification into hardware and software. Determine what features to be implemented in hardware and what in software. This partitioning can lead to an issue where the hardware design cannot meet its constraints, either in area, timing, or power. It is obvious that a hardware which is designed specifically for doing a certain task will give a better performance compare to a general hardware that is not designed specifically for doing the task. However, implementing those features in hardware is more expensive compare to in software. One distinct disadvantage of implementing a feature in software is performance degradation compare to in hardware.

The existence of virtual platform fills the gap between hardware and software world in ESL design flow [10]. Therefore to decide the hardware and software partitioning is not as hard as it used to be. By utilizing the virtual platform, system engineer can see the benefit and cost of implementing a certain feature between in hardware and in software. This could happen since the software can be developed early before the RTL platform is ready using the virtual platform. The hardware architecture and specification can also be designed in more affordable way by using the virtual platform. Hence, the system engineer can play with both world to find the best hardware and software partitioning for the system. This leads to easier hardware and software integration, as both can be simulated together in Lotus-G virtual platform environment. Hence it can expose any possible bugs that might occurred during hardware and software integration phase. The integration phase of hardware and software in traditional design methodology always come at the end. Therefore any bugs occur in this stage will be costly. Virtual platform technology minimizes the risk of getting unexpected bugs during hardware and software integration by bringing it forward much early where changes can be made inexpensively.

In Lotus-G, an example of hardware and software partitioning and integration is the implementation of the AES-128 encryption task. The AES-128 encryption main task is implemented in the hardware. Since the virtual platform is ready, it is not hard to see how the hardware will work when the feature is implemented in hardware instead in software. The integration of an AES accelerator model can be done and reviewed in the virtual platform. Lotus-G uses Texas Instrument's AES-128 high level model. The model is later

wrapped by an AES wrapper to provide control to the core model. The firmware and AES driver can be developed based on that model, both hardware and software then tested together in the virtual platform to see the overall system functionality. The software (firmware and drivers) is cross-compiled using Mentor Graphic's Sourcery CodeBench Lite Edition to target ARM Cortex-M0 processors and the help of linker file to map the hardware (virtual platform). The integration part between hardware and software can be observed within Lotus-G simulation where the complete electronic system delivers correct results.

### IV. Simulation

High level simulation is based on transaction level communication protocol and ISS. OVP's ISS uses time quantum and temporal decoupling features from TLM to simulate the virtual platform. The goal is to minimize context switching and give maximum simulation speed. Due to low context switching and OVP ISS tool specification, synchronization between the threads is sacrificed. The global time quantum can be redefined into a certain time unit, when it is necessary to attain more synchronization, the global time quantum can be set into smaller amount of time unit [11].

OVP's ISS tool will run the virtual platform executable file. This file is produced by compiling the virtual platform and other related models source code. After the executable form of the virtual platform exists the tool will execute it in terminal and start the simulation. In general the tool loads software binary file to the ROM and starts simulating the processor behavior by running the processor with the software binary image file that is already inside the ROM. The existing RAM in the system will keep any dynamic memory allocation that is requested by the processor during simulation. The simulation will continue running until the control reaches end of the software source line.

In Lotus-G the virtual platform is created so it can take user input during runtime. This enhancement makes a big difference to those fixated virtual platforms. It allows Lotus-G user to input number of processors, RAM size, software filename, and other simulation, debugging, and architecture settings. These enhancements give scalability and configurability to Lotus-G to the extent of the user (hardware and software engineers) requirements and system specifications. Lotus-G main menu and other submenu can be seen in Fig. 2 below.

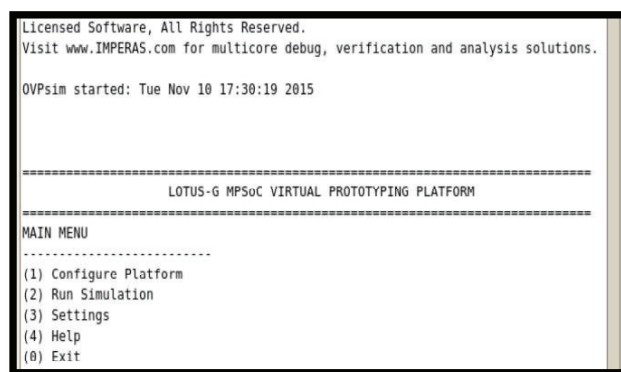


Fig. 2 Lotus-G Main Menu

The main menu of Lotus-G consists of four submenus. The first is “Configure Platform” submenu that is also displayed in the Fig. 2 above, it is where user can input the number of processing element(s) to be generated, the software filename for each of the processing elements, and other related software settings i.e. block size, word processing size and whether or not the ISR (Interrupt Service Routine) is implemented separately. The rest are the ROM and RAM size and start address, user can input “0” for default configuration of Lotus-G. Other settings that related to platform component configuration, simulation, tracing and debugging are presented under “Settings” submenu as can be seen in Fig. 3 below.

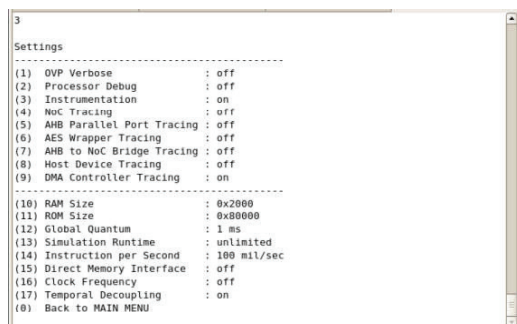


Fig. 3 Lotus-G Settings Submenu

“Settings” submenu contains several features and parameters of the virtual platform including settings for the simulation. It provides user with information about the size of the RAM and ROM, tracing, instrumentation, processor debug, global quantum value, simulation runtime limit, nominal MIPS (Million Instructions Per Second), clock frequency, and temporal decoupling settings. The default values can be adjusted per user requirements. Better accuracy can be achieved in simulation by minimizing the global quantum and instruction per second (nominal MIPS) value, user can also enable or disable the DMI and temporal decoupling features of TLM. Software debug can be performed by enabling the processor debug setting and choose which processor to be debugged. After that user can start a debug session using GDB for that particular processor. Tracing and verbose settings can be activated by the user to ask Lotus-G to dump out information about every steps that are happening during simulation as showed in Fig. 4 below. Tracing is based per module, verbose is for Lotus-G to print out general information related to the simulation, model basic status, and simulator info and warnings. If Instrumentation is enabled, Lotus-G will generate a log file for modules which have the tracing setting enabled.

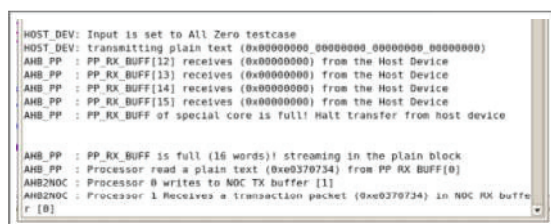


Fig. 4 Example of an Enabled Tracing Setting

## V. Results

In this paper, the virtual platform has been tested with AES-128 encryption for hardware and software co-design and co-verification. Lotus-G is used to develop the software for AES-128 encryption. The software can be used for the RTL platform without having the need to make any changes to the software. There are two firmware(s) that are created, one for special core and another for normal core. The special core firmware has to divide the input blocks into several smaller blocks and distribute it to all of the normal cores. It waits for the normal cores to finish the encryption process and exits. The normal core firmware has to handle input blocks that are assigned to it and send the output back to special core. Both firmware(s) is supported by a set of device drivers to access and use the peripherals. Software development does not exist early in such stage unless the software team has access to use virtual platform. Lotus-G delivers hardware functionality and provides programmers view that allow software engineer to design and verify the software much early before the hardware is even ready. Fig. 5 and Fig. 6 below display some part of the special core and normal core firmware source code for 16 words per block processing size.

```

36 NVIC_EnableIRQ(2); // enable Ext INT 2 (NOC_RX_INT0)
37
38 NOC_CSR1 = 0x14000000; // set NOC RX interrupt and RX_IM
39 PP_ST_BLOCK16 = 0x00000000; // SET PP_RX_IE and PP_RX_IM
40 DMA_CSR = 0x00000000; // set DMA interrupt
41
42 main_scheduler();
43
44 __WFI(); // NOTE: there is no need of using a while(1) forever loop
45 // because __WFI() makes the core sleep immediately after every ISR
46
47 return 0;
48
49
50 void main_scheduler(void) {
51     int channel_selected;
52     unsigned char dest_name;
53
54     while(1) {
55         // -----
56         // check availability of pp data
57         // -----
58         if (pp_data_ready == 1 && plain_distributed < 2) {
59             channel_selected = dma_transfer (0x50000000, 0xA000004C, 0, 0, 2, 1, 0);
60         }

```

Fig. 5 Special Core Firmware for 16 Words per Block Processing Size

```

39 AES_KEY2 = 0x12345678;
40 AES_KEY3 = 0x12345678;
41
42 main_scheduler();
43
44 __WFI(); // NOTE: there is no need of using a while(1) forever loop
45 // because __WFI() makes the core sleep immediately after every ISR
46
47 return 0;
48
49
50 void main_scheduler(void)
51 {
52     int result;
53
54     while(1)
55     {
56         // check availability of plain text
57         if (plain_ready == 1)
58         {
59             if (plain_count == 0)
60             {
61                 AES_PLAIN0 = NOC_SPECIAL_RX_BUFFER;
62             }

```

Fig. 6 Normal Core Firmware for 16 Words per Block Processing Size

Other software components that developed by using Lotus-G other than the firmware are peripheral drivers, ISR and linker file. One example of the peripheral driver that presented in this paper is DMA controller driver software coded in C as showed in Fig. 7. Part of the special core ISR is displayed in Fig. 8 and linker file in Fig. 9.



```

5 int dma_transfer(unsigned int SRC_ADDR, unsigned int DST_ADDR,
6               unsigned char SRC_INC, unsigned char DST_INC,
7               unsigned char SIZE, unsigned short N_MINUS_1, unsigned char R_POWER) {
8     unsigned int channel_cfg;
9     unsigned int channel_src;
10    unsigned int channel_dst;
11    unsigned int *ptr1, *ptr2, *ptr3;
12    unsigned char channel;
13
14    channel = DMA_CSR & 0x7;
15
16    if(channel == 4) return 4;
17
18    if(channel == 0) {
19        ptr1 = (unsigned int *) GDMA_CH0_CFG;
20        ptr2 = (unsigned int *) GDMA_CH0_SRC;
21        ptr3 = (unsigned int *) GDMA_CH0_DST;
22    }
23    else {
24        ptr1 = (unsigned int *) GDMA_CH0_CFG + (3 * channel);
25        ptr2 = (unsigned int *) GDMA_CH0_SRC + (3 * channel);
26    }

```

Fig. 7 DMA Controller Driver Software

```

64 // NoC RX interrupt
65 void EXTERNAL_2_handler(void)
66 {
67     receive_noc = 1;
68     // ext_2_cnt++;
69     NVIC_DisableIRQ(2); // disable NoC RX interrupt until the data processed
70 }
71
72 void EXTERNAL_3_handler(void) // DMA0
73 {
74     // ext_3_cnt++;
75     DMA_CSR = 0x0001000; // clear interrupt
76     ext_3_cnt++;
77 }
78
79 void EXTERNAL_4_handler(void) // DMA1
80 {
81     // ext_4_cnt++;
82     DMA_CSR = 0x0002000; // clear interrupt
83 }
84
85
86

```

Fig. 8 Special Core ISR

```

OUTPUT_FORMAT ("elf32-littlearm", "elf32-bigarm", "elf32-littlearm")
ENTRY(_start)
SEARCH_DIR(.)
GROUP(-lgcc -lc -lcs3 -lcs3unhosted -lcs3micro)

MEMORY
{
    /* ROM is a readable (r), executable region (x) */
    rom (rx) : ORIGIN = 0, LENGTH = 512k

    /* RAM is a readable (r), writable (w) and */
    /* executable region (x) */
    ram (rwx) : ORIGIN = 0x20000000, LENGTH = 8k
}

```

Fig. 9 Lotus-G Linker File Example

In this work, the DMA software is created in a sense to match and utilize the DMA hardware model as the part of Lotus-G MPSoC. It has been proven in this work that the software team can develop drivers for the DMA controller hardware model, the firmware for the special core along with its ISR and the linker file for compilation purpose. All of these are happening when the hardware team is also still in progress of developing the DMA hardware model and the rest of the Lotus-G platform components in hardware. Even better those software are able to be simulated on the virtual platform to allow software engineers to observe the software behavior, interaction between software and hardware, and to verify the software functionality so that it conforms with the system specification and bring the hardware to perform to its best. To start software development, testing, and integration only after when the hardware is ready will cost a time to market loss and to do any changes after the silicon is ready will be very costly, time consuming, and require more efforts.

The hardware co-design and co-verification take place by utilizing the virtual platform and high level peripheral (IP) models as the guideline during hardware design and ultimately use the high level platform and models as the golden model during hardware verification. One example shown in Fig. 10 below is the mapping of all components within Lotus-G special core domain. The special core is connected to local bus. The local bus is connected to all slaves in the domain. The addresses for each component in the system are mapped. It also connects AHB2NOC BRIDGE to allow the special core to communicate with other cores through the NoC mesh topology.

```

53 if(r==0) { // special core connection
54     bus[0] = initiator_socket[0] (intel_flash) -> flash_socket; // connect bus and flash mem
55     bus[1] = initiator_socket[1] (private_ram) -> ram; // connect bus and private ram
56     bus[2] = initiator_socket[2] (pp) -> pp_socket; // connect bus and pp
57     bus[3] = initiator_socket[3] (bridge) -> v_socket_bridge; // connect bus and bridge (ahb2noc)
58     bus[4] = initiator_socket[4] (app_xpi) -> xpi_socket; // connect bus and app_xpi
59     bus[5] = initiator_socket[5] (dmuc) -> dmuc_socket; // connect bus and dmuc
60
61     bus[6] = vnetDecoder[0] (p_ram_addr, p_ram_addr, ram_size);
62     bus[7] = vnetDecoder[1] (p_ram_addr, p_ram_addr, ram_size);
63     bus[8] = vnetDecoder[2] (ADDRESS_pp[0], ADDRESS_pp[1]); // ahb_pp address
64     bus[9] = vnetDecoder[3] (ADDRESS_bridge[0], ADDRESS_bridge[1]); // ahb_bridge address
65     bus[10] = vnetDecoder[4] (ADDRESS_app_xpi[0], ADDRESS_app_xpi[1]); // app_xpi address
66     bus[11] = vnetDecoder[5] (ADDRESS_dmuc[0], ADDRESS_dmuc[1]);

```

Fig. 10 Lotus-G Special Core Connection and Address Mapping

The hardware co-design that is presented in this paper is about the DMA controller design. The DMA controller is modeled in high level using SystemC with TLM and get refined into RTL. During the refinement process, there is added timing detail (clock cycle in RTL) to the model, reset signal, pin, but the functionality has to be precisely the same. Fig. 11 shows some part of the DMA specification document and Fig. 12 shows some part of DMA high level modeling related to the DMA control signal register that is expressed in DMA specification document as displayed in Fig. 11.

address offset	register	
00-03	DMA_CSR	
04-07	DMA_CH0_CFG	
08-0B	DMA_CH1_CFG	
0C-0F	DMA_CH2_CFG	
10-13	DMA_CH3_CFG	
14-17	DMA_CH4_CFG	
18-1B	DMA_GRANT	

register	symbol	permissions	description
DMA_CSR[2:0]	DMA_CH_AVL	R	read this register will return the index of idle DMA channel. if DMA_CH_AVL == 4, there are no idle DMA channel. Read this register will set the correspondent DMA channel to booked state. The state of the channel will be back to idle after DMA transfer using this channel are completed.
DMA_CSR[3]	DMA_IE	R	DMA interrupt enable. If this bit is one, when a DMA transfer has finished, DMA_INT pin will be driven high.
DMA_CSR[4]	DMA_IE_SET	W	Write 1 to this bit will set the DMA_IE to 1, write 0 takes no effect.
DMA_CSR[5]	DMA_IE_CLR	W	Write 1 to this bit will clear the DMA_IE to 0, write 0 takes no effect.
DMA_CSR[6]	DMA_CH0_CIF	R/W	When channel 0 has finished its transfer the DMA will set this register to 1. If the DMA_IE is high, DMA will put DMA_INT high too, and writing 1 to this bit will clear the DMA_INT, write 0 takes no effect.
DMA_CSR[7]	DMA_CH1_CIF	R/W	When channel 1 has finished its transfer the DMA will set this register to 1. If the DMA_IE is high, DMA will put DMA_INT high too, and writing 1 to this bit will clear the DMA_INT, write 0 takes no effect.

Fig. 11 Lotus-G DMA Control Signal Register Specification

```

for(unsigned int i=0; i<10; i++) // Only
DMA_CSR[i] = (DMA_CSR_temp & (1 << i));

if(DMA_CSR[4] == 1) DMA_CSR[3] = 1; //
if(DMA_CSR[5] == 1) DMA_CSR[3] = 0; //
if(DMA_CSR[6] == 1) DMA_INT.write(0);
if(DMA_CSR[7] == 1) DMA_INT.write(0);
if(DMA_CSR[8] == 1) DMA_INT.write(0);
if(DMA_CSR[9] == 1) DMA_INT.write(0);

```

Fig. 12 Lotus-G DMA Control Signal Register in High Level

The DMA controller implementation in RTL is displayed in Fig. 13 below. It shows some part of the RTL source code of the model which correlates to Fig. 11 and Fig. 12 above, the part where "DMA\_CSR" control signal register are specified and designed. The "DMA\_CSR" control signal register is useful for controlling the interrupt pin of the DMA model and for accessing available channel from the DMA model.



```

else if(APhase_HSEL & APhase_HWRITE & APhase_HTRANS[1])
begin
  if(APhase_HADDR[MEMWIDTH:2] == 0)
  begin
    // DMA_CSR
    if(byte0)
    begin
      if(HWDATA[4] == 1) //CH0_IE_SET
        DMA_CSR[3] <= 1;
      else if(HWDATA[5] == 1)//CH0_IE_CLR
        DMA_CSR[3] <= 0;
    end
  end
end
end

```

Fig. 13 Lotus-G DMA Control Signal Register in RTL

The hardware co-verification part of the DMA model uses the high level DMA model as comparison for the RTL DMA model. In future works it may be feasible to create an adapter that facilitates communication between TLM and RTL so that the hardware high level model can be incorporated directly inside the RTL test bench. The current trend of hardware co-verification now is to compare the high level and low level model separately.

Lotus-G simulation ends up with information about simulation statistics i.e. the executed instruction number per processors, time consumed by those processors, total simulation time and other statistics from OVP's peripheral model as shown in Fig. 14 below.

```

Info -----
Info
Info -----
Info TOTAL
Info Simulated instructions: 4,400,000
Info Simulated MIPS : 1.1
Info -----
Info
Info -----
Info SIMULATION TIME STATISTICS
Info Simulated time : 0.01 seconds
Info User time : 3.98 seconds
Info System time : 0.00 seconds
Info Elapsed time : 5.34 seconds
Info -----
Info
OVPsim finished: Wed Nov 11 02:15:45 2015

OVPsim (32-Bit) V20150901.0 Open Virtual Platform simulator from www.OVPworld.org.
Visit www.IMPERAS.com for multicore debug, verification and analysis solutions.

```

Fig. 14 Lotus-G End of Simulation and Simulation Statistics

## VI. Conclusions

Before the existence of virtual platform and high level modeling technology, the only way to do hardware and software co-design and co-verification is by using FPGA (Field Programmable Gate Array) and hardware prototype. Both technologies have their own disadvantages and clearly much more expensive, inefficient, and late availability compare to the virtual platform and high level modeling technology. Lotus-G virtual platform displays the capability of what virtual platform and high level modeling can do for solving the hardware and software co-design and co-verification issues. The virtual platform itself is made scalable and configurable, allowing user (either hardware or software engineers) to be able to adjust the system architectures and other components to suite different simulation and testing requirements.

Other related works on virtual platform technologies that are delivered by big EDA tool vendors i.e. ARM [12], Cadence [13] and Mentor Graphics [14] are similar to each others which they give its user ability for early availability of hardware model for software integration, visibility of debugging complex software/hardware interactions, suffi-

ciently fast simulation model for OS and application software validation. However these do not come cheap which turn to be limited only for big players to have access on those technologies and mainly targeted for business and commercial purposes. Another research work has been done in an open source domain is so called MPSoCBench which is to be a toolset for MPSoC system level evaluation [15]. Its main goal is to provide a benchmark to enable the development and evaluation of ESL tools, methodologies and components. This is limited to ArchC technology and their own configured MPSoC architectures.

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# Exploring Software-Defined Radio on Multi-Processor System-on-Chip

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**Abstract**— Software-Defined Radio (SDR) has been proposed as a solution for a single device to overcome various and changing radio standards. It allows wide range of computational device, such as personal computer processor and Multi-Processor System-on-Chip (MPSoC) to function as radio baseband processor. Number of works of SDR implementation on MPSoC has been done, variously differing according to underlying hardware platform. Main reason is to utilize the hardware architecture, providing power efficiency and effective processing. This paper explores idea of utilizing RUMPS401 chip, an ARM based heterogeneous MPSoC designed by Universiti Tunku Abdul Rahman VLSI Center, as a baseband processor based on its architecture. A workflow of implementing SDR on ARM based MPSoC using Matlab and ARM Keil Development Tools is also proposed here. The implementation and testing of the proposed idea is still an ongoing work.

**Keywords** – Software-Defined Radio; MPSoC; SDR Hardware Platform

## I. INTRODUCTION

Various and evolving radio standards offer better radio performance, and wide range of scheme to be deployed. It leads to need of a single radio device to support multiple standards, which one way to achieve is through multiple Radio Frequency (RF) chains. This solution however, results in more circuitry, hardware complexity, and larger power consumption [1]. Same problem arises for accommodating evolving radio standards. For a device to adapt new standards, it may need a change in its hardware circuit thus introducing more cost and effort to be poured, especially in large volume deployment. Reconfigurability of radio device is a key point to cover wide and evolving standards [2], which can be achieved through a programmable processor and RF frontend element.

Software-defined radio (SDR) has been proposed as a

solution for flexible signal processing [3]. Software is used to define how signal is processed in digital CPU. This SDR technique can be implemented on general purpose CPU such as in our computer [4], or on System-on-Chip that through proper utilization of its hardware architecture will result in efficient power consumption, and effective utilization of hardware resources during processing.

This paper discusses Universiti Tunku Abdul Rahman (UTAR) first MPSoC, the RUMPS401, and possible exploitation of its architecture as baseband processor to achieve power efficiency and effective processing. The SDR implementation flow on RUMPS401 is proposed by using Matlab and ARM Keil development tools. Implementation and testing of proposed RUMPS401 utilization and Matlab-ARM SDR workflow is still an ongoing work.

The rest of this paper is arranged as follows. Section II describes previous work of SDR implementation on MPSoC. Section III describes about RUMPS401 chip. Section IV explains RUMPS401 architecture utilization for SDR implementation and Matlab-Keil workflow of implementing SDR on ARM based MPSoC. Finally section V will conclude this paper.

## II. RELATED WORKS

KUAR [5] is built to provide portable, powerful, small-sized, flexible software defined radio hardware platform. It consists of one Pentium-M Embedded PC and Xilinx FPGA as processing unit, and a complete Rx/TX radio front-end chain to enable ready-to-use SDR platform, leaving user only to work with software part. Control-oriented task is handled by Pentium-M, while computational task is assigned to FPGA.

Didier Lattard, *et al.* [6] designed and employed FAUST chip, a heterogeneous Network-on-chip (NoC) based MPSoC architecture. The chip consists of specific-purpose signal processing units hardwired to a programmable core, which provides processing effectivity, but lacks in flexibility. An SDR framework built by integrating FAUST chip with RF frontend is targeting high data rate Multiple Input Multiple

Output (MIMO) Orthogonal Frequency Division Multiplexing (OFDM) radio application.

Studying heterogeneous MPSoC platform for LTE modem MAGALI [7], Camille Jalier, *et al.* [8] present a homogeneous NoC based MPSoC architecture named GENEPIY. This architecture is based on homogeneous unit called Smart ModEm Processor (SMEP) that is constructed of memory and its controller as memory cluster, and two DSPs as processing cluster. Two types of this SMEP unit is discussed, one is SMEPv0 which structure are explained above. The second one is SMEPv1 which basically a SMEPv0 with additional control core integrated. Based on these two types of SMEP unit, two GENEPIY architectures are proposed. One is GENEPIYv0 which based on SMEPv0 unit, shown by Figure 1. It consists of N units SMEPv0 and a host processor for global control, connected through Asynchronous Network on Chip (ANoC). This work emphasizes on better performance in homogeneous MPSoC architecture. Second architecture is GENEPIYv1, consisting of N units SMEPv1. In this architecture there is no host processor, offering more flexibility and autonomy of each SMEP unit. Figure 2 depicted GENEPIYv1 architecture. Comparison between these two architectures shows that better power efficiency and speed is achieved on the architecture without host processor.

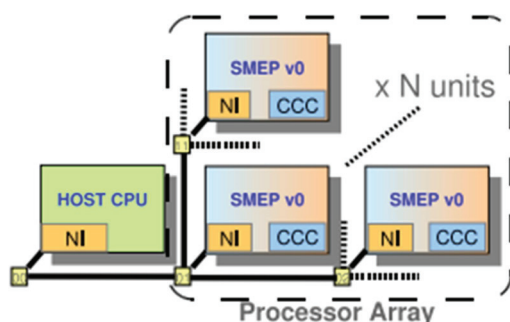


Figure 1. GENEPIYv0 Architecture

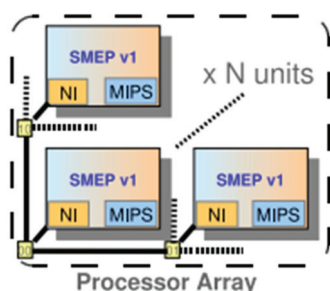


Figure 2. GENEPIYv1 Architecture

Shenghou Ma, *et al.* [9] proposed porting of GNU Radio, an open-source SDR software platform which naturally runs in general CPU, to run in ARM-core based SoC. In this work, they are using Keystone II SoC from Texas Instrument as the target hardware. Their target for long term is to build GNU

radio based SDR software platform that could map tasks defined by software, into the target hardware's block that executes specific task in most effective manner. This work will serve as good platform to assist future deployment of SDR on MPSoC.

Casas *et al.* [10] implements IEEE 802.11ah, an open standard for IoT application on MPSoC. The proposed architecture consists of Cadence Fusion DSP incorporated with specialized hardware blocks for signal processing. Their work emphasizes on efficiency of power and better performance by assigning high-throughput processing to hardware block in the SoC, and complex calculation processing to DSP.

### III. RUMPS401 CHIP

RUMPS401 is a four core ARM-based MPSoC designed by UTAR VLSI center, based on a work by Dicky *et al.* [11]. It consists of one IO Control Core, one core with MAC hardware accelerator which is called DSP Core, and two cores with AES hardware accelerator, called Normal Core. The MAC accelerator is able to support single cycle 16-bit multiplication, 32-bit multiplication, and single cycle 32-bit multiply-accumulate operation. Each of these cores is ARM Cortex-M0 which also provides DSP functionality inside their instruction sets. Local resources are available to each of the cores, which are 32 KB SST Flash and 8KB ARM low power SRAM. A 32-bit GPIO and parallel communication is available to IO control core, while three 8-bit GPIOs are available to each of other cores.

Connection between cores is provided through UTAR's adaptive NoC. Figure 3 shows RUMPS401 architecture. This MPSoC itself is designed by emphasizing on low power design that allows partial shutdown of each core during sleep mode.

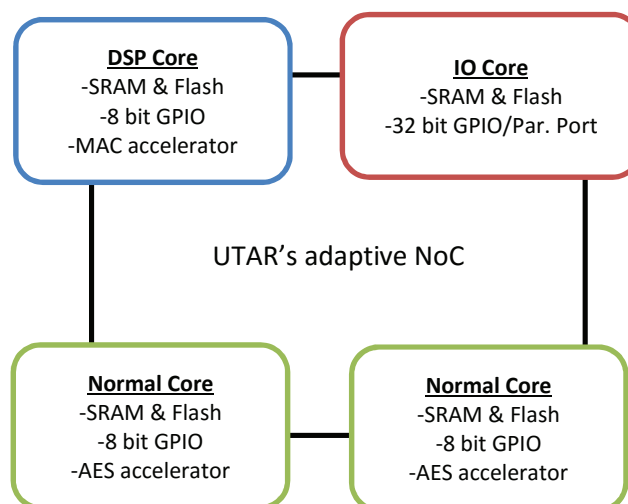


Figure 3. RUMPS401 Architecture



#### IV. SDR IMPLEMENTATION ON RUMPS401

##### A. RUMPS401 Architecture for SDR Implementation

Review on previous works shows that radio implementation on heterogeneous MPSoC architecture benefits its efficiency and effectiveness from correct assignment of task into each of different cores. The same concept will be adapted for SDR implementation on RUMPS401.

Communication task between the RUMPS401 and RF frontend element is assigned to IO control core due to its larger GPIO and its support for parallel communication. This core will receive baseband down-converted data from RF frontend, and supply the frontend with data to be up-converted for data transmission. For digital modulation such as QAM and PSK, this core can also be programmed to separate I and Q component of the baseband complex signal. These I and Q component later can be processed in parallel by other cores.

MAC accelerator on the DSP core will be focused on tasks involving complex calculation, such as phase estimation, delay estimation in spread spectrum system to obtain needed parameters. These parameters then are used to process received data, which is administered to Normal Cores. This way the complex calculation can be done in faster and more reliable manner, while data hunger operations are assigned to Normal Cores.

Normal Cores are responsible for data hunger operations, such as Forward Error Correction (FEC), signal spreading. AES accelerators in these cores can also be utilized to provide fast and reliable encryption into the communication system. Synchronization and control mechanism between all four cores is needed, assuming each core is on same level of hierarchy. This configuration is preferable than having one core as global controller, which inherently leads to bottleneck on that core. Radio tasks assignment on RUMPS401 is depicted in Figure 4.

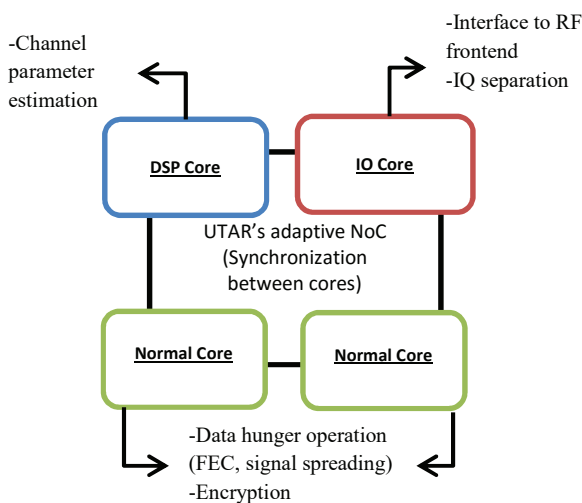


Figure 4. Radio Task Assignment on RUMPS401

##### B. Matlab-Keil SDR Implementation Flow

The following flow is defined for SDR implementation on ARM-based SoC. First, a Matlab model of corresponding radio baseband processor is build. Since Matlab is naturally a tool for signal processing purpose, this allows easier and more reliable method of building baseband processor. The model built can be simulated and refined in software, without dependence on the hardware.

Next, utilizing Matlab Embedded Code Generator feature, each of the baseband processor blocks is mapped into an ARM code, based on ARM CMSIS-DSP library. This library supports 8-bit, 16-bit, 32-bit integer operation, and also supports fix-point (fractional Q7, Q15, Q31), single precision floating-point (32-bit) operation [12]. While this feature itself allow conversion of whole system into code, it is preferable to convert individual blocks of baseband processor to allow more flexibility during implementation of the code on hardware platform.

Last step is to utilize mapped functional blocks and implement these codes into target hardware platform. ARM Keil Development Tools with CMSIS library integrated is used as development environment. Figure 5 summarizes the proposed flow. The proposed flow emphasizes on use of Matlab at initial stage of baseband processor development for easier and more reliable system, and faster way to implement model into target hardware through Matlab's code generator feature.

However, a tradeoff for flexibility in method of partial system mapping is it may not be able to fully utilize Matlab and ARM Keil Development Tool link feature. It allows a Matlab model to link directly to a Keil project, and runs the model real-time in target hardware.

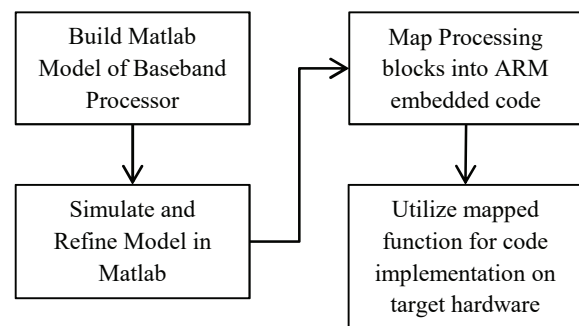


Figure 5. Matlab-Keil SDR Implementation Flow

#### V. CONCLUSION

SDR implementation on MPSoC is benefitting in terms of efficient power consumption and effective processing, and this is achieved through proper task assignment of each block. Task assignment of radio baseband processing on RUMPS401 is discussed, utilizing unique feature of each core to achieve

complete function of baseband processor. Synchronization between cores is preferred than having global control administered by single core to avoid bottleneck. Utilizing Matlab and ARM Keil Development Tools, a flow of SDR implementation for ARM-based MPSoC is proposed. The use of Matlab for initial modeling offers easier and reliable method of building baseband processor, and Matlab's embedded code generator feature provides faster way of implementing system into target hardware.

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# A Scalable Bootloader and Debugger Design for An NoC-based Multi-processor SoC

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**Abstract** - This paper presents bootloader and debugger architectures that are designed for an NoC-based Multiprocessor System On-Chip (MPSoC). An MPSoC demands scalable bootloader and debugger architectures, especially with the increasing of the number of the processor cores. The proposed bootloader and debugger designs utilize the NoC interconnect network to distribute data to and from the cores. With this design approach, the bootloader and debugger require relatively small hardware overhead and are able to fully utilize the benefit of the NoC architecture's scalability.

**Keywords** – Bootloader, Debugger, NoC, MPSoC, VLSI, MPMD

## I. INTRODUCTION

The advancement in CMOS Integrated Circuit (IC) manufacturing technology enables the growing complexity of System On-Chips (SoCs). Network-on-Chip (NoC) has been proposed as a better interconnect solution for these complex SoCs, especially for MPSoCs. A lot of challenges in designing an NoC-based MPSoC have been addressed by various researches. Some research works focus on the application partitioning and mapping [1, 2]. Other researches try to improve the network topology [3] or the routing algorithm [4, 5].

In the last few years, there is a trend to increase the number of processor cores in SoCs. In this large-processor-count MPSoCs, the loading of application programs to the cores can be an issue. Low hardware overhead and time-to-market are the two important targets in designing the Bootloader as also addressed in [6]. In fact, the SoC design is always driven by the cost and market competition.

In addition, large number of cores also delivers challenges in software development and debugging. The nature of the non-deterministic behavior of MPSoCs is prone to introduce concurrency bugs [7]. A Debugger architecture is required to manage the debug data from multiple processor cores. Other than that, MPSoC

introduces the needs to debug inter-processor communication traffics [6, 7].

Traditional solutions of debugger design utilize serial debug architecture [8] or JTAG architecture [9]. These serial debug data path designs might hit performance barrier when the number of cores grows. Some researches offer the use of dedicated debug bus-interconnect [10, 11]. However, the bus-based debug architectures are not suitable for scalable NoC-based systems as also highlighted in [12].

NoC-based debug architectures are proposed [6, 12] as novel debug data-path designs. The solutions provide mechanism to debug individual core and the packet interchanges. These NoC-based debuggers provide more robust and scalable debug architecture. The architectures need to incorporate some dedicated debug components for the debug data transmission.

There are several commercial debugger and bootloader architectures that are offered to be used together with commercial processor cores. ARM's CoreSight Infrastructure is one of the examples. Other microcontroller manufacturers also have specific Debugger and Bootloader architectures for their multicore products. These solutions usually are not come in cheap.

In this paper, we proposed designs of Bootloader and Debugger architectures that are suitable for an NoC-based MPSoC. The target of the design is to provide a scalable, simple and low overhead Bootloader and Debugger architecture. The proposed Bootloader and Debugger designs utilize the NoC interconnect to deliver data across the cores. The Bootloader architecture implements two stages bootloading mechanism and is able to use the on-chip peripherals to retrieve program codes. The solution offers flexibility and fully utilizes the hardware components in the chip.

The rest of the paper is organized as follows. Section II introduces the architecture of RUMPS401 chip. The proposed Bootloader and Debugger designs are implemented in this chip. Section III describes the architecture of the Bootloader. The design of the

Debugger is discussed in Section IV. In Section V we show the performance analysis results of the Bootloader and Debugger. Section VI gives the conclusion.

## II. NOC-BASED MPMD MPSOC ARCHITECTURE

The proposed Bootloader and Debugger designs are developed for an NoC-based MPSoC. These Bootloader and Debugger architectures are implemented and tested in the RUMPS401 chip. RUMPS401 is an Universiti Tunku Abdul Rahman (UTAR) VLSI Design Centre own ARM Cortex-M0-based MPSoC. It implements UTAR NoC as the inter-processor interconnect network. The UTAR NoC architecture is the result of another research work of UTAR VLSI Design Centre [15].

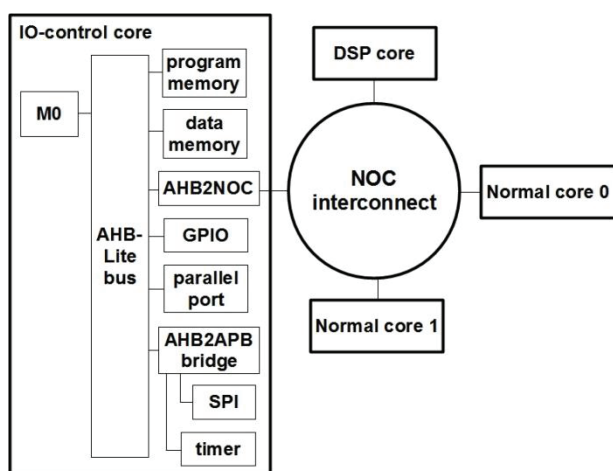


Fig. 1 RUMPS401 Architecture

RUMPS401 architecture falls into the category of Multiple Program Multiple Data (MPMD) of the Flynn's computer architecture classifications. Figure 1 shows the basic architecture of the RUMPS401 chip. Each of the cores has its own program and data memories. Flash memories from SST are used as the program memories and ARM's Artisan SRAMs are used as the data memories. AHB2NOC module is designed as the bridge between the M0 processors and the NoC interconnect. The bridges inside each core handle data packetizing and de-packetizing and also manage the flow control.

The four cores in the RUMPS401 chip are categorized based on the sets of peripherals that it has. The three categories are: IO-control core, DSP core and Normal core. The IO-control core has controls on more IO peripherals such as SPI, timer, GPIO and parallel port controller. The DSP core has a hardware Multiply - Accumulate (MAC) accelerator. AES encryption accelerators are implemented in the Normal cores. In this scheme, The IO-control core is designed to be the main processing core and mainly utilized in the Bootloading and Debugging process.

## III. BOOTLOADER DESIGN

The proposed bootloading scheme is divided into two steps – Hardware Bootloading phase and Software Bootloading phase. The two stages Bootloader design is also proposed in the other research work [16]. In the Hardware Bootloading Phase, an hardware Bootloader circuit is used to load a Software Bootloader program to one of the core's program memory. In the Software Bootloading phase, the selected core executes the Software Bootloader and acts as the secondary Bootloader. The core loads the application program of itself and the other cores.

### A. Hardware Bootloader Architecture

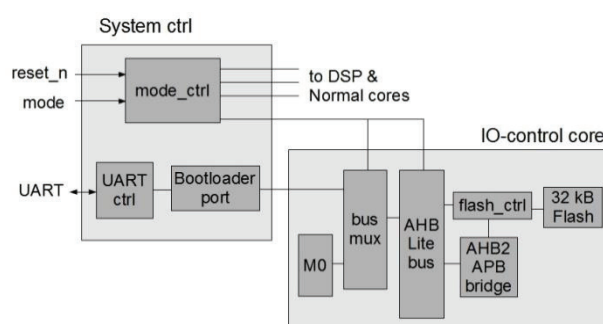


Fig. 2 Hardware Bootloader Architecture

In the RUMPS401 chip, IO-control core is selected to be used to run the Software Bootloader program. Figure 2 shows the architecture of the hardware components that participate in the Hardware Bootloading process. The Hardware Bootloader module uses UART interface to communicate with a programmer device. The protocol that is used by the programmer device and the Hardware Bootloader circuit to communicate is similar with the Intel Hex Frame as shown in Table I. Once the bootloading process is initiated by the programmer device, the program codes are then transferred through the UART interface.

TABLE I  
Bootloader Frame Format

	mark ':'	length	type	data	checksum
number of character sent	1 byte	2 bytes	2 bytes	2n bytes	2 bytes
number of byte represented	1 byte	1 byte	1 byte	n bytes	1 byte

The flash memory of the IO-control core is designed to have the capability to contain two types of programs – Software Bootloader and application program. In this Hardware Bootloading process, the Hardware Bootloader gets exclusive access to the IO-control core's AHB-lite bus. The Hardware Bootloader



performs write transfer to write the Software Bootloader program to the flash memory of the IO-control core. The program is written to the Software Bootloader partition in the flash memory.

### B. Software Bootloader Architecture

In the Software Bootloading Phase, IO-control core takes over the bootloading task. Figure 3, shows the architecture of the modules that participate in the Software Bootloading phase. All the IO peripherals of the IO-control core can be selected as the media to transfer the program codes. This functionality is fully controlled by the Software Bootloader program. A programming device is attached to the selected IO peripheral to communicate with the IO-control core.

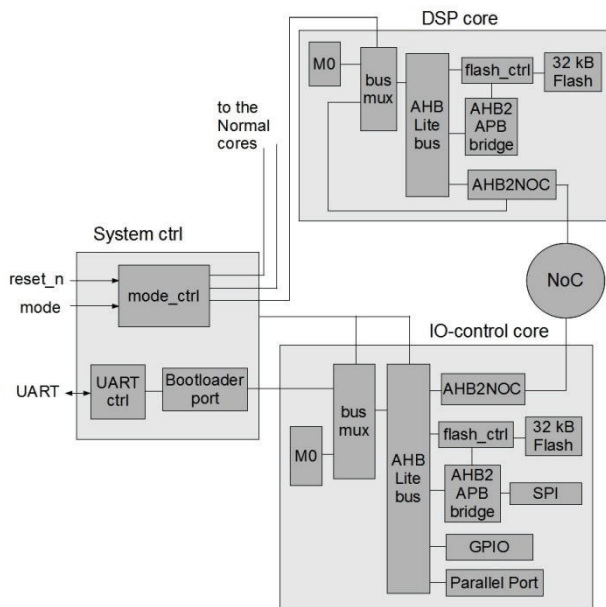


Fig. 3 Software Bootloader Architecture

IO-control core utilizes the NoC interconnect to transfer the application program codes to the DSP and the Normal cores. In this Software Bootloading mode, the AHB2NOC of the DSP and Normal cores take over the AHB-Lite bus of the corresponding cores. Once the IO-control core receives the program codes, it transfers the codes to the AHB2NOC module of the selected destination core. The AHB2NOC module of the destination core then generates write transfer to its flash memory to write the program codes. The IO-control core can also be programmed to write an application program codes to its own application program partition.

## IV. DEBUGGER DESIGN

The proposed debugger design focuses on transferring the individual cores debug data. The debug event is initiated by one of the processor cores. Once the debug event is triggered, the debug data from all the cores are collected and transferred out the chip. During this time, the processor cores are halted until the process is finished.

### A. M0 Processor Halt Mechanism

To ensure that the M0 processors are able to recover from the debug halt, we utilize the Non-Maskable Interrupt (NMI) of the M0 processors. After one of the cores starts the debug event, NMIs of all the M0 cores are pulled high. The M0 processors automatically go to the NMI service routine. In the middle of the process of the cores loading data to its stack memory, the M0 processors are halted by using the HREADY signal until the debug process is done.

### B. Debugger Architecture

The architecture of the debugger is shown in Figure 4. When the processor cores are halted, the controls of the AHB-lite buses are given to the AHB2NOCs and the Hardware Debugger. In RUMPS401, AHB2NOCs of the DSP and Normal cores control the buses of the corresponding cores. The Hardware Debugger controls the bus of the IO-control core.

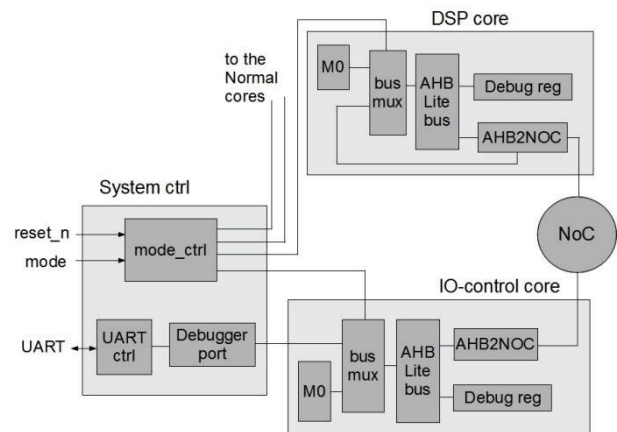


Fig. 4 Debugger Architecture

The AHB2NOCs of the DSP and Normal cores read the debug data from the corresponding core's debug registers and sent it to the IO-control core. The AHB2NOC of the IO-control core collects these data. The Hardware debugger then reads the data in IO-control core's debug register and AHB2NOC. The combined data are transferred out through the UART interface. The process then repeated until all the debug

data from the cores are latched out. Once the process is finished, the M0 processors are released and able resume the operation until the next debug event is triggered by one of the processors.

## V. PERFORMANCE ANALYSIS

We evaluate the performance of the proposed Bootloader and Debugger designs by utilizing the RUMPS401 chip simulation model. The model is written in RTL abstraction level. A hierarchical verification platform, written in System Verilog verification language, is used to drive the test patterns and sample the results. The verification platform is the part of the other research project from UTAR VLSI research center [17]. All the simulations are run with the VCS tool from Synopsys.

### A. Bootloader Performance

To measure the Hardware and Software Bootloader performance, we use the implemented Bootloader architecture to load some amount of codes to the flash memories of the cores. The UART interface is set to work with 15200 baud rate. The system clock frequency is at 16 MHz.

TABLE II  
Hardware Bootloader code load time

program size	load time (ms)
1 kb	381.81
2 kb	762.84
4 kb	1524.90
8 kb	3049.01
average (1 kb)	381.40

Table II shows the measurement results of the time durations to load program codes through the Hardware Bootloader. In average, the Hardware Bootloader is able to load 1 kB of data in 381.40 ms. The performance of the Hardware Bootloader is limited by the transfer of the program codes through the UART interface. However, this Hardware Bootloader is only used to load the Software Bootloader program. Usually, the size of this Software Bootloader program is relatively small.

TABLE III  
Software Bootloader code load time (1 core)

program size	load time (ms)
1 kb	58.45
2 kb	116.90
4 kb	233.81
8 kb	467.63
average (1 kb)	58.45

The performance of the Software Bootloader relies on the type of the IO interface to retrieve the program codes. In our measurement, we utilize the 32-bit parallel port interface of the IO-control core. There are two Software Bootloading test scenarios. In the first test scenario, the Software Bootlaoder architecture is used to load an application program codes to one of the Normal core. In the other scenario, the Software Bootloader concurrently loads codes to the two Normal cores and the DSP core.

The time durations to load program codes to a single Normal core are shown in table III. The average program loading time is significantly faster as compared to the Hardware Bootloader's. The selection of the type of the IO interface can be a tradeoff between the application program code size and the external programming hardware resources.

Table IV shows the time durations to load program codes to three cores. There are no significant differences as compared with the earlier results due to the capability to perform parallel writes to the flash memories of the cores. The codes are distributed simultaneously through the NoC and the AHB2NOC in the three cores independently write to the corresponding flash memories. The additional time durations are only contributed by the codes loading through the parallel port IO.

TABLE IV  
Software Bootloader code load time (3 cores)

program size	load time (ms)
1 kb	59.34
2 kb	118.69
4 kb	237.40
8 kb	474.80
average (1 kb)	59.35

### B. Debugger Performance

In the RUMPS401 chip, the Debugger architecture loads two types of debug data, the M0 core's internal registers and user defined debug data. The size of the M0 internal registers is 80 bytes and the user defined debug data is 16 bytes. In total, during one debug event, the chip outputs 384 bytes debug data from four cores.

TABLE V  
Debugger data load time

debug data size	load time (ms)
384 Bytes	121.16

Table V presents the required time to load the debug data in one debug event. The time duration is measured from the start of a debug event, triggered by software,

until the last data is loaded through UART. The UART operates with 15200 baud rate.

## VI. CONCLUSION

The proposed Bootloader and Debugger designs provide scalable architectures to load application program and perform the debugging for an NoC-based MPSoC. The Bootloader and Debugger design utilize the NoC interconnect and the IO peripherals in the chip. The key idea is to deliver basic debugging and bootloading feature in low hardware overhead design. This simple design offers relatively inexpensive solution and support fast time-to-market approach. The utilization of the NoC to transfer the data across the cores is the key to achieve the scalability.

Future works to improve the Bootloader and Debugger design include providing a better IO peripheral to replace the dedicated UART. This can be done to improve the Hardware Bootloader and the Debugger loading time. In the other hand, the Software Bootloader performance is highly affected by the variety of the IO peripheral. More Debug feature such as break points can also be added. In addition, a switch to select which core to have its debug data to be latched out will give better control and performance especially when the number of cores grows.

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# **Interactive Media Design and Mobile Technology**



# Cyber Village Environmental Security and Early Warning Base On SMS Gateway and CCTV Integrate

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**Abstract**—In general, social life in the village or villages in Indonesia for the security aspects, supervision and early warning systems in the neighborhood residents still manual by using the traditional system termed the siskamling (“sistem keamanan lingkungan” Environmental Security System), by the use of the gong or patrols by village officials/village while using loudspeakers or hitting objects that can emit a loud noise in case of contingency in the region, such as the incidence of theft or natural disaster. Responding to the development of an evolving technology, it is possible to develop a surveillance system that is efficient living environment with CCTV for surveillance technology, speakers are integrated into the system for early warning and SMS Gateway so that people can come into play to give the latest information and update the database for the mutilation of events the environment so that the future can be used as an evaluation for government officials and the public. In practice, researchers built a wireless network infrastructure to connect all devices (PC Server, CCTV, SMS Gateway) needed for this system to work. Researchers also makes special software to receive SMS containing the emergency message from the citizen where the prearranged delivery format for several emergency conditions, then system will broadcast message to all user (citizen) was registered. The real impact of these results is the reduction in the incidence of theft and robbery on the environment and the anticipation of early disaster for the citizens so as to minimize losses and cultivate an attitude of caring and mutual help among local residents.

**Keywords:** *Cyber Village, Early Warning, Security, SMS Gateway, CCTV*

## I. INTRODUCTION

In general, social life in the villages in Indonesia for safety and surveillance and early warning system is still manual by traditional system in the form of SISKAMLING (sistem keamanan lingkungan). Siskamling is security models together is usually carried out by a group of citizens who dwelt in the area and usually use a gong or patrolled by village residents, using loudspeakers in case of contingency in the region, such as the incidence of burglary or natural disaster. Although it has long been used, the system has some weaknesses, including patrol officer is generally limited to the responsibility of a wide area, making area supervision less than the maximum, the other drawback is the lack of material to be studied further evaluation in case of similar cases [1].

Technological developments that occur at this time, it is possible to develop a long ways to be more efficient by providing additional technology on some sections, by using the CCTV in strategic areas to monitor the state of the region as a whole, provision of emergency information services using SMS technology (Short message Service), where if there is a public emergency incident simply send an SMS with the use of a specific format to a predetermined number, then be accepted by the server, then the server will automatically broadcast to all users who have registered previously, Recording emergency events which occurs in more regular society and the future can be used as an evaluation for the government or society so that patterns can be evaluated for certain events, all forms of activity will be recorded by the system and stored in the form of log file [2] [3].

The main objective of this research will be to maximize the use of siskamling and Early Warning System in the Village become more efficient in its implementation [1] [4]. The virtue of this research lies in the aspect of the utilization and development of existing technologies to further apply to activities that are common in the social life of the community in Indonesia.

Basic changes in the Early Warning System in which government officials become the executor or administrator and citizen became the object or purpose of this early warning but can also serve as a community organizer and warn other community members. Making an application which can receive and process SMS received from the modem GSM/CDMA or Cellular Phone connected to the Server [2]. CCTV utilization to monitor the Village, this technology is still fairly new and only used by a minority of people in this country. Utilizing the database to record the events of the disaster or emergency so that an evaluation can be made of materials that can be studied by government officials and the public. The innovations that are written above can be applied simultaneously or separately used for specific needs [4] [5].

## II. RELATED WORK

### A. SMS (Short Message Service)

Short Message Service (SMS) is a service electronic messages can be done via a mobile phone to send or receive

short messages. At first SMS was designed as part of GSM, but is now found in other mobile networks including UMTS network [2] [6] [7].

An SMS message consists of a maximum of 140 bytes, in other words, a message can contain 140 characters 8-bit, 160-character 7-bit or 16-bit 70 characters for Japanese, Chinese and Korean languages that use Hanzi (Kanji Script / Hanja). In addition to this there are 140 bytes of other data included. There is also some methods to send a message that more than 140 bytes, but a user must pay more than once [11][12].

SMS can also to send pictures, sounds and movies. This form is called MMS SMS. SMS messages sent from a mobile phone to the message center (SMSC), here the message is stored and try to send it over several times. After the allotted time runs out, usually 1 day or 2 days, then the message is deleted. A user can get confirmation of this message center [6] [7].

SMS is very popular in Europe, Asia and Australia. In the United States of SMS rarely used. SMS popular because it is relatively inexpensive. Because of the difficulty typing or to save space, usually abbreviated-short SMS message. But the obstacle has been overcome because many cell phone that has a dictionary function.

### B. Closed Circuit Television (CCTV)

Closed Circuit Television (CCTV) means use the signals that are closed, not as an ordinary television broadcast signal. In general, CCTV is used as a complementary security and is widely used in industries such as military, airports, shops, offices, factories and even now housing had been many who use this technology.

CCTV as an integrated system that has some camera gear. CCTV camera is functioning as a picture taker, there are several types of cameras that differentiate in terms of quality, the use and function. The main thing is that there are two types of cameras, analog CCTV cameras and CCTV Camera Network where analog cameras using a solid cable for each camera, which means, each camera must be connected to the DVR or system directly while the Network Camera or commonly called IP camera, can use the network, which means it will save in terms of installation because the network is parallel and branching does not require a special cable for each camera in accessing. The development of advanced electronic technology utilization of IP Camera is integrated with wireless systems and even some of the equipment has been integrated with a wireless sensor network components so it is possible placement in an area that may be difficult even impossible to reach by humans [8] [9] [13] [14] [15].

The second is the completeness of DVR (Digital Video Recorder), this is the system used by CCTV cameras to record all the images sent by the camera in this system are many features that can be utilized for supplementary security, one of which is to record all events and these recordings used in court to prove an event based camera recording, the number and quality of the recording will be determined by DVR.

### C. Early Warning System

Early Warning System is a set of systems to inform would be the emergence of natural events, can be a disaster or other natural signs. Early warning to the public for the disaster was an act of giving information in a language that is easily digested by the public. In critical circumstances, the general warning which is the delivery of information is realized in the form of a siren, gong and others. However sirens are just part of the form of delivery of information that needs to be done because there is no other faster way to deliver information to the public [17]. The hope is that the information can respond quickly and appropriately by citizen. Alertness and reaction speed is necessary because narrow time when the release of information by the time of (alleged) the coming disaster. Critical condition, while narrow chance, major disasters and rescue the population are all factors that require an early warning. The earlier information is submitted and accepted by the community, the more loose time for residents to prepare for and respond [10].

The release of information about the condition of danger is the outcome of a process flow analysis of raw data about the source of the disaster and the synthesis of a variety of considerations. The accuracy of the information can only be achieved if the quality of analysis and synthesis that leads to the release of information has a high accuracy. Thus in this case there are two main parts in the early warning that the upstream side in the form of attempts to package the data into the appropriate information in the form and into downstream businesses to quickly reach the information society.

## III. DESAIN MODEL AND IMPLEMENTATION

On the application of an early warning system to the scope of a small area like District (village) still use siskamling (sistem keamanan lingkungan) manually whose implementation is still less efficient.

By adding the latest technology and innovation in some parts of the siskamling expected to increase the efficiency of the system making it more flexible as an early warning system for society and reliable in terms of data or a history of events that have occurred so that an evaluation can be made of materials that can be studied by government officials and society. Systematic study was designed as follows:

- Identification of variables, namely the factors that influence in a research. There are several variables in a research. To determine the effect of a variable to another variable. Observations carried out on these variables, and measure variables that influenced. Meanwhile, another variable is made permanent (controlled) to isolate the phenomena that may affect such observations. There are also variables:
  - The independent variables, namely environmental conditions, calamity, disaster, or other emergency matters.
  - Dependent variables, namely society.
  - Variable controlled, ie CCTV equipment, mobile phones, wireless media to connect CCTV, PC Server, a software created and used and electric power.





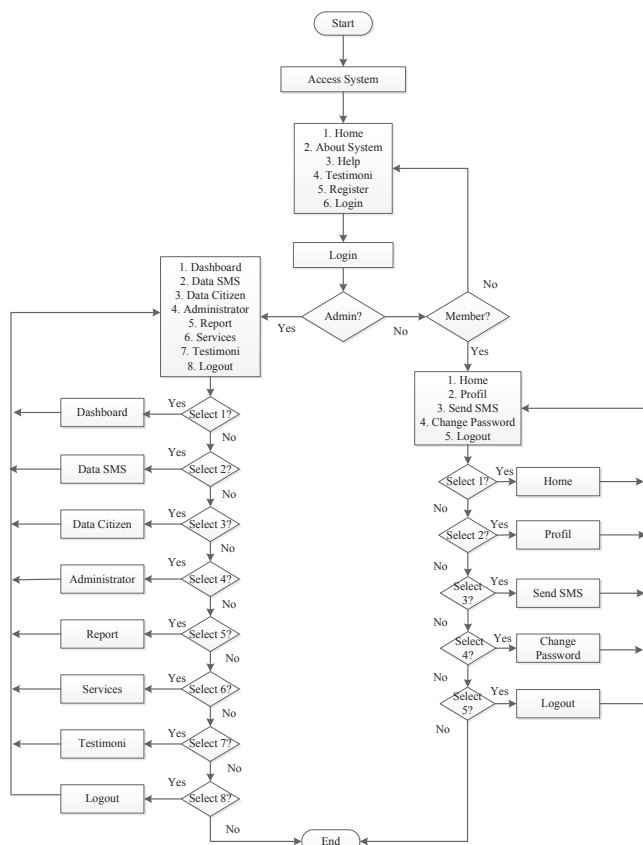


Figure 3.3 Flowchart website system

#### IV. EXPERIMENTAL RESULTS

The results obtained form of a system designed with the programming language PHP (Hypertext Preprocessor) and MySQL database to establish an early warning system for society (early warning system) and environmental safety by implementing SMS Broadcast technology. This system is applied as a substitute for the gong function is often used by people in safeguarding the environment. Residents will be able to send SMS warning disaster, threat or danger or has happened to the system are made. Each SMS sent by citizens will be processed by the system automatically and to broadcast messages to all mobile numbers of citizens registered in the system database. Based on Flowchart Figure 3.2 illustrates the SMS Broadcast workflow system. When citizens send SMS to number the server with a particular format, then the system will automatically process the SMS. The following SMS format that is used on this system:

- 1) Registration of citizens : REG#NAMA#NO. KTP#ALAMAT#PEKERJAAN
- 2) Information systems : INFO
- 3) SMS alert fires : EWS#1#PESAN
- 4) SMS theft warning: EWS#2#PESAN
- 5) Send SMS to all citizens: EWS#3#ISI PESAN
- 6) Unsubscribe: UNREG



Figure 3.4 How to use the application a. The message does not fit the format, b. displays information on the registration of new users, and, c. when residents managed to register to the system



Figure 3.5 Service early warning. a. EWS for category 1 b. EWS for category 2 and c. EWS to category 3

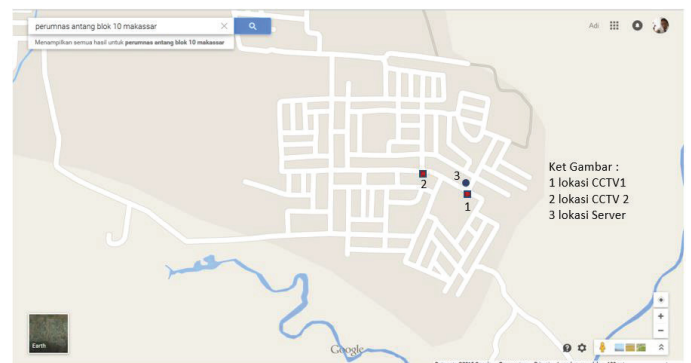


Figure 3.6. Map location and layout placement device

Figure 3.6 shows a map of location implementasi research. The area is an area that is prone crime in Makassar so with a touch of this technology is expected to be a solution for people who have chosen to settle in the area.



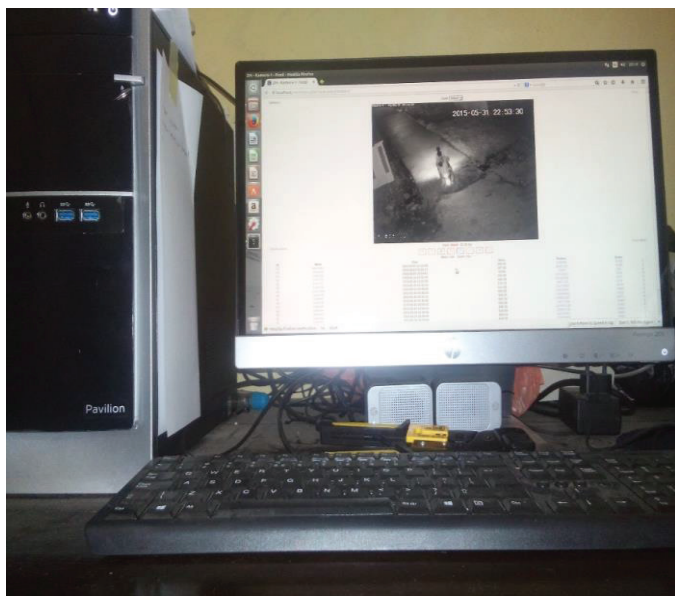


Figure 3.7. CCTV server and SMS Gateway

Figure 3.7 shows the display server placed in homes in the area inplementation. This server based ubuntu with core i5 specifications. CCTV DVR for recording activities is not used because the function of the server is very representative and it is possible to put the system SMS Gateway Server and Server CCTV are on one PC server.



Figure 3.8. Monitoring system using Android

Figure 3.8 shows that capture the results display in the view using android smartphone. From the picture looks view of the camera 1 and camera 2 does not appear because of the problem of electricity power supply to the device again problematic.

## UTILIZATION ANALYSIS SYSTEM

The effectiveness of these systems can be tested and housing solutions for highly vulnerable to the security system and social life of the community. The main thing is that when there are events that happen, the integration of the SMS Gateway CCTV and this will be the solution. Broadcast SMS will directly inform all of the citizens when there is an indication of anticipated disasters or catastrophic events that could be done earlier. Then CCTV will record the activity. Simplicity that this system can be accessed by mobile by all citizens and can be monitored directly. It just takes a sizable fee for the procurement of this system. But this will be greatly outweighed by a sense of security.

Some drawbacks are perceived by researchers are as follows:

- Public awareness is needed to be able to maintain this system, let alone the equipment components are placed in an open area and it is possible at damaged by people who feel uncomfortable.
- For the continuation of required system administrators figure who can do routine maintenance, because the system is not ever need to be restarted, especially CCTV.
- Procurement of this technology is still considered citizens fairly expensive, though this is their need.

## V. CONCLUSION

Results from this study strongly felt directly benefit the local community, and be a suggestion in themselves that at any time they need help then the system could be the solution. Some people from the local community have commented with this system they feel something different than before and expects update technology and equipment additions. Several conclusions can be drawn:

- Integration of CCTV systems and SMS Broadcast is a very good collaboration for the anticipated environmental security system.
- Early warning system (early warning system) be a solution in disaster-prone areas and social evils.
- Integration of the system is running well by using the same server.

After observing the results of the implementation of this research, then some of the things that we see are still needed for the completion of this system, namely:

- This system will be very good if it is able to make adjustments and be able to recognize the characteristics of the type of disaster so that the system automatically sends a message broadcast all of the citizens.
- Early warning sirens were able to arrange the words automatically, according to broadcast messages can

also be a solution that is integrated into mosque loudspeakers wirelessly.

### ACKNOWLEDGMENT

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# Parent-Child Interaction In Correlation With Interactive Design Of Finger Puppet

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**Abstract**— This study discusses analysis of interactive design, which can be used to facilitate parent-child interaction with finger puppet metaphor. A narrative approach is described selected studies and field with interconnected hypothesis. Multi touch screen, augmented reality and kinect analyzed as interface that allows used by many people at one time. Literature study on child development, finger puppet field, and hand gesture recognition are needs to presents what it needs to produce analysis the correlation. The analysis of suitable media used by parent and child, and literature study are combined to define the right way to produce product that support communication between parent and children, but also had value of immersion display. After comparing several interfaces, this paper concludes that augmented reality can be used to add the experience in storytelling with finger puppet, and augmented reality have opportunity to maximize their use in developing the story.

**Keywords**— *parent-child interaction, interactive design, finger puppet*

## I. INTRODUCTION

Quality time, term that often used nowadays by parents to spend their time with their children. Parents spend their valuable times with many activities. Parents often overwork because they need to survive economically. The less they had time with their children, more valuable the value of parent-children quality time. With the tiny bit of their time they have to teach their children with moral-social value. This is become problem when parent do not know how to spend their quality time. Some parent had seminars about parenting, read books and articles, build a community so that they can share their how-to and learn more for their children's education and development. All these efforts are made with the same question, how to fill the quality time with the kids?

Some parents that are busy with work or confused by how to handle their kids would rather give their kids gadget in order to make their kids behave and silent. This is to keep the child calm and under guard while they are busy playing games.

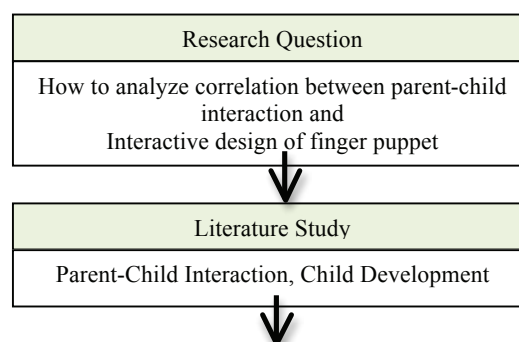
The use of technology has become out of control towards children under the age of 10. With the increase quantity of technology usage, the amount of people that are against the technology for kids increased significantly. Parents doubts the safety of technology towards kids and confused whether it is right to let them play with it. Seto Mulyadi as child counselor [1] has limited the access of gadget towards kids under the age of 10. This is to avoid the changes of children behavior for being introvert and unsocial.

Kristina E. Hatch in her study discussed the pro and con of technology towards children, for technology could make children lessened the ability to do multitasking work. Further more it is said that children spend more of their time on gadget, which makes them focused and engaged to it, that disturbs their social life. This kind of matter affect the children brain development, which was caused by the habit of splitting focus to several kinds of tasks, effects the ability to focus on one singular task [2].

Several researchers conclude that a multitasking person have difficulty to focus on one particular task and makes it hard for them to select the important problems that leads to stress and depression. The fact that limitation use of technology has become uncontrolled, parents are strictly notified to give limitation on medias that suitable for kids and also involve in guiding the usage of media in order to give a positive outcome towards children.

These days, lot of medias created that involves parents and child to interact in an application. Various types of interfaces are made to give an immersion image for both child and parents, without forgetting the main purpose of child development.

Focus of this study is to compare between several media interfaces that involves two or more users in same place and time under one medium, then analyze the media interfaces that are suitable for support interaction activity between parent and child. Hopefully from this evaluation, a medium that is suitable for interaction between child and parent is earned, and would be able to deliberate the massage of bonding between parents and child.



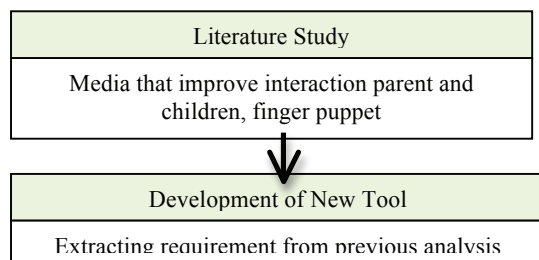


Fig. 1. Methods of the study

## II. PARENT-CHILD INTERACTION

### A. Early Childhood Development

According Rahman [3], characteristics of early childhood development could be seen from:

- Physical-motoric Development

Physical-motoric development divided into 2 parts, rough motoric and mild motoric. Rough motoric development of 3 years old age can be seen with a simple basic movement. 4 years old could take a risk and carefully on action. 5 years old could be more confident than before and competitive.

Mild motoric on 3 years old age already holds pencil near the point in preferred hand, and uses it with good control. 4 years old build tower carefully, 5 years old can active and skillful doing various stunts activity and moves rhythmically to music.

- Cognitive Development

According Piaget's theory, cognitive development divided into 4 stages that describe how people's intelligence change as they grow older, (a) sensorimotor (birth to 2 years old) the baby constructs an understanding of the world by coordinating sensory experiences with physical actions, (b) preoperational (2-7 years old) stage of the child begins to represent the world with words and images, (c) concrete operation (7-11 years old) stage of child can reason logically about concrete events and classify objects, (d) formal operation (11-adulthood) stage of the adolescent reason in more abstract and logical ways [4].

- Socio-Emotional Development

1- 1,5 years old age kids likes to be in sight and hearing of familiar people, both on request and spontaneously, emotionally labile and closely dependent upon adult's reassuring presence, plays contentedly alone but likes to be near familiar adult or older sibling.

2 years old age kids defends own possessions with determination, resentful of attention shown to other children, particularly by own familiars, and unwilling to defer or modify immediate satisfaction of wishes.

2,5-3 years old age kids are emotionally still very dependent on adult, shows some appreciation of difference between present and past and of the need to defer satisfaction of wishes to the future.

4 years old kids are need companionship of other children with whom he is alternately cooperative and aggressive, but

understands need to argue with words rather than blows, understands taking turns as well as sharing.

5 years old kids are more sensible, controlled and independent, show definite sense of humor, and comforts playmates in distress [5].

- Language and Speech

1-year-old age kids may use a few words and understand simple instructions associated with gesture (holophrastic).

1,5-2 years old age kids say a few recognizable words spontaneously in correct context and understand and obey simple instructions (telegraphic). 2,5-5 years old age kids could talk in long monologues and listen eagerly to stories, tell long stories, sometimes confusing fact and fantasy [3].

### B. Quality Time Parent-Child

The most important factor in quality time is not the event itself but that parent and child do something together [6].

Mental development of children begins from the ways their parents provide communication and interaction with children. Children will be successful in their social life, if get full attention from their parents. In fact, children more interact with gadget than the parent. Children more influenced by television, cyber hood, games yet they need the strengthening influence of personal time with their parents.

All children love stories. Chapman recommended parent to often tell story to their children. Michigan State Board of Education researched that parents and teachers needs utilize drama and the arts to fully engage child in learning and encourage role-play and problem solving of classroom situations or reinforcing positive social skills. Parents could give their child view images and the other media materials for variety purposes such as to gain information, pleasure, to add their understanding, for visual cues or creative purposes. The three and four year's old age range could gain information from listening conversations, stories, songs, etc. [7].

Parents could storytelling their children through conversations so that moral education and kindness perceived by children. During or after a story, parent could let their child to identify his feelings about the events or characters and talk about them.

Many kids do not seem understand their behavior is tied to their feelings. They lack a key to controlling their behavior.

## III. REQUIREMENTS OF MEDIA FACILITATE PARENT-CHILD INTERACTION

### A. Impact of Finger Puppet for Early Childhood

According Suharto and Iryanto on Maryam [8], finger puppet is a doll made by flannel materials the formed according pattern. Finger puppet made so that can be insert into human fingers. Finger puppet used to convey moral message through storytelling and Puppet Theater, which is driven by fingers.





Fig. 2. Model of Finger Puppet [9]

Storytelling is one of the most used method to teach early childhood a moral value, religion, social-life, culture, etc.

According Maryam, finger puppet can increase development aspect of children such as (1) children willing to invite friend to play, (2) love to help others, (3) forgiveness, (4) and always be grateful.

Finger puppet can help early childhood education through stimulating, guiding and provide fun learning activities. Parents could provide an interesting story, then respond and give direction for child behavior afterwards.

#### B. Real-Time Hand Gesture Recognition

Interaction between human comes from different sensory modes like gesture, speech, facial and body expressions. The state of art of HCI presents the facts that controlling the computer processes gestures of various types of hand movements have been used.

Liu and Lovell implement a technique for real time tracking of hand capturing gestures with the use of a web camera, personal computer and image processing algorithms making it more users friendly.

Based on Rautaray et al. research [10], resulting gestures for virtual and augmented reality applications have experienced one of the greatest levels of uptake in computing.

Furthermore, their research found that sign language is an important case of communicative gestures. Since sign languages are highly structural, they are very suitable as test beds for vision algorithms [11].

#### C. Review of Interaction Design That Facilitates 2 Players Or More In The Same Time

Interaction design is about shaping digital things for people's use [12].

Previous researches have been designing interaction design that allows 2 or more players. Parent-child interaction will occur by multiplayer usable device. Result of the researches will analyze in terms of usability, behavior, advantages and limitations.

##### 1) Multi-touch Screen

According to Tresnadi [13], Jefferson introduced multi-touch screen technology. Han, an interface researcher in New York University said in his presentation, multi-touch screen device is capable of giving reaction to multiple touches of fingers. This device is applicable like an ordinary computer that can run multiple orders and application at once with touch as its controller.

This device is divided into two categories, Frustrated Total Internal Reflection (FTIR) sensing technique and Diffuse Illumination (DI) sensing technique. FTIR is a way to defuse infrared randomly around the transparent glass to create pattern for detecting several types of interactive gesture on an interface. FTIR is known for reading gesture with a highly sensitive accuracy.

While for DI has a similar ability to FTIR, but only it collects infrared rays into one point across the window. It is able to read sensitive gesture to produce response.

##### 2) Augmented Reality

Carmigniani et al. [14] define Augmented reality as a real time direct or indirect view of a physical real-world environment that has been enhanced/augmented by adding virtual computer-generated information to it.

AR uses different method of computer vision mostly related to video tracking. These methods usually consist of tracking stage and reconstructing stage. Connection made between the 2D image and 3D world frame, and projecting 3D coordinates of their feature into observed 2D image coordinates. The constraints for camera pose estimation are most often-determined using point features. The reconstructing stage uses the data obtained from the first stage to reconstruct a real world coordinate system.

There are 3 types of displays used in Augmented reality such as head mounted displays (HMD), hand held displays and spatial displays.

HMD is worn on the head as part of helmet and that place image of the real and virtual environment over the user's view of the world.

Hand held displays employ small computing devices with a display that user could hold in their hand. Video-see-through techniques used to overlay graphics onto the real environment an employ sensors [12].

Bimber resulted on Carmigniani et al. [14], Spatial Augmented Reality use of video-projectors, optical elements, holograms, radio frequency tags, and other tracking technologies to display graphical information directly onto physical objects without requiring the user to wear or carry the display.

##### 3) Kinect Sensor

Because of the nature of optical sensing, quality of captures images is sensitive to lighting conditions, made traditional vision-based hand gesture recognition are still far from satisfactory for real-life applications. One of the ways is to use other sensors to capture the hand gesture or motion through the data glove. This is requires calibration, it is inconvenient to use and may hinder the natural articulation of hand gesture. Such

data gloves are usually more expensive than optical sensors. Kinect sensor tried to solved that matter. Kinect sensor can detect and segment the hands robustly. Many recent in applying the kinect sensor to articulated face recognition, human body tracking and human action recognition.

Ren et al. [15] in their research of kinect sensor, resulting hand detection and hand gesture recognition. On hand detection, firstly detecting the hand shape, then represent it as a time-series curve. Such a shape has been used for classification and clustering of shapes.

The time-series curve records the relative distance between each contour vertex and a center point. On hand gestures recognition, used template matching for recognition [15].

The input hand is recognized as the class with which it has the minimum dissimilarity distance with the template. The other way, used finger-earth mover's distance (FEMD). This way based on Rubner et al. Earth Mover's Distance (EMD) to measure the distance between signatures. EMD applied to shape matching and contour retrieval. Somehow to measure the FEMD distance between hand shapes, represent the hand shape as a signature with each finger as a cluster to detect finger parts from the hand shape [15].

TABLE I. COMPARISON OF INTERACTION DESIGN

<b>Multi-touch screen</b>	
Behavior	Scattering / Gathering rays direction of infrared on transparent medium (glass/acrylic board) that form a pattern to catch various gesture interactions as input
Advantages	One display can be used by 2 persons or more at the same time
Limitation	Require a wide screen as input and display device.
<b>Augmented Reality</b>	
Behavior	The methods consist of tracking stage and reconstructing stage. The constraints for camera pose estimation are most often determined using point features
Advantages	AR uses method related to video tracking. The minimum required device is smartphone.
Limitation	Features based on capabilities of device in term of input interaction and display
<b>Kinect Sensor</b>	
Behavior	Detect the shape, the represent it as a time-series curve
Advantages	Ability to capture more detail movements of user
Limitation	Require sensory device

#### IV. ANALYSIS OF CORRELATION INTERACTION DESIGN AND PARENT-CHILD INTERACTION ON FINGER PUPPET DIGITAL

Based on review of interaction design on table 1, we conclude that some interface could use by multiplayer once time. Multi-touch screen, Augmented reality and kinect sensor have their classification and behavior that provide multiplayer usability.

Technology nowadays not only provide one player game, but for more player on one device. This way will help people to build self-personality and social skills. Children counselor opinion to keep away child from their gadget will lessen if

designer could design the best application so that meet good aim, and could be choice to give to the children.

Some of interaction design had been analyzed, have many kinds of input methods. Hand gesture, additional device, or natural motion of body can be used as input. Media usability should meet with the function of application to ease the parents and the children assessment, do not require additional cost for additional device, and easy to use. From analysis of table comparison, showed that augmented reality can handle this purpose.

Designing for children, consider the right design for the mental development, even how to use and visualization. Designing finger puppet based digital media with the aim of providing facilities for parents and children storytelling with interactive media, then adapt the conventional method and combined with interaction design.

Review of some interface to analyze the interface that possible to be played by some people, as long as hypothesis children could play with their parent.

User of this product aim for early childhood with hypothesis the children are able to understand the meaning of sentence and recognize objects, which added by image, animation and sound. According Sheridan wrote that 2,5 years old age could use two hundred or more recognizable words, but speech shows numerous immaturities of articulation and sentence structure and enjoys simple familiar stories [5]. According Rahman, 2,5-5 years old age kids could talk in long monologues and listen eagerly to stories, tell long stories, sometimes confusing fact and fantasy, and 3 years old can hold things, are emotionally still very dependent on adult. From cognitive perspective, 2-7 years old is in very egocentric phase. They assume others see the world the same way they do. Children do not yet have ability to see others points of view [3].

From the information above we can conclude that there are three important things to investigate so that be the base of creating finger puppet digital.

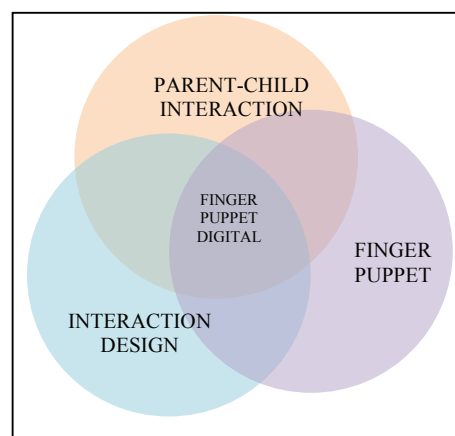


Fig. 3. The Correlation Between Three Fields

Therefore, design of application based metaphor to adapt finger puppet methods of storytelling. Hand based gesture is used to move puppet as input, then will translate by interaction design.

Wang et al. [16] has conducted previous research to virtualize Taiwan Puppet Show with Augmented Reality as an input. They analyzed finger gesture to operate a virtual puppet in real time by simplifying the movement of hand into geometric patterns. It gives the possibility that the finger puppet with base of augmented reality can be developed towards more effective to use in interactions between parents and child.

TABLE II. QUALIFICATION OF PRODUCT

	QUALIFICATION
<b>USERS</b>	Young child 2-5 years old
<b>AVAILABILITY</b>	Includes 2D and 3D animation, sound
<b>USABILITY GOAL</b>	<ul style="list-style-type: none"> <li>• Safety for child</li> <li>• Easily executed by parents and children</li> <li>• Efficient and effective</li> <li>• Do not need additional device</li> </ul>
<b>VISIBILITY</b>	Difference between buttons color and characters color to make the contrast with the surrounding
<b>FEEDBACK</b>	Feedback is obtained by recognize hand gesture based pattern which in database system then read as a command to manipulate visual on display
<b>CHARACTER</b>	Based on animal are familiar or local content such as folklore
<b>INTERFACE</b>	2D or 3D based augmented reality, which can manipulate through Real-Time Hand Gesture Recognition.

The behavior, availability and limitation of each interface, consider to choose media usability, so that parents and children easy to identify 'how to use' and do not have trouble in capture the value.

#### CONCLUSION

Advances in technology allow parents to provide interactive media for play with their children in their quality time. Media are build with the concept of immersion interface, could give add value when parents do storytelling to their children. Finger puppet is used as media to telling a story could adapt as immersion interface, with addition of real-time hand gesture recognition to read hand movement input into manipulate visualization of display in augmented reality. Augmented reality has effectiveness to provide product because user do not need additional device, which better that the other media that require additional device.

Prospects for the future is that use of technology to increase interaction of parents and children in the real world. Media in

the future with the progress of technology development is increasingly pervasive in the real world, can be used all the benefits as much as possible to help the development of children. The use of media such as augmented reality can also stimulate motoric for children by maximizing the function, which adds another dimension to the real world as its use in some games and applications. Designers should pay attention that the application design will actively involve parents in the use of technology with children to reach the aim of creating a good interaction in the family.

By utilizing interactions using augmented reality in an effort to interact with the children it might be possible to building other applications are added to the daily activities with the children.

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# *Interactive Media*

## *Introduction to Motion Dance*

### *And Visual Meaning of Topeng Malangan*

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**Abstract—** The growth of technology is the identity of the spirit of the age that makes traditional cultures must be able to adapt to the state of the times in order to survive and Topeng Malangan Dance is one of them. Topeng Malangan is one of the distinctive culture of Malang which has 76 players of different characters in the story. A large number of characters that are owned by Topeng Malangan certainly has many meanings that want to convey from the mask of that or of the dance movements of each character are also a manifestation of the character of human nature, is a potential as a visual element to be published in digital form as a interactive media. Based on the reasons, it will be designed interactive learning media of Topeng Malangan in an attempt to re-popularize the Culture of Topeng Malangan and to provide awareness of the existence of the Topeng Malangan through visual elements of interactive media. With the theory ATUMICS by Adi Nugraha, in transforming the culture, conducted this research with qualitative methods to classify visual elements of Topeng Malangan defined in the model WASBUMIL (*Werno / Color, Alis / Eyebrow, Sumping, Brengos / Mustache, Ukiran / Engraving, Moto / Eye, Irung / Nose and Lambe / Mouth*) as a basis for designing interactive learning media. In this case the author also provides an alternative execution of interactive media products which have been designed in the form of a virtual character with motion capture technical as an added value which will give a special attraction in the application of interactive media.

**Keywords—** *Topeng Malangan, Interactive Media, Virtual Character*

#### I. INTRODUCTION

Motion and rhythm, expression of the human soul that is disclosed by the beautiful rhythmic movements. Movement that emerged in the expression of all human emotional experience. Appears based on several motivations, where encouragement is not based on the willing of the mind but a desire that comes from the heart, the feeling that grow as very strong vibration, to rule over all organs of the body moves .. Dance.

Topeng Malangan dance is a fusion between human faces and puppet with rigid dance movements. This style is better

known by the Malangan style which means strong and depicts a knight. Topeng Malangan dance comes from Kediri, created by Airlangga, the son of Dharmawangsa Beguh. Then he spread the art of Mask dance to Singosari kingdom led by Ken Arok. Topeng Malangan is a unique art which grows around the area of Malang (the former Majapahit in East Java). Known as the masked art in the kingdom of Kediri, and use the Panji's character since the Majapahit era.

The standard of Topeng Malangan there are 6 types, namely: *Klono, Bapang, Asmoro Bangun, Sekartaji, Gunung Sari and Ragil Kuning*. *Klono* describe the greedy and arrogant character, *Bapang* describe the wise character, *Asmoro Bangun* epitome of beauty, *Sekartaji* symbol of purity, *Gunung Sari* and *Ragil Kuning* epitome of human kindness.

The culture's phenomenon, especially traditional dance arts that grow in Java, particularly in the area of Malang East Java province which is currently very worrying . This is due to the accelerated pace of cultures that resulted in a shift in society and culture, including through the spread of culture by foreign countries that brought by the displacement of the nations, who produce mix of old and new culture create a renewal process in relation with the new invention in the form of new culture.

The emergence of various types of man-made technology has created a new culture. Starting from the culture created by the principles of old culture which is adopted and adapted to the needs of the times, such as music and dance that used to be done as part of a sacred ritual that has now shifted into an entertainment commodity, to a culture that is really new born as the impact of technologies lifestyle, such as culture in actualize themselves in the virtual world of social media.

Technology with all the conveniences that offered, make some old culture began excluded. Convenience and entertainment offer that can be accessed easily from behind the scenes to places that offer entertainment with technology and practicality make some art of traditional culture which offers entertainment also be displaced the existence.

In addition to the factors a performance of Topeng Malangan dance is impractical and the concepts are still



conventional, the introduction to art of Topeng Malangan dance among students in particular and society in general is still lacking and is still conventional, namely in the form of text and images. So that the readability of the public, especially students and young people in Malang to the arts of Topeng Malangan Dance very alarming.

Of the above problems, the authors attempted to rebuild the awareness of the existence of Topeng Malangan culture are exist in Malang. The solve is to design an interactive media to introduce the Topeng Malangan art in the form of a virtual character. Technically, Motion Capture it's used as a medium which is expected to let users interact with directly demonstrate the motion of dance. Besides technical Motion Capture is also used to increase the appeal of its own.

Based on the elaboration, the author trying to formulate a form of presentation an interactive media of Topeng Malangan dance in the form of a virtual character is related to the context of the virtual simulation in virtual form, the characters created as duplication of the real character. From the merger between this virtual character is expected to be an extra value that will give a special attraction on the segment, especially middle school students.

## II. PRESENTATION OF TOPENG MALANGAN DANCE

The life of Topeng Malangan dance is a traditional art is one of aspect that might be considered minor and insignificant for the Indonesian nation and now the situation is very alarming. The traditional art of Topeng Malangan dance, not only spectacle of entertainment, but more fundamentally, a guidance about manners and behavior of human beings living in this world. The values conveyed through visual symbols such as dance, fashion, color masks, musical accompaniment, ritualistic behavior and others all have a moral nobility, which continues to maintain the harmony and balance of life between human and the environment, and with The Creator.

This dance is a symbol for the human nature, therefore many models of masks describe the different situations, like, crying, laughing, sad, embarrassed and so on. This dance is usually displayed in a saga fragmentation or local folklore about many things especially telling stories of panji.

Presentation in Topeng Malangan dance performance generally demonstrates the character of panji or the cycle of Panji term or Panji Romance, namely: *Malat*, *Wasing*, *Wangbang-Wideha* and story of Angraeni. Presentation of a Topeng Malangan show with the sort order as follows:

- *Gending Giro* (first beating the *gending eleng-eleng*, *Krangean*, *Loro-loro*, *gending Gondel* and ends with a *gending Sapu Jagad*),
- Opened with *Besalan Lanang* dance (*Bangtih* Mask),
- *Jejer Jawa* (Kediri),
- *Perang Gagal* (interlude of *Bapang* dance),
- Scene of *Gunungsari-Patrajaya*,
- Scene of *Jejer Sabrang* (*Klana Sewandana*),
- Scene of *Brubuh* war and *Bubaran*.

Presentation of Topeng Malangan dance at the level of social function, that is when the Topeng Malangan dance was

invited to enliven a celebration. The presence of the performance is constitute a reality that is both kindship and solidarity. The reality appears in the presence of *Sing Duwe Gawe* 'host', *Sinoman* 'energy contributor', *Tontonan* 'show', and *Wong Nontok* 'spectator'. The fourth phenomenon appears in a Topeng Malangan dance performance to confirm the existence of the host (owner of intent), which puts *lungguh* 'position'. It can be listened to at the intent of *nadir* repayment 'pay a promise', or as a tribute to the spirit in the village *pundhen*.

In the Topeng Malangan Dance performance is only held on specific events and require the preparation and completeness of the property that much. The concept of the traditional performances are still making the audience have to jostle to be able to watch this show. With the impractical reason and concept of the show is still conventional, the Topeng Malangan began to replaceable position by alternate performances and entertainment more exciting with the more practical packaging technology.

In addition to the factors a performance of Topeng Malangan dance is impractical and the concepts are still conventional, the introduction to art of Topeng Malangan dance among students in particular and society in general is still lacking and is still conventional, namely in the form of text and images. So that the readability of the public, especially students and young people in Malang to the arts of Topeng Malangan Dance very alarming.

Topeng Malangan has 76 different characters, number of characters that was owned by Topeng Malangan as the embodiment of the character of human nature, is a potential as a visual element to be published in digital form as an interactive learning media.

## III. THE GROWTH OF DIGITAL ERA

Along the era thrive, the technology has changed rapidly towards the advance of globalization has affected to almost all aspects of community life. The era globalization is becoming very dependent on technological advances that can create efficiencies in its use.

A significant sign in today's digital era is a rapid growth in the sector of science and technology. The first challenges of the digital era in Indonesia is should strive to equalize or keep up with the era towards the technology growth of world, because of the technology and information growth is very rapidly. The Indonesian people must be increase the creativity in the world of technology in order to keep abreast of the todays times in conditions that completely up to date.

Digitalization in the realm of information also go through a metamorphosis in accordance with the characteristics and the paradigm of the digital era, in presenting of information and presentation the digital media information must be concise, solid and instant because of digital era people tend to know a little about a lot of things.

The growth of Information and Communication Technology at this time is so rapidly will certainly open up the horizons of our thinking that in the virtual universe there are

various kinds of information or learning resources that are unlimited. Of course we would all agree to say that we should take advantage of a wide range of information scattered in the virtual universe as a source of learning after going through a selection based on learning needs, considerations of morality, religion and others. The digital revolution has indeed brought convenience to the future, still with the consider of human rights and moral considerations.

#### IV. INTERACTIVE MEDIA AND TOPENG MALANGAN

Interactive media is a media delivery system that presents the material with computer control to the audience/users that not only hear the sound and see the video, but also give an active response and the response was that determine the speed and sequence of presentation. Interactive media has an audio-visual elements (including animation) and is called interactive because the media is designed to actively involve the user's response. Moreover, according to *Kamus Besar Bahasa Indonesia* (KBBI), interactive media is an intermediary tool or a link related to computers that are mutually inter-action and mutual relations active. From the above definition can be concluded that interactive media is an intermediary tool that is designed with the use of computers using elements such as sound (audio), pictures (visual) and text to convey a message.

Interactive digital media controlling an important role in the learning process. The successful of learning is determined by two main components delivery methods and media. The use of computer-based learning media has a significant influence on the attractiveness of the user to learn the competencies taught. Interactive classification within the scope of learning media is not with the system hardware, but rather refers to the learning characteristics of the user in response to a stimulus that is displayed screen computer monitor. The quality of user interaction with the computer is determined by the sophistication of the computer program. Scwheir and Misanchuk (1993: 11) states there are at least three levels of interaction based on the quality of the learning interaction. The third level is fully shown in the following table:

TABLE I. LEVEL OF INTERACTION BY SCHWEIR AND MISANCHUK

Table of Quality Learning Interaction		
Levels	Function	Transaction
Reactive	Confirmation	Space Bar/ Return Key
Proactive	Pacing	Touch Screen Target
Mutual	Navigation	Touch Screen Ray Trace
	Inquiry	Mouse Click
	Elaboration	Mouse Drag
		Barcode
		Keyboard-Key Response
		Keyboard Construction
		Voice Input
		Virtual Reality Interface

Due to some of the terms that have the broadest sense, the author will give some understanding of the term is based on the scope of the discussion as follows:

#### A. Virtual Character

There are several interpretations of the term character. This study has focused more on the aspect of character term figures Topeng Malangan with visual representation. While the term virtual consists of two kinds of understanding. The first is virtual in the form and the second is virtual in the sense of form and meaning. In the case of this discussion virtual character in the mean is an understanding in the sense of a more devoted to the figure of virtual or simulated. "The virtual worlds is a simulation" (Shield, Rob. 2003). Based on Rob Shield statement can be understood that the concept of Virtual is a simulation of a single object or shape simulated by digital media. Then, the meaning of virtual characters is a visual representation and dispositive of Topeng Malangan characters are packaged in digital interactive media as a simulation.

#### B. Topeng Malangan

Almost certainly most of the people in Indonesia have seen the mask. The civilization of the world has shown that the mask has a manifestation of imagination, creativity, and the power of human spiritual expression of infinite. Topeng Malangan is a unique art which grows around the area of Malang (the former Majapahit in East Java). Known as the masked art in the kingdom of Kediri, and use the Panji's character since the Majapahit era. The standard of Topeng Malangan there are 6 types, namely: *Klono*, *Bapang*, *Asmoro Bangun*, *Sekartaji*, *Gunung Sari* and *Ragil Kuning*. *Klono* describe the greedy and arrogant character, *Bapang* describe the wise character, *Asmoro Bangun* epitome of beauty, *Sekartaji* symbol of purity, *Gunung Sari* and *Ragil Kuning* epitome of human kindness.

The growth of Topeng Malangan, could not be separated from the service of Raden Suryo Atmojo who took him to the pavilion of Malang, during the first Regent Kanjeng Surgi, in the Dutch colonial era. Reni (Polowijen) and Gurawan (Kepanjen) participated to explore more. The karimun great grandfather, Serun, learn about the mask from Gurawan. Up here, the function of Topeng Malangan is not to spread the Islam religion, but a means of entertainment, tells the story of Panji.

There are two studio association is still active today in Malang that still maintain the existence of Topeng Malangan. Both galleries are, Studio Asmarabangun in the Kedungmonggo village, and Sri Marga in the Glagah Dowo village. Related to this research, the authors will focus its research on the Kedungmonggo village the grip of Asmarabangun association. Because of the Asmarabangun association is a conservative who is still maintaining the original of traditional art Topeng Malangan dance. Furthermore, in this study, making the visual elements of dance will be taken from the actual model of the dancers and their clothes, and for the retrieval of mask visual meaning will only take a visual element of the elaboration of the elements that forming the mask.

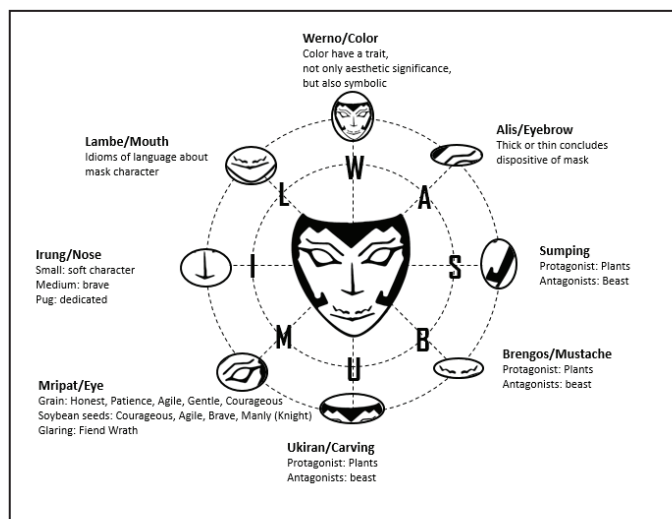


Fig. 1. Visual Element of Topeng Malangan

### C. Motion Capture

Motion capture or motion tracking is a term used to describe the process of movement recording and to cognition the movements into digital models. Basically, motion capture means recording the actions of human actors and use that information to drive the digital character animation into a computer model of two-dimensional or three-dimensional can even directly to an object. In this study, the authors focus on using motion capture technology which has a motion sensor on the camera so that when the actor moves the device emits a signal which is then captured by a camera are capable to detecting the movement of the user and processed in a computer to generate the movement data. Finally, the object of virtual character eventually will move like the actor / user.

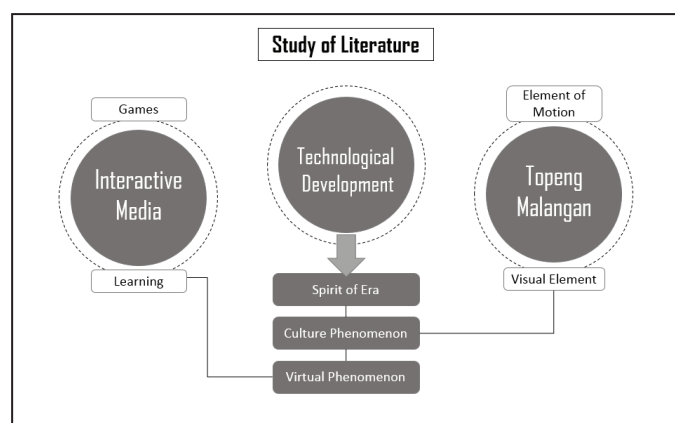


Fig. 2. Development Scheme\_1

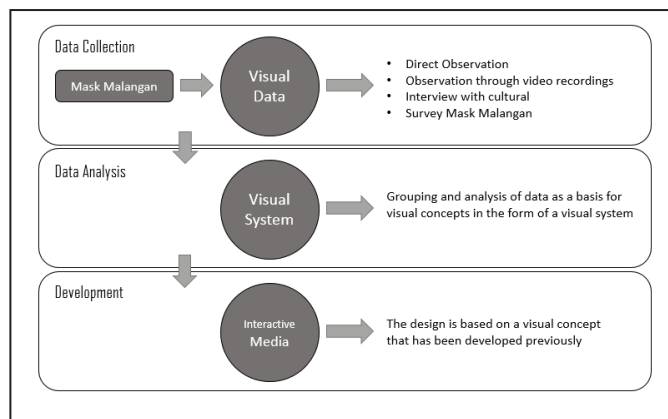


Fig. 3. Development Scheme\_2

## V. CONCLUSION

The life of art Topeng Malangan dance is a traditional art that is one of aspect that might be considered minor and insignificant for the Indonesian people and now the situation is very alarming. The traditional art of Topeng Malangan dance is not only for entertainment or spectacle, but more fundamentally, a guidance about manners and behavior of human beings living in this world.

The values that conveyed through visual symbols such as dance, fashion, color masks, musical accompaniment, ritualistic behavior and others all have a moral nobility, which continues to maintain the harmony and balance of life between human and the environment, and with The Creator.

Therefore, it is necessary to create an interactive learning media that introduces the art of Topeng Malangan dance that not only introduces to motion of Topeng Malangan dance, but also explain in sufficient detail the meaning to be conveyed on the Topeng Malangan in the form of virtual characters.

Due to the extent of the description of the character and extent of the possibilities in the application of interactive media in the form of a virtual character then this will be focused on the use of virtual characters as a form of alternative experimentation in the Topeng Malangan dance.

For that eventually interactive media in the form of a virtual character in this design would represent the user when studying the movement of Topeng Malangan dance. While the types of media that will be used to display a virtual character in the aforementioned interactive media will choose the motion capture media. This is done in an effort to introduce the dance and visual meaning of Topeng Malangan interactively to the user.

The target of this research is to create the interactive media to introduce of dance and visual meaning of Topeng Malangan that will be packed in the motion capture concept to give more values in the research of this interactive media, in association with the concept of duplication of reality in the virtual world, so that virtual characters can be moved in real time in accordance with the original user's movement.

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# ANALYSIS OF DIFFERENCES IN HONEST AND DISHONEST HANDWRITING FROM THE SIZE OF WORDS: CASE STUDY OF STUDENTS THE UNIVERSITY OF MULTIMEDIA NUSANTARA

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**Abstract-** *Lies occur in social life because of human desires to cover up something that is personal. Lies may happen through human handwriting. This study is conducted as a comparative study that is focused on the sizes of written words. The word sizes are measured through Matlab to get more precise measurements about the length and height of some words that are written when people are honest and dishonest. The data is also analyzed by applying some paired t-tests in SPSS. As a result, there is a significance different between the size of honest and dishonest writings. This result may be useful to an organization that needs data from a personal in nature who is required to fill a blank form with honesty.*

**Keywords:** *lies, handwriting, data analysis.*

## I. INTRODUCTION

Basically, humans possess many characteristics. One of human characteristics is honesty. This characteristic is shown up when some people interact with each other and provide information that refers to the actual situation. Honestly is a kind of heartfelt expression that indicates a person's heart clarity without covering anything at all.

However, honesty is sometime not shown by humans. For example, when people make mistakes, they try to cover it up. They state something that does not refer to the facts. In addition, they tend to keep it off from others, and afterwards, people may make more and more lies. So that human may lie and make other lies.

Lying behavior can occur through some words that come out either at the time people is talking, typing, or even writing. A person tends to lie through handwriting to hide the actual facts. (Gunadi & Harjoko, 2012) Lying through handwriting is quite interesting since handwriting is applied in many business activities such as filling business forms and writing business letters.

## II. LITERATURE REVIEW

In the study of Priyatno (2014), parametric analysis is applied using the paired T test. It is necessary to test the normality of the data to determine whether the data is normally distributed or not. If data are normally distributed, then the data is stronger believed as the representative of the population.

According to Santoso (2014), test of paired sample T test works on two samples are paired. Paired samples can be interpreted as a sample with the same subject but had two different treatments or measurements. This test is utilized to examine the same samples, which are normally distributed, and afterward, can be used to measure the results of the comparison. If the significant value is less than 0.05 then null hypothesis is rejected meanings that the average population is not identical or different. If the value of significance is greater than 0.05 then null hypothesis is accepted and the average population is identical.

## III. RESEARCH METHODOLOGY

This study applies the method of comparative research. Comparative research is a study that resulted in the alleged statement showing the value in one or more variables on different samples (Sugiono, 2010).

This research is conducted in the University of Multimedia Nusantara and sample data is collected by using simple random sampling. This technique is chosen because respondents are taken without regard to strata of the population and all members of the population possess the equal opportunity to be chosen.

Each student is asked to write a true story and a false story about her or his experiences in senior high school on a piece of paper. For every participant, each frequent same word will be measured using Matlab about its length and height to find their averages. Afterwards, the data distributions will be tested whether they are normally distributed or not. If they pass, the process of analysis will be performed by using Paired T Tests in some pairs between the averages of word sizes from both honestly and dishonestly writings.

In this study, the software that is utilized is IBM SPSS (Statistical Package for the Social Sciences)

version 22 to test the normality of the data and paired T test. Part of statistics that is applied are statistical inference and a parametric statistical. The data form is quantitative and all data scale ratios consisting of sample pairs. So the test the hypotheses are performed using Paired T-Test.

#### IV. ANALYSIS AND RESULTS

The sample is taken from the students of the University of Multimedia Nusantara. The total respondents is 30 consisting of 30% females and 70% males gathered by using simple random sampling technique. The sample consists of students who come from various study programs including Information System, Information Technology, Computer System, Management, and Visual Communication Design.

Figure 1 shows an example of the measurement of the frequent same word sizes. All handwritings are scanned and afterwards will be measured though image measurement tools in MATLAB software.

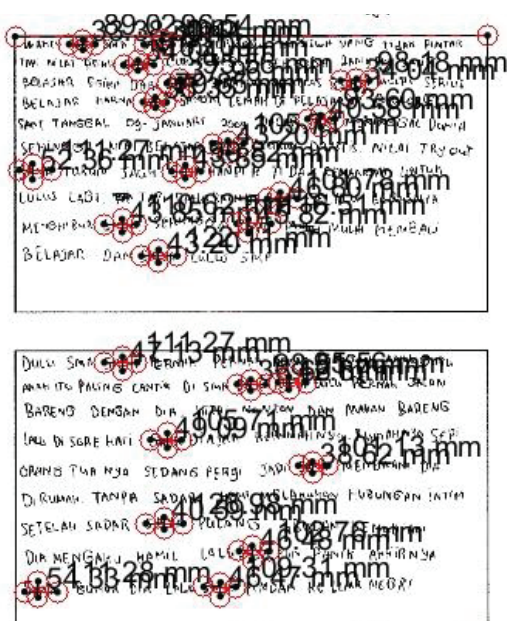


Figure 1 word size measurement

The following figure shows the example of the honest handwriting of the word SAYA (figure 2a) and the dishonest handwriting of the word SAYA (figure 2b) collected from the same respondent. The length of honest handwriting of word SAYA is 79.85 mm and its height is 35.35 mm whilst the dishonest handwriting has bigger size as its length is 105.71 mm and its height is 49.09 mm.



figure 2a honest handwriting size of SAYA

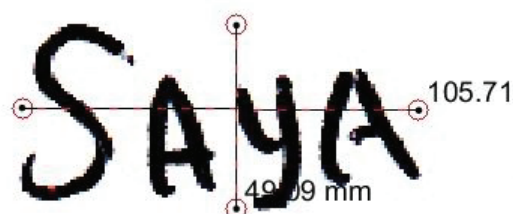


figure 2b dishonest handwriting size of SAYA

Afterward, normality test is taken, to make sure all data has normally distributed. Table 1 shows some results of normality test for honest handwriting. The length of the word ADALAH on the honest handwriting is coded as **adalah\_x\_jujur** whilst the height of the word ADALAH on the honest handwriting is coded as **adalah\_y\_jujur**, and so on. Table 2 shows some results from the normality test processes for dishonest handwritings. The length of the word ADALAH on the honest handwriting is coded as **adalah\_x\_bohong** whilst the height of the word ADALAH on the honest handwriting is coded as **adalah\_y\_bohong**, and so on. Both honest and dishonest data has passed at normal test.

Table 1 Normality Test for honest handwriting

No	Words	Shapiro-Wilk		Result
		Df	Sig.	
1	adalah_x_jujur	3	0,564	Normal
	adalah_y_jujur	3	0,778	Normal
2	berkesan_x_jujur	4	0,755	Normal
	berkesan_y_jujur	4	0,342	Normal
3	dan_x_jujur	16	0,149	Normal
	dan_y_jujur	16	0,811	Normal
4	di_x_jujur	8	0,369	Normal
	di_y_jujur	8	0,936	Normal
5	itu_x_jujur	7	0,488	Normal
	itu_y_jujur	7	0,263	Normal

Table 2 Normality Test for dishonest handwriting

No	Words	Shapiro-Wilk		Result
		df	Sig.	
1	adalah x bohong	3	0,085	Normal
	adalah y bohong	3	0,887	Normal
2	berkesan x bohong	4	0,134	Normal
	berkesan y bohong	4	0,184	Normal
3	dan x bohong	16	0,400	Normal
	dan y bohong	16	0,152	Normal
4	di x bohong	8	0,472	Normal
	di y bohong	8	0,460	Normal
5	itu x bohong	7	0,263	Normal
	itu y bohong	7	0,830	Normal

Table 3 Result of paired t-test honest word length and dishonest.

Kata	Sig. (2-tailed)
berkesan_x_jujur - berkesan_x_bohong	0,024
dan_x_jujur - dan_x_bohong	0,023
itu_x_jujur - itu_x_bohong	0,031
karena_x_jujur - karena_x_bohong	0,045
kelas_x_jujur - kelas_x_bohong	0,044
masa_x_jujur - masa_x_bohong	0,029
pada_x_jujur - pada_x_bohong	0,012
pengalaman_x_jujur - pengalaman_x_bohong	0,025
saat_x_jujur - saat_x_bohong	0,030
saya_x_jujur - saya_x_bohong	0,000
sma_x_jujur - sma_x_bohong	0,002
untuk_x_jujur - untuk_x_bohong	0,002
yang_x_jujur - yang_x_bohong	0,032

Table 4 The result of paired t-test honest word height and dishonest:

Kata	Sig. (2-tailed)
adalah_y_jujur - adalah_y_bohong	0,018
berkesan_y_jujur - berkesan_y_bohong	0,040
dan_y_jujur - dan_y_bohong	0,042
itu_y_jujur - itu_y_bohong	0,015
karena_y_jujur - karena_y_bohong	0,032
kelas_y_jujur - kelas_y_bohong	0,012
masa_y_jujur - masa_y_bohong	0,004
pada_y_jujur - pada_y_bohong	0,025
saat_y_jujur - saat_y_bohong	0,001
saya_y_jujur - saya_y_bohong	0,003
sma_y_jujur - sma_y_bohong	0,010
yang_y_jujur - yang_y_bohong	0,039

The last test is Paired T-Test applied for testing the significances of some pairs of honest and dishonest handwritings. As shown on table 3 and table 4, there is a significant different between some

particular words that are written on both honest and dishonest handwritings. Followings are the words that have been tested:

- There are 13 words that are significantly different, which are measured by the lengths of word, which include: *berkesan, dan, itu, karena, kelas, masa, pada, pengalaman, saat, saya, sma, untuk, yang*.
- There are 12 words that are significantly different, which is measured by the heights of word, which include: *adalah, berkesan, dan, itu, karena, kelas, masa, pada, saat, saya, sma, yang*.
- There are 8 words that are not significantly different, which is measured by the lengths of the word, which includes: *adalah, di, menjadi, paling, pun, sekolah, teman, tidak*.
- There are 9 words that are not significantly different, which is measured by the heights of word, which include: *di, menjadi, paling, pengalaman, pun, sekolah, teman, tidak, untuk*.

## V. CONCLUSIONS AND SUGGESTIONS

### Conclusions

Based on the analysis and discussion above, it can be concluded with respect to testing on the size of the written words honestly and dishonestly.

Most frequent same words on dishonest handwriting are significant different in their length when they are compared with honest handwriting. Amongst all significant different in length, the length of words on dishonest writings are longer than on honest writings.

Similarly, the heights of most frequent same words on honest and dishonest writings are significantly different. Amongst all significant different in heights, the height of words on dishonest writing are bigger than on honest writings.

### Suggestions

Further researchs are expected to perform a comparative study that is more focused on handwriting pressures as well as the use of computer applications for the data processing purposes that will be helpful in measuring the sizes of words automatically. So that it can determine directly distinguish in terms of the size of writing between honest and dishonest handwritings. It is also suggested to study the handwriting on some popular gadgets with regards to the differences between honest and dishonest writings.

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# Digital Interactive Music Book for Children

*Digital Interactive Music Book to Increase Children's Interest in Playing Classical Piano*

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**Abstract--** *Music is the language of the soul. Through music, the composer and the listener establish a way to communicate. That is also the case with classical music, particularly classical piano. From musical scores and notes written by the composers, in both numeric notations and musical notes, a code system is created. If it is understood and played by someone who understands the said codes, it will create the beauty of music interpreted through the sound of piano. Other than that, classical piano is believed by the parents to be able to encourage the better development of both the right and left part of their children's brain, especially when it is started at the early age. This phenomenon can be seen through the increasing number of music schools that offer classical piano classes. However, playing classical piano imposes its own challenges for the children, the tutors and the parents, which is to make the children enjoy learning classical piano despite the strict rules of how it is played. Through observation and interview, it is found that an interesting interactive medium, combined by the theories of classical piano initially considered as strict and boring, will assist children in the process of learning classical piano and make it more interesting. The children will understand the basics of classical piano in a faster period of time, in a more imaginative and fun atmosphere.*

**Keywords—***music, classical piano, interactive media*

## I. BACKGROUND

Music has become an essential part that colours human lives and feeds their souls. Classical music, in particular, has a special place in the society because it is believed to be able to encourage the better development of the brain. By learning classical music, the function of both left and right brain will be more balanced, therefore increases the potential for developing critical thinking and positive influences in study, motivation, and behavior (Campbell, Don. 2001 : 218) Since the past few decades, the awareness of the parents to introduce classical music to their children from the early age has risen considerably. On the other hand, the image of classical music being something exclusive contributes into the idea that learning classical music can raise someone's social status and pride.

However, unlike piano pop or jazz, which tend to be more accommodating in terms of free expression, playing classical piano requires following certain standards and styles developed by the original composers to be considered as the

proper performance. Many people believe that the essence of classical music is to follow the strict rules, while on the other hand there are also the element of appreciation and expression in playing classical music, according to the mood of the composer in a particular piece.

Classical piano books used in classical music classes for children are also considerably dull, filled with merely musical bars and notes in black and white. Even if there is any pictorial element in it, it would only exist on the covers. In the early stages of playing classical piano, children are indeed given books full of illustrations to encourage their studying, but in advanced levels, the visual element is not there anymore, making them easily bored and learning classical piano becomes no longer interesting. Eventually, the children tend to have less appreciation when playing classical songs on the piano. Meanwhile, other than the precision of notes, melodies, rhythm, tempo, and dynamics of the song, appreciation is also needed in playing a classical piano piece. With appreciation and imagination, a song can be considered comprehensively interesting, so that children will not play the piano like a robot, but can move the feelings of the listeners, and it is actually the essence of playing music.

In the present day, children are starting to get accustomed to the use of interactive media such as e-books and games as up-to-date means of storytelling. These new media offer an interactive experience, where the users do not passively receive information but instead can feel the experience that is close to reality. Other than written information, e-books and other types of interactive media can present pictures, sounds, and other experiences that stimulate children's senses and imagination.

Based on the research data gathered from the result of the interviews with a classical piano teacher, writer of children's stories, and classical piano performer, as well as location study by directly visit music schools that offer classical music courses, a reference is found that other than interesting visual elements, the new medium for teaching classical music for children that can be formed in digital music book can also incorporate the elements of movement and story in order to build the children's imagination.

Therefore, the research questions are as follows:

1. How to design an interactive teaching medium that is different from conventional musical books to encourage children's interest in playing classical piano?

2. How to design the visualization of interactive music book that is appropriate for children?

## II. CLASSICAL MUSIC AND FEELINGS IN PLAYING MUSIC

### A. Brief History of Classical Music

In its original definition, classical music is musical compositions born in European culture from the year 1750 to 1825. It is usually categorized from certain periodization, starting from the Classical period, followed by Baroque, Rococo, and Romantic period. In this era, illustrious names such as Bach, Mozart, and Haydn created their musical pieces of many kinds, such as sonnets, symphonies, solo concertos, string quartets, and operas. However, in reality, the classical music composers themselves had never categorized the types of compositions they have written. The categorization we have known today is done only to simplify, particularly for academic purposes. There is also another definition of classical music (although this one is rarely used), which is every kind of music with high intellectual beauty from all ages, be it a Mozart symphony, a Bach cantata, or even later pieces from the 20<sup>th</sup> century. The term 'intellectual beauty' itself has a relative meaning for everybody (Muhammad, Syafiq; 2003)

### B. Feelings in Classical Music

Feelings is an experience every individual surely has. Everybody will feel the change of emotion or feelings in every moment of their lives. However, although everybody can feel different kinds of emotion, not all of them can express what they feel, be it in verbal or non-verbal. Actually, every note written by a composer symbolizes his own deepest emotion. The challenge now is to interpret what he felt at the time of writing the piece into a spectacular performance with sincere feelings by the music performer on stage.

The context of feelings in music means the emotion in performing a musical piece that involves feelings. As music is the language of the soul, the embodiment of feeling is the most important thing to be shown by a classical piano performer. Of course it is very challenging to express the feelings in music without the ability to technically master the art of classical piano. On the other hand, the issue arises is when a piano player focuses his practices on the accuracy of dynamics and tempo – which are among the important elements of the precision of piano playing in technical manner – then he will have the tendency to lose his ability of expression. What will happen is a performance that is less satisfying because it is too technical and strict. To counter this problem, the performers must be able to incorporate the element of emotions in their performance. With the presence of the dynamics, tempo, and accents on the musical notes, a piano performance can be better expressed; it will not sound flat and strict. The difference of sound and pressure while hitting the piano keys can also be the means of expressing feelings in playing the piano. In teaching classical piano for

children, the children would usually be invited to sing along or see interesting pictures to induce the feelings in the song. Because, the most important thing in igniting feelings in playing music is high imagination or fantasy (Bernstein, Seymour; 1981:63).

### C. Illustration in Interactive Music Book

Children tend to accept information in pictures more easily; because their ability to process more advanced words are still developing. In children's growth period, the term 'Golden Age' is widely known to describe the period where the children's brain ability to absorb information is considerably high. Any information given will have the future impact for the child. Although a number of experts state a little difference on the length of the Golden Age; which are 0-2 years old, 0-3 years old, 0-5 years old or 0-8 years old respectively, but they generally agree that the first years of a person's life is his or her Golden Age. Therefore, the Golden Age is also known as the most important and irreversible period in the life of a child. In this period, parents are encouraged to play their part in educating and making the most of their children's intelligence, be it intellectually, emotionally, and spiritually (Salisbury, Martin; 2004:06).

The illustrations that can set the mood will be able to help children in imagining the situations a composer tried to present to the listeners. Interpreting the sound of the piano from the sets of notations into an illustrated scene that tells a story is no easy feat, but it will greatly help encouraging children in understanding classical music through visual storytelling.

Interactive media such as digital books and games represent sophisticated storytelling media and an embodiment of many branches of science and media. This new type of media offers a 'lean forward experience', where the users do not passively accept information, but can feel the experience that is close to reality. Not only visual elements, but there are also sound and movement shown through the touchscreen feature. Through these two elements, children's difficulty in reading the codes on the musical scores will be accommodated through interesting illustrations and interactions in a digital book.

### D. Interactive Music Book in Touchscreen Technology

The digital era is coming inevitably, as the technology is developing considerably faster. Indonesians are generally keen in embracing the advancements of technology, especially ones that can help making lives to be easier and more practical. This phenomenon also occurs in the children's world. Many educational books for children are presented in a more interesting and interactive way such as e-book applications in their gadgets. Teaching and learning activities have also become more stimulating, because many teachers have used smartphone applications to support them throughout. This also applies to the teaching of classical piano. For example, some students would have their musical scores in their smartphone or tablet, as it is a more practical alternative compared to conventional music books.

One of the most prominent elements from the gadgets widely used nowadays is the touchscreen feature. Touchscreen is a electronic visual display that enables the users to directly interact with the presented information by touching the areas on the screen. The event of touching can be done by fingers or hand or items that can function as a stylus pen.

The touchscreen medium itself is an electronic visual display in the form of a screen that can effectively detects the touch of hand or stylus on the objects presented on screen. Through this feature, when an illustrated book has characters in them, children can be invited to move the characters in the book with their fingers and have a different reading experience compared to that of a conventional book.

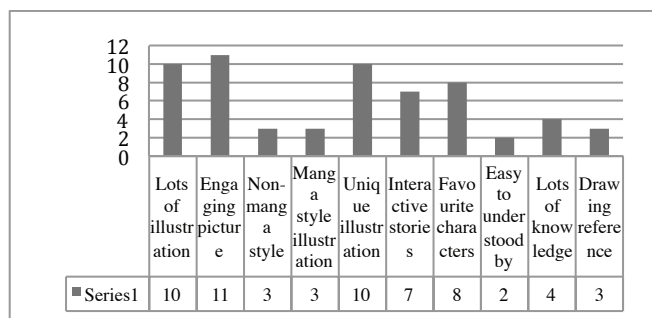
### III. DATA AND METHOD

In order to compose the visual and the content of an interactive music book for children, it is important to have not only the musical matter, but also an interesting storyline and visualisation. Therefore, data gathering was conducted through interviews with Indrawati Tjiptorahardjo, the owner of Indra Music school of music, Handayani Widiatmoko, a piano classic tutor and writer, and Ananda Sukarlan, Indonesian illustrious classical piano performer.

Other than interviews, a survey and field study to observe the children learning classical piano course were also conducted. The targeted children are aged 8 to 10 years old, and the targeted locations are Indra Music School, Yamaha Music School and Purwacaraka, because the three schools provide classical piano courses at the heart of Bandung city.

The survey was conducted to find the types of stories, characters, and illustration style that children will like. The result of the survey can be seen on the graphic below.

TABLE I. REASONS WHY CHILDREN LOVES THE BOOK



From the survey, it is found that children's books that are considered interesting are ones that not only has a lot of pictures, but also have unique stories that moves their heart. The presence of the said elements will keep the children from being bored of reading the books, and possibly interested in continue reading the books in a particular series that interest them.

Apart from interviews and survey, literature study was conducted on music books used in classical piano teaching

curriculum at three visited music schools. The result is as follows.

TABLE II. PIANO BOOK APPEARANCE ANALYSIS

	Piano Book Title	Illustration	Colored Illustration	Story with Illustration
1	<i>Burgmuller Op.100 25 Easy Studies</i>			
2	<i>Streabbog</i>			
3	<i>Hours With The Masters for Piano</i>		•	
4	<i>Yamaha For Children</i>	•	•	
5	<i>Alfred Publishing</i>	•	•	
6	<i>Ying Ying Ng</i>	•	•	
7	<i>Peter &amp; The Wolf</i>	•	•	•
8	<i>Jack and Jill</i>	•	•	•
9	<i>A Dozen a Day</i>		•	
10	<i>Snowman</i>	•		

Out of 10 musical score books, 5 of them use illustrations and are printed in full colours, 2 of them have illustrations that tell stories, and there are two books that are not illustrated and printed in black and white. This finding shows that there is still a need of piano musical score books that are illustrated, printed in full colours and tell stories. Also, there is a potential in merging piano musical score books that are illustrated, printed in full colours and tell stories with the element of technology, by presenting it in the form of a digital book.

### IV. DESIGNING REFERENCES

In order to make the designing process simpler, the reference used to design the project is the researcher's undergraduate final project, titled *Soldier's March: Illustrated Music Book for Children*. The development of the final project includes the change of title to *Andi at the Land of the Soldiers: Illustrated Music Book for Children*, collaborating with Handayani Widiatmoko as the writer of the story. The general concept being used to develop the interactive music book is to have illustrations that can set the mood with an interesting stories that is close to children's hearts.

#### A. Arranging The Mood and Feelings With Chosen Various Songs

Taking the theme of setting the children's mood to play, the visualisation concept is divided into different moods presented in the classical songs. The presented moods are described with the situations that engage the characters in the story, which becomes the way of telling the series of events in the book. The presented moods are as follows:

- Lively marching
- The mood arises in the first song titled *Soldier's March*, composed by Schumann. It is visualised by the tin soldiers marching in line in a high-spirited manner.
- Relax and flowing

The mood arises in the second song titled *The Limpid Stream* composed by Burgmuller. It is visualised by the characters in the story that are swimming in a stream of clear pool water, together with the fishes inside it.

- Mysterious

The mood arises in the third song titled *The Bear* composed by Rebikov. It is visualised by a bear that is sneaking in the corner the room along with other characters.

- Running and chasing

The mood arises in the fourth song titled *The Race* composed by D.Kabalevsky. It is visualised by the sudden appearance of a hunter which caused the bear to run among the musical scores.

- Sadness

The mood arises in the fifth song titled *The Sick Doll* composed by Tchaikovsky. The feeling of grief is illustrated to match the how the other characters in the story feel when one of them, the doll, was hurt and fell ill.

- Happiness and relief

The mood arises in the sixth song titled *Waltz of the Doll* composed by D.Kabalevsky. The situation is illustrated to match the feeling of the characters when they get to march in line again and help the hurting doll.

- Lively and Majestic

The mood arises in the final song titled *Home Sweet Home* composed by Henry Rowley Bishop. The situation is visualised in a lively and majestic manner, showing the characters gathering in a room where their owner is waiting for them.



Fig. 2. Tin Soldiers



Fig. 3. A big bear



Fig. 4. A doll



Fig. 5. A hunter and his horse

## B. Character Design

As this book is an illustrated story book, characterisation was made to provide certain roles in explaining the storyline, in order to set the mood of the readers. The theme of the story is the universe of children's toys, with the characters as follows:



Fig. 1. A boy

## V. DESIGN RECOMMENDATION

This digital book has a menu page that is similar to the table of content in conventional books. The readers can choose to read the book chronologically based on the page numbers, or jump into the pages with piano scores to play. The piano scores which are originally printed on the pages of conventional music books are made more interactive with changing colours of the musical notations as a song is played. Other than that, there will be a short description of the composer of the songs to provide the information for the



children reading the piano scores. In order to add the fun in the reading experience, every character of the story presented on every page can move in a simple animation to follow the rhythm of the song. To make the piano scores interactive, sound-recognition feature is added. If the children play the correct musical note on their piano, the music note on the digital music score that equipped with piano sound-recognition feature will be highlighted in bright colors. So, the children also can practice musical note reading by themselves, based on the highlighted correct musical note.



Fig. 6. Landing Page



Fig. 7. Story Page Layout

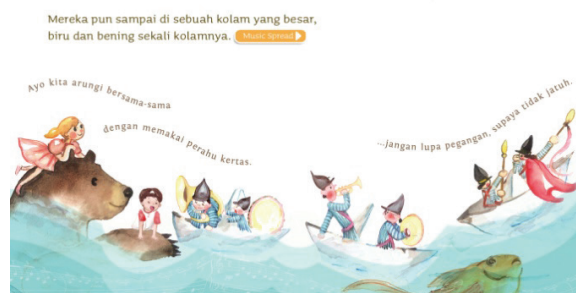


Fig. 8. Story Page Layout with Music Spread Menu Option

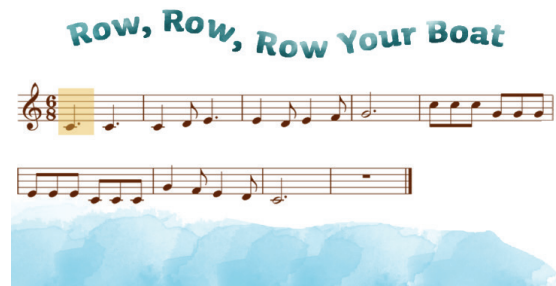


Fig. 9. Interactive Piano Scores With Sound Recognitive Feature

## VI. CONCLUSION

In order to teach classical piano lesson for children, certain attention is necessary because children, especially those who are in the early age, tend to get quickly bored and always try to find variations in learning. Children need to enjoy the experience of learning classical piano, apart from the strict set of rules in playing classical piano. If they are relaxed since the beginning of the lesson, and consider that learning classical piano is fun, they will continue to enjoy the process itself.

Actually, the challenge that is also faced by piano tutors in the modernisation era is how they can keep on following the advancements of technology and apply them in the way they educate. One of the ways to apply these advancements is through a classical piano-themed interactive storybook.

With the breakthrough of classical piano teaching through digital music book with animated characters and sound-recognitive musical score features, both parents and classical piano tutors can easily introduce children to learning classical piano. The delivery of teaching materials is no longer a one-way method from the tutor, but it can be done in a two-way by using interactive games. On the other hand, interactive books can serve as a medium to sharpen children's imagination and invite them to appreciate the richness of classical piano, which used to be considered ancient, strict and dull. Now, classical piano can be made interesting with colourful illustrations, a variety of sound and dynamic movement.

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# DESIGN AUGMENTED REALITY FOR COLECTIONS DISPLAY BANDUNG GEOLOGY MUSEUM

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**abstract** its start from the interest to learn more about geological historic in Indonesia and also around the world. It can made by harness modern technology as alternative way to create augmented reality that can be use to build more innovative information delivery. This design application is one of any solution to preservation about geological historic. At last, past representative would be the best way to prove the existence geological historic and could be the Augmented Reality development.

## 1. Introduction

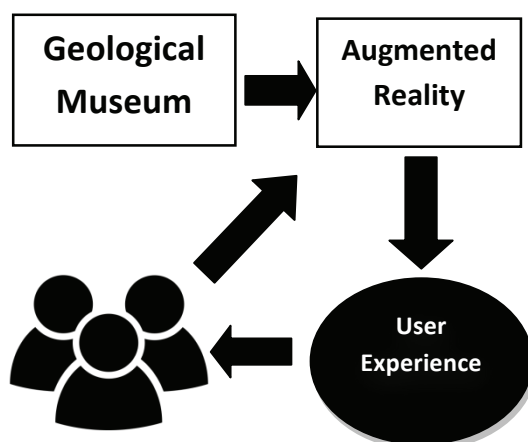
This museum is expected to application design is one solution preservation of historical and geological activity in Indonesia in particular or about geological world at large, which in kppo.bappenas.go.id, accessible dated March 21, 2013 explained that "the Museum is one of the means to improve understanding and planting noble values history nation in the past that can be applied in the present ". Therefore, This design is expected to give birth to the insight and awareness comprehensive for users because of the process simulation and interactive in the form of visual information that can help the process of learning about geological history museum

in the form of application-based Augmented Reality (AR).In the end, the representation of the past this would be a preservation solution museum which is a testament to the geological history and presence applications museum based Augmented Reality (AR) also serves as a development history and science. Application design museum is packed in a mobile phone that has a operating system support, where each object museum collection geology is made in the form of 3D animation (three-dimensional). Application of media on mobile Augmented Reality (AR) aims to simplify user to obtain complete information personally because objects collection may appear on the screen when the gadget is

directed to a pattern that has been provided. One of the advantages of augmented reality is the ability to organize where virtual reality environments can be combined with the real environment resulting in a perception of reality real.

## 2. Interactive Theory

According to Rubin (1982), Interactive theory give very complex intellectual



**Picture 1.** Interactive Process

By this way, interactive solution can be called as multiple personal action which influence to each other in information sharing.



**Picture 2.** Interactive Media

process meaning, that consist of two main element called meaning understanding skill and verbal concept think skill. This theory that could be used to explaining the information that harness the user experience.

## 3. Simulation Theory

Simulation is the imitation dynamical system that using computer model to evaluate and develop system performance (Harrel, etal, 2000 : 5). And according to Kakiay (2004 : 1) the simulation is the complex system that use to solve uncertainties in real life with or without certain model and focused in computer ussge to get the solution.

People could be more interest in something new like this simulation model. Because that's the nature of human to brandnew technology responses. According to Suryani (2006 : 6) simulation is classified to 3 concept there are Based on Time Simulation, Variable Change Status Simulation, Uncertainty Simulation.

Reading process according to interactive point of view is a complex intellectuality that consist of two main ability called understanding meaning ability and verbal



concept thinking. So it can be concluded that museum application is into abstract user experience which Geological Bandung Museum simulated and the information explanation method. the ideas contained in each experience gained involve the sense of vision, hearing, and feeler which this application will provide indirect experience to the user to present information interactively.

#### 4. Augmented Reality

According to the Klaus H. Ahlers., et. Al (1995) Augmented reality is a more natural and effective means to exhibit a design in its real-world context. A user is present in the real environment, or receives a view from a video camera on location. The users view is then merged with a graphical representation of the design, either by using a see-through display by combining video with graphics. Meanwhile Ronald T. Azuma (1997:2) said :

“Augmented reality (AR) is a variation of Virtual Environments (VE), or Virtual Reality as it is more commonly called. VE technologies completely immerse a user inside a synthetic environment. While immersed, the user cannot see the real world, with virtual objects superimposed upon or composited

with the real world. Therefore, AR supplements reality, rather than completely replacing it.”

With augmented reality, artificial information about the environment and its objects can be overlaid on the real world. The technology can transformed the museum experience for a child into a interesting story puzzle. The app can be sets up a game or something which rewards the visitor and get the attention of them.



**Picture 2.** Augmented Reality



**Picture 3.** Augmented Reality

## 5. Conclusions

One of the main problem to transfer information collection in the museum is the lack of media. People get bored with the conventional media. One of the effective media to transfer information is augmented reality. Mobile application Augmented Reality (AR) aims to simplify user to obtain complete information personally because objects collection may appear on the screen when the gadget is directed to a pattern that has been provided.

People could be more interest in something new like this simulation model. Augmented reality makes a different thing to provide of all the collections in the museum. People usually only see rocks, fossils, geological fault (faulting), folds and other in museum, now can see it directly through the help of the media of augmented reality technologies. Through

this technology, people are invited to enter the Hall of geological time with no time restrictions, so that people will better absorb the information provided in a museum especially Bandung Geology Museum.

Augmented reality can makes the visitor experience non-linear. The system constantly adapts to a visitor's preferences. For example, if a visitor fails in a game or stays longer in front of certain collection, the system can adapt the storyline. It makes the experience more dynamic and relevant, so instead of sending the visitor to X exhibit, the system might instead choose to send you to Y exhibit, where you will get more information that's relevant to what you've shown an interest in.

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# NomNom, Mobile App about Digestive Health for Children

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**Abstract**—Foods consumed by children without parental supervision are not always healthy, which can cause to disease especially digestive diseases. Children should have knowledge about what is happening in their digestive and reaction after consuming food, so that they can avoid consuming bad food for their health. The medium used to convey it through games and activities is a mobile application app called *NomNom*. Research conducted through field and references studies about children favorite character and similar mobile apps. The character and design in accordance with a simple yet attract the children's attention.

**Keywords;** *mobile, app, digestive, children, edutainment*

## I. INTRODUCTION

One of the common diseases among children in Indonesia is diarrhea [1], as said by Aritonang and Johannes Ridwan, a doctor in *Bethsaida Hospital* in an interview on February 28<sup>th</sup>, 2015. Preliminary research conducted through questionnaires to 51 parents of *Ehipassiko Elementary School* in Tangerang, showed that other common diseases are sore throat (72.5%), nausea and vomiting (60%), toothache (47.1%), and food poisoning (23.5%). All these types of disease associated with digestive organs. It happened because children in school age have their own pocket money, but they do not really understand about what happened in their body if they consume unhealthy food. Ridwan suggested that children supposed to have basic knowledge about their body metabolism, so they understand the consequence of food consuming.

Introduction of healthy food for children can be done through the right media for their stage of cognitive development. Adib Setiawan, a psychologist who is a member of *YPPI (Yayasan Praktik Psikolog Indonesia)*, said that school age children prefer games, visuals, stories, awards, rather than formal learning activities. They love exploration activity, as claimed by Plaisant [2], that children do not like to get ruled comments as in textbook or exam, they prefer to explore character and environment. At this age stage, children are interested in their body, including the organs and other parts that are visible, due to their experience in interacting with other children [3]. They develop their systematically

ability to learn languages, understand symbols, categorize objects and understand arrangements based on the order [4]. The abilities of children at this stage used to inform the healthy food to avoid digestive diseases.

Considered media used to this purpose is interactive edutainment app, because it able to present a more varied interactivity compared to other media. The selected platform for this app is the most widely used for their parent gadgets, because not all children have their own gadgets. Preliminary research showed that 58 of 94 (61.7%) parents give access to *Android* platform gadget. The research focuses to children age 6 – 9 years, because they expected to grasp knowledge about food consequences to their body.

## II. CHILDREN AND INTERACTIVE MEDIA

Interactive edutainment mobile app with *Android* platform designed in this research called *NomNom*. According Heinich as quoted by Riyana, this kind of interactivity app is a medium that uses a wide variety of objects as an intermediary to deliver information to user and requires user involvement in the media. [5]. User involvement is the most important thing to consider in this media design, because children have a tendency to explore and self-study their knowledge. Susilana & Riyana claimed that this kind of medium has ability to support learning process for children as long as it can carry appropriate messages that contained learning materials [5].

Some elements that should consider in designing interactive mobile application are flow and character. For the first element, Castillo & Novak explained that flow is the movement of the game that can be leveling, which determines interaction mechanism between the device and the player (user) [6]. The flow that used in this design is linear type with alternate flow in the whole game to avoid player boredom. Second element explained by Ibister [7], there are four principles of character design; visceral feedback, cognitive immersion, social affordance and fantasy affordance. Visceral feedback makes player feels that his own body is the character's body. Cognitive immersion makes player feels that his level of cognition is similar to the character, which can be implemented by character's gestures and voices. Social



affordance makes player feels that his social background is similar to the character. Fantasy affordance makes player can experience the fantasy that experienced by the characters. These forth principles will support character ability to facilitate player interaction and immersion in the media.

A combination of visuals, texts, images, sounds, and animations allowed player to manipulate the game that generate interactivity [8]. Children will explore by see the visuals, touch the gadget's screen, and hear the audio in their interactivity with *NomNom*. In order to achieve this interactivity, Benyon's four principles of interactivity [9] will be applied to *NomNom* design.

- **Accessibility:** Everyone, without exception, should be able to use the design. The ability of children to understand the icons and use interactive media are different, however *NomNoms* should be accommodated those differences, it should be able to use by children with the targeted age.
- **Usability:** The design should be easy to use and flexible. Factors that considered in order achieving the principles of usability are the user, the activities to be carried out, and the device used by the user. Research should observed and evaluate how children use similar applications to produce an optimal usability for *NomNom*.
- **Acceptability:** Reaching acceptability in *NomNom* is the most challenging accomplishment, because the context of its use is variably. However, it should be accepted voluntarily by children with the targeted age through non-patronizingly, non-distractingly and economically design.
- **Engagement:** Player feels satisfied and happy after interacting with the media. Interest, enjoyment and satisfaction in media interactivity support immersion and flow with the game, so player voluntarily repeat the game more than one times and get the attached information about *healthy food* for their digestive better.

*NomNom* should consider the design principles in its media visualization to support the interactivity and information optimality, such as balance, rhythm, emphasis, unity and Gestalt theory (closure, similarity, proximity and continuity). The layout principles should be considered in elements structuring in the media screen to make it artistically accepted and facilitate the information delivery clearly. These principles mainly used in GUI (Graphical User Interface), because what shown on the screen layout is the only tool to make interaction with the media. Player as the user should be able easily to use it to manipulate the system and avoid player discouragement [10]. Therefore, the GUI design should be consistent, forgiving, simple, understandable and compatibility between input and output.

### III. CHARACTER DEVELOPMENT

Since character is an important tool for interactive edutainment mobile app, *NomNom* design preceded by analyzing popular characters from animations and games.

These characters was chosen based on its popularity and quantity shown on television when the research conducted, such as Boboiboy, Frozen, Upin Ipin, Doraemon, and Naruto. This analysis was preceded by identified a main character from five favorite character among 110 children with the targeted age in Ehipassiko Elementary School in Tangerang with the results showed in the following table.



Fig. 1. Boboiboy, Doraemon, Upin Ipin (left to right, above) and Spongebob, Naruto, Frozen (left to right, below)

The result showed that most of the children who became respondents chose character based on fantasy story (70.1%), such as Boboboy who has superpowers and ability to separate in three, Elsa who has magical ability to create ice and snow, Doraemon who come from future and Spongebob who is a sponge live in underwater world. Most of respondents preferred characters in 2D (50.8%) with a highlight but not detailed (50.8%) and shaded (100%). Moreover, the most preferred characters have a body size ratio 1:2 (44.4%), with the head size as a benchmark.

The data from the research underlined the characters development for *NomNom*. The designed characters have 1:2 head to body comparison, two dimensions shape with shading and undetailed highlight, so that it has a three dimensions impression. Characters used to support content about food consequences to children's body through the app are two opposed characters that represent the good bacteria and bad bacteria. The result of the characters development are shown on the below image.

Those two characters are fantasy figures that have arbitrary role, named Lacto and Bacil as expressed in a short motion graphics at the beginning of the game; however, it was not mentioned again throughout the game. The opening motion graphics intended that the children know that the green character with purple cloth is Lacto, who represent the good bacteria (protagonist) that exist in human body, meanwhile the

purple character with green cloth is Bacil, representing the bad bacteria (antagonist) from food consuming. The shapes of those two characters based on bacillus bacteria shape with anthropomorphic principle applied, so the bacterium can show human traits. Lacto traits are safe, energetic, and healthy, while Bacil traits are naughty and mysterious.



Fig. 2. *NomNom* Character, Lacto (left) and Bacil (right)

Both Lacto and Bacil have body proportion 1:2, with the size of their head as large as their body and have bright colors, which are still visible in the background application. The characters expression displayed by a half-circular upward curve mouth when they feel excited, but Bacil's eyebrows also curve upward in his excited expression. Meanwhile, when the characters feel sad, the expression displayed with lip curves downward, while the shape of their eyebrows remain unchanged. These character expressions show feedback for players action result whether they win or lose.

#### IV. *NOMNOM* DEVELOPMENT

There are some interactive edutainment mobile apps about digestive health for children in app market both *App Store* and *Play Store*, but they have different goal and strategy. Reference study conducted to learn flow and how their strategy to deliver information among three selected apps (Table 1); *Listen to My Body*, *Science Heroes – Digestive System* and *The Human Body*.

Based on the results of the data collection and references study, known that most apps give much information in app and represent in visually attractive to children in simple way. It will ease children to understand abstract concept about digestive object and process since they do not have any knowledge yet about what happen in their body. The information represented in interactive games or activities, so the communication happens in two-way.

The strategy that *NomNom* adopted to represent a lot of information in the app which still can be understood easily by children is categorize the contents into four main part; about digestive organs, systems, food nutrition and digestive diseases. Information about the human digestive organs contained in the *Fakta* menu, system and human digestive process in the *Pencernaan* menu, human digestive disease and food nutrition contents in the *Aktivitas* menu. The overall *NomNom* contents summarize in interactivity wireframe as seen on below diagram.

*Pencernaan* menu will link to games that contained information about human digestive processes. Before the game starts, children should to choose one of the four healthy foods such as fried chicken, vegetables, rice and fruit. Children can click, drag and rub the screen to communicate with the games that give simulation of the digestive processes that occurred from chew food in the mouth until secretion. Children can play the game sequentially or freely choose any of it by return to the home menu.

TABLE I. COMPARISON OF SIMILAR APPS

Kategori	Listen to My Body	Science Heroes	The Human Body
Developer	Mangosense pvt. Ltd	Yogome, inc.	Tinybop inc.
Background Theme	Home environment	Sains/robot	Children's body
Content	Story, puzzle, word search, memory game	Story, object dictionary, video	Game
Content flow	Stories and games separated in two sub parts. Games consist of 1 stage without leveling	Start with the video than games, which are consist of 3 levels in every stage. Object in the visual dictionary unlocked gradually after finishing every stage	Start with some choices of visual customization, level complexity, preferable body system, than start to play
SFX on buttons	No	Player can choose animatic button or button with SFX audio	SFX audio and animatic buttons
Story content	Illustrated story using transitional pages	Comic story using transitional pages	No story
Play instruction	No play instruction	On the game opening	No play instruction
Leveling	No leveling	3 level every stage	No leveling
Reward	Congratulation text	Stars	No reward
Layout	Inconsistent, illustration bigger then text	Consistent in every pages	Consistent, divided into 3 columns
Background sound	Continuously beat	Repeatedly beat in every different level	No background sound

On the *Kegiatan* menu, player can access information interactively about the body reaction if players choose to consume by click good or unhealthy foods. It also contains information how to avoid or cope with uncomfortable conditions after consuming food that is not good for body. As an example, in the sub menu *Sakit Gigi* (toothache), there will be some good and unhealthy food choices and it will link to animation that shows teeth reaction after eating and how to prevent it.

Meanwhile, the *Fakta* menu contains some information various information about digestive organs, such as how much water we need for the body metabolism process, ideal number of teeth to process the food, average weight of the human

heart, and other information about metabolism organs. The information represent by short text with simple animation without any interaction. These pages together with game activity are useful to support delivering knowledge about food consequences to children body.

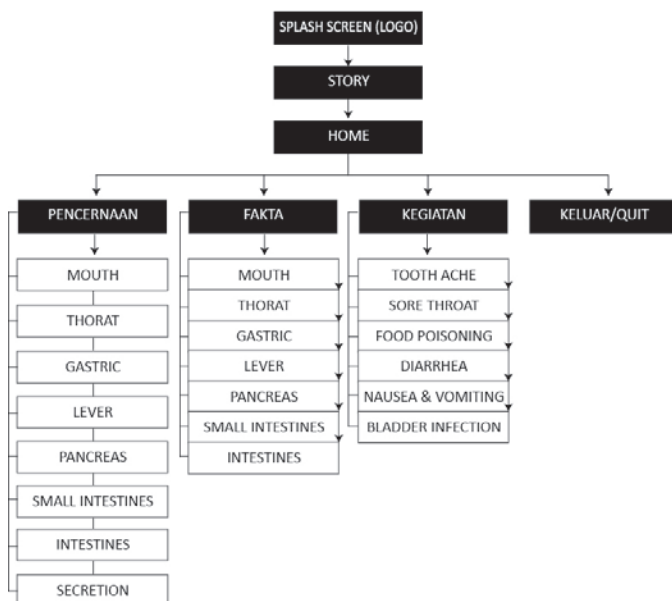


Fig. 3. *NomNom* Wireframe

## V. APP VISUALIZATION

The three apps that became the subject of study underlie *NomNom* design development. The visual display of the app should have consistency to facilitate the players to learn how the app works, especially for the first user. This consistency represented in the layout, symbols, typeface setting. Some universal symbol will facilitate the players to recognize the function, such as buttons for next, back, play, pause and home command. The selected colors should also be considered in order to keep it simple and do not hurt player's eyes; however, it still varied to avoid boredom. The typeface types that used in the app are not too varied, medium sized and applied the principle of legibility and readability. Audio application is also important to build expected atmosphere by implementing the background sound and sound effect to add dynamism to the interaction.

The *NomNom* prototype is 240 x 432 pixels in 72 DPI. Layout for *Home* and other pages use center alignment so that the objects evenly aligned, meanwhile columns and lines regulated by modular grid. Buttons placed on the front layer and highlighted to give contrast to background and give a sense that it can be pressed like a physical button. There are 7 different games in the app with a consistent layout, but the background colors are variably to help player to distinguish the type of game and navigate the page position they currently access. The background colors chosen by considering kind of colors that can attract children attention and contrasting yet harmonious with the characters.

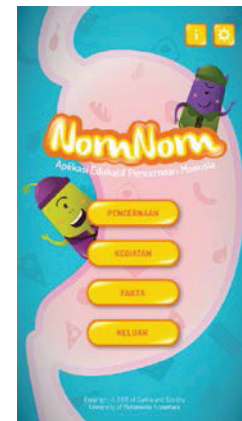


Fig. 4. Home Menu

To help children understand the information better, the game pages layout shown in human organ shapes, which looked like it placed in the human body. The organs glow to indicate that each organ is clickable. Every click on the organ part will linked to different game. There are *Home* and *Close* buttons in every game page, so player can use it to go back to previous menu. Players can manipulate the screen on the game page by tap and drag to interact with the game. After finishing the game, the application system will provide information about their status, whether they win by or lose as feedback.



Fig. 5. *NomNom* Pages

## VI. CONCLUSION

*NomNom* as an interactive edutainment mobile app can help children to understand about their digestive system and the fact that any food that goes into their body will give reaction. This will make them understand that they should carefully choose what they consume and avoid unhealthy food such as greasy, sweet, or dirty food. The information organization in the media should be simple but has many contents and delivered gradually through games, activities, or animated information. The use of characters can help the player to enjoy the application, so that they voluntary keep on interact or using it more than once. The applied design is consistent, simple, dynamic, yet still looked varied.

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