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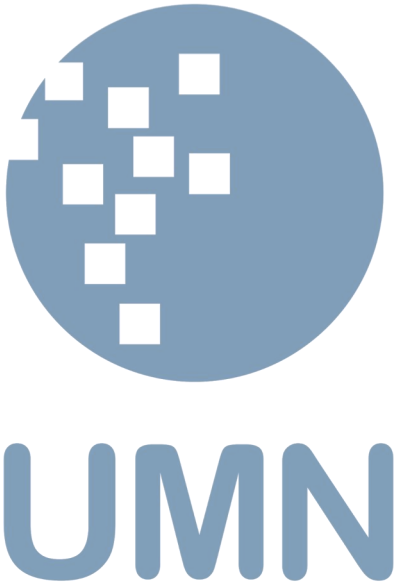
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Application Software For Learning CPU Process of Interrupt and I/O Operation

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***Abstract*— The purpose of this research is to have simulation software capable of processing interrupt instruction and I/O operation that in the future it can contribute in developing a kernel. Interrupt and I/O operation are necessary in the development of the kernel system. Kernel is a medium for hardware and software to communicate. However, Not many application software which helps the learner to understand interrupt process. In managing the hardware, there are times when some kind of condition exist in the system that needs attention of processor or in this case kernel which managing the hardware. In response to that condition, the system will issue an interrupt request to sort that condition. As the I/O operation is needed since a computer system not just consists of CPU and memory only but also other device such as I/O device. This paper elaborates the application software for learning Interrupt application. With interrupt instruction and I/O operation in the simulation program, the program will be more represent the process happened in the real life computer. In this case, the program is able to run the interrupt instruction, I/O operation and other changes are running as expected. Refers to its main purpose, perhaps this simulation can lead to developing the kernel in operating system. From the results of instruction's testing above, has a result that shows that 90% of instructions are run properly. In executing instructions, simulation program still has a bug following after the execution of Jump and conditional Jump**

***Index Terms*—Interrupt; I/O; Kernel; Operating System**

I. INTRODUCTION

Central Processing Unit (CPU), play a role as the "brain" of the computer and It handles all the instructions where all of the activities in a computer are arranged inside the CPU. The processing of instructions given to the CPU is processed in a cycle known as instruction cycle. This instruction cycle consisting of three steps: fetch, decode, and execute. In carrying out these steps, processor also involves memory and I/O devices. It is impossible to see in live how the process happened in hardware. What can be done is to try to visualize the process into software in the form of simulation. The simulation program cannot give a perfect detail of the process of the hardware because of the complexity of the process. The simulation software can give a simple picture of the interaction between processor, memory and the peripheral devices.

The purpose of this research is to have simulation software capable of processing interrupt instruction and I/O operation that in the future it can contribute in developing a kernel. This is because of the frequency of using the interrupt instruction and I/O operation is quite often in developing software. Other purpose of this research is to have simulation software that can represent more of the work of memory and the process of instruction cycle so that it can reflect of the process in the CPU in a more complete way.

II. FUNDAMENTAL THEORY

A. *Components and Classifications in Computer System*

A computer system can do the data processing properly if it has five units or main components that functioning independently. These components are input unit, processing unit, output unit, storage unit, and communication unit [1]. CPU is a main component in a computer system, where the main function of CPU is to carry out instruction or program stored in memory by performing the instruction cycle that is fetch, decode, and execute. CPU consist of two main components, that is Arithmetic and Logic Unit (ALU) which carries out arithmetic operation and logic on data, and Control Unit which responsible for directing the flow of instruction and data in CPU. Besides that, in CPU there are also several registers that functioning as temporary data storage in CPU. Register divided into main registers like Instruction Register (IR), Program Counter (PC), Memory Address Register (MAR), and Memory Buffer Register (MBR), and general purpose register which consist of operand register and accumulator [1].

B. *Instruction Set and Instruction Cycle*

In a computer system, there is collection of instructions able to be carried out by processor in the system. That collection of instructions is known as Instruction set. Those instructions when executed, will

experience a cycle started from fetch, decode, and execute. The instruction cycle will always looped in a computer. Instruction set in a microprocessor is a collection of instruction and basic operation able to be carried out by device to be used by programmer. Instruction set is divided into several categories which connected functionally, which is data transfer instruction, arithmetic instruction, logic instruction, shift instruction, and rotate instruction [2].

Instruction cycle consist of several read or write process (machine cycle) in doing the execution of microprocessor/microcontroller instruction. Three machine cycle which are done for one instruction cycle consist of reading the instruction (fetch), decoding the instruction (decode), and executing the instruction (execute). Decode process usually merged with the fetch process [3].

C. *Interrupt Handling*

Interrupt is an event which indicate that there is a condition somewhere in system, processor, or in program which is currently executed that needs attention from processor. Interrupt usually have the impact on forcefully transfer the execution from the running program to a routine or special task called interrupt handler [4] . To help handling the interrupt, every interrupt in IA-32 architecture that needs special handling by the processor is given a unique identification number, called vector. Processor used the vector assigned to every interrupt as index in Interrupt Descriptor Table (IDT) to determine the starting point of interrupt handler [5].

Processor can receive interrupt from two sources, that is external interrupt and software generated interrupt. External interrupt is received from pin in processor or from local Advanced Programmable Interrupt Controller (APIC) [5]. Software generated interrupt is generated from instruction INT *n* from the software and provide the interrupt vector number as operand. Example, instruction INT 7 will force a definite call to interrupt handler for interrupt 7 [5].

D. *Input and Output*

Processor enables an application to access I/O port in two ways, which is from distinct I/O address space and from memory-mapped I/O. Accessing I/O port from I/O address space is handled by string of I/O instruction and special I/O protection mechanism. Accessing I/O port from memory mapped I/O is handled by *move* or *string* instruction from processor, with protection provided by segmentation or paging [6].

Besides able to transfer data from and to external memory, a processor is also capable to transfer data from and to the I/O port. I/O port is made in hardware system from string that do decodes about the control, data, and address pin in processor. I/O port then configured to communicate with surrounding device. I/O port can be an input port, output port, or bidirectional port [5]. I/O device that responds like memory component can be accessed from physical memory address. When using memory mapped I/O, all processor instruction involving the memory can be used to accessed I/O port placed in physical memory address. As an example, MOV instruction can move the data between register and memory-mapped I/O port. AND and OR instruction can also be used to access I/O port [6].

I/O address space from processor is distinct and different from physical memory address space. I/O address space consist of 2^{16} (64 K) 8-bit I/O port individually addressable, from 0 to FFFF H. I/O port with address 0F8 H to 0FF H is reserved. Assigning I/O port in these addresses is prohibited [6].

I/O address space can only be accessed by IN, OUT, INS, and OUTS instruction.

III. Design of CPU Simulation Program

A. *Archiecture of Simulation Program*

CPU simulation program that is developed in this research has architecture component as followed [4]:

- ControlTrack, which is a module where user can interact with the simulation program like inputting instruction, and controlling the work of classCpu, CMemory, and IOAddressSpace
- StatusTrack, which is playing the role as a window to display the status and value of all registers in classCpu and contents of Cmemory
- ClassCpu, which is a component or a class in the simulation program that do the execution of instructions given
- CMemory, which is a component or a class in the simulation program that has a role as data storage or memory
- IOAddressSpace, which is a component or a class in the simulation program that has a role as I/O address space as means to access the I/O ports
- File Instruction Set, which is a file containing a list of instruction pattern, instruction code, and instruction code.

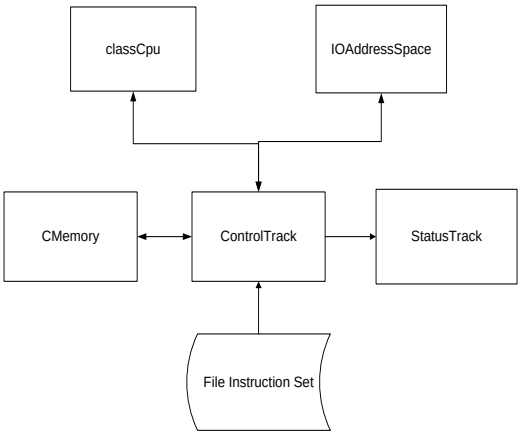

Fig. 1. Archictecture of Simulation Program

In running the simulation program, there are steps that the user will encounter in. Those steps are the mechanism of the simulation program described in the following flowcharts

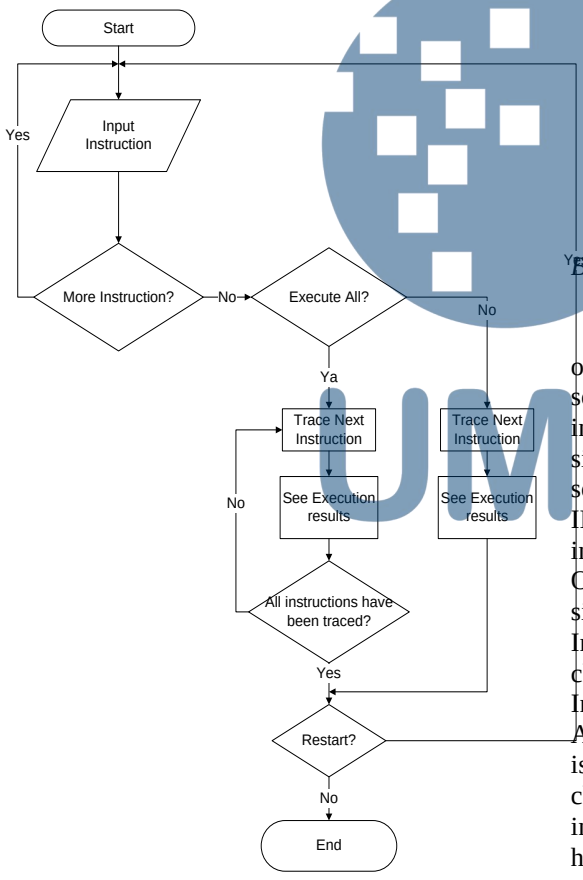

Fig. 2. Mechanism in Running the Simulation Program

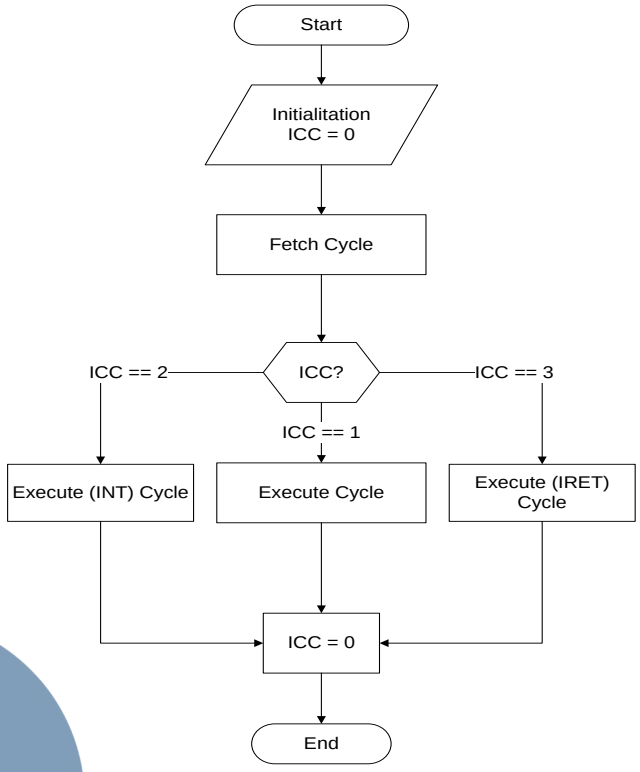

Fig. 3. Mechanism of Tracing the Next Instruction

B. Design of Interrupt (INT) and Interrupt Return (IRET) Instruction

Interrupt is an instruction that is used to interrupt or halt the execution of a program. Interrupt by the sources is divided in two, hardware-generated interrupt and software-generated interrupt. In this simulation program, the one able to be simulated is software-generated interrupt, which is by executing INT *n* instruction, with *n* is vector number of the interrupt to be executed. The INT instruction has an OpCode of 1C H and instruction size of 3 byte. In this simulation program, Set Interrupt Flag (STI) and Clear Interrupt Flag (CLI) instructions that facilitate the change of flag from Enable Interrupt (EI) to Disable Interrupt (DI) and vice versa, are not yet available. Also, in this simulation program, the interrupt process is assumed the same to all interrupt vector and flag change for this instruction is IF flag. If an INT *n* instruction is found, then to search for the interrupt handler address of particular interrupt with vector number *n*, simulation program will look into IDTR (Interrupt Descriptor Table Register), which contains base address of IDT (Interrupt Descriptor Table). IDTR has size of 24-bit

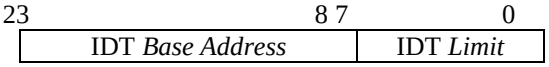

Fig. 4. IDTR Register

In simulation program, the contents of IDT are not gate descriptor, but direct address of the interrupt handler. To obtain the address, simulation program will multiply the vector number by two (the address length of interrupt handler is 2-byte), then added with the base address of IDT. The result is an address contains the address of interrupt handler. Interrupt handler for every vector number only filled with simple instruction that defined when the simulation program is loaded for the first time ended with an IRET instruction to return back from executing the interrupt handler and back to execute the program left because of the interrupt instruction. IRET instruction has an OpCode of 2C H.

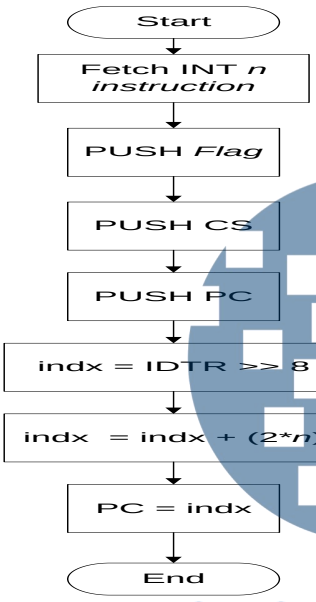

Fig. 5. Flowchart of Executing Interrupt Instruction

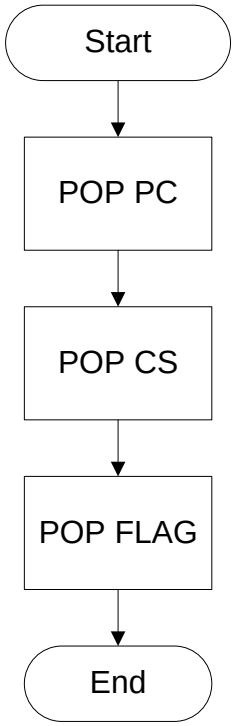

Fig. 6. Flowchart of Executing IRET Instruction

When the INT instruction is found, first, the simulation program will enter the fetch cycle, like other instruction. After the fetch cycle, simulation program will enter the execute cycle for interrupt instruction. In this cycle, the first thing to do is to store the value of register FLAG, CS and PC into the stack with PUSH instruction. Then, simulation program will take the last 16 bit of IDTR that contains the base address of IDT. Index of the IDT's base address then added with two times the vector number of interrupt. The result is stored in MAR, then from the memory address pointed by MAR the simulation program will read the base address of interrupt handler and then save it in MBR, and then moved to PC register. Simulation program will then start the execution of interrupt handler started from the address pointed by PC until the simulation program executes the IRET instruction. When the IRET instruction is found, it indicates that interrupt handler has been executed. When that happened, simulation program will load the value of FLAG, CS and PC register from stack with POP instruction, and then resume the execution of the program left behind. IRET instruction has an OpCode of 2C H and size of 1-byte

C. Design of I/O Instruction

I/O instruction (IN, OUT, INS, and OUTS) will provide access to the I/O port by means of I/O address space for processor (these instructions cannot be used to access port thorough memory-mapped I/O). There are two groups of I/O instructions [5].

- Used to move one item (byte, word or double word) between I/O ports and general purpose register. Included in this group are IN and OUT instructions
- Used to move string of item (string of byte, word or double word) between I/O ports and memory. Included in this group are INS and OUT instructions

In the simulation program, group of I/O instruction able to be handled are only IN and OUT instructions

IV. Implementation and Testing

A. Implementation of Class CMemory

In class CMemory, there is an array that acts as storage but has private attribute. The data in this array can only be accessed using functions or methods contained in this class. The array has the capacity of 4 KB (4096 byte). The functions or methods in this class have a function to read or write data in the array. There are four main methods in this class, methods to write and read byte like writeByte and readByte, and methods to write and read word like writeWord and readWord

B. Implementation of Instruction

The main focuses of this research are interrupt instruction (INT), interrupt return instruction (IRET) and I/O operations

1) Implementation of Interrupt and Interrupt Return

Interrupt is an instructions used to halt the running program. Based on the sources, interrupt is divided into two type, hardware generated interrupt and software generated interrupt. In simulation program, the type that can be handled is software generated interrupt, called through INT *n* instruction. *n* is the vector number of the interrupt called. Vector number is allowed only in the range from 0 to 1F H. Interrupt in simulation program is still simple, because there is no proper interrupt handler like the one in Intel processor

The interrupt process in this simulation program only shows how the interrupt handler is called through INT instruction. In this simulation program there no instructions to facilitate change in FLAG from EI (Enable Interrupt) to DI (Disable interrupt) vice versa like STI (Set Interrupt Flag) and CLI (Clear Interrupt Flag). In this simulation program, the interrupt process is considered the same for all interrupt vector and FLAG changed in this instruction is IF flag.

After the process of calling the interrupt handler, the simulation program then proceeds to executing the interrupt handler. Interrupt handler in this simulation program only contains simple instructions ended with IRET instruction, to return the value of register FLAG, CS and PC back to the value before the interrupt instruction enter execute cycle.

2) Implementation of I/O Instructions

I/O instructions that can be handled by simulation program are IN, and OUT. IN instruction is an instruction to read the value of I/O address space with the address pointed by displacement or general purpose register and store it in general purpose register. And OUT Instructions will write the value of a general purpose register into I/O address space with address pointed by displacement or general purpose register.

C. Testing of Simulation Program

Testing for the simulation program is done to see if the program can run according to expectations. Testing is done by trying to execute variety of instructions that contained in file instruction set. The following is an example of instructions run by the simulation program.

TABLE I. Testing Of Arithmetic Operations

ADD *Testing*	SUB *Testing*	MUL *Testing*
ADD R1, 5 *ADD R1, R2* *ADD [R3], R4*	*SUB R1,5* *SUB R3,[R2+5]* *SUB R5, R8*	*MUL R6,5* *MUL R6,[R5+1]* *MUL R3,R4*

DIV *Testing*	*Mixed Testing*
DIV R1,R4 *DIV R1, [R6]* *DIV R7,[R5+1]*	*ADD R1,R5* *MUL R1, 56* *DIV R1,R2*

TABLE II. Testing of Boolean Operation

NOT *Testing*	AND *Testing*	OR *Testing*
NOT R1 *NOT R2* *NOT R3*	*AND R1,5* *AND R2,45* *AND R2, [R4+6]*	*OR R1,4* *OR R5,R6* *OR [R3+1], R5*

XOR *Testing*	*Mixed Testing*
XOR R1,55 *XOR R4,R8* *XOR R5,[R4+65]*	*NOT R1* *AND R1,5* *XOR R1,55*

TABLE III. Testing of Stack Operations

PUSHF Testing	POPF Testing	PUSH Testing	POP Testing	Mixed *Testing*
PUSHF	*POPF*	*PUSH R1* *PUSH R2* *PUSH [R1+23]*	*POP R3* *POP R4* *POP [R4+12]*	*PUSHF* *POP R1* *PUSH R4*

TABLE IV. Testing of Compare Operations and Conditional Jump Operations

CMP (>) *Testing*	CMP (<) *Testing*	CMP (=) *Testing*
CMP R1,R2 *CMP R2,[R3+1]*	*CMP R2, R1* *CMP R4,AA*	*CMP R1,R1* *CMP R1,R2*

CMP R3, 5	*CMP [R1+1], R2*	*CMP R3,R3*

Unconditional Testing	Mixed Testing
JZ 10	*CMP R1,R2* *CMP R1,R1* *JZ 10*

TABLE V. TEsting of Interrupt Instructions

Interrupt Testing
INT 0 *INT 8* *INT 1F*

TABLE VI. Testing of I/O Operations

Input Testing	Output Testing	Mixed Testing
IN R1, 45 *IN R3, 12* *IN R7, 2FF*	*OUT 12, R4* *OUT 123, R6* *OUT 7FF, R3*	*OUT 12, R1* *IN R5, 12* *IN R5,R1*

TABLE VII. Testing of Mixed Operations

Mixed Testing I	Mixed Testing II	Mixed Testing III
MOV R1,R2 *PUSHF* *CMP R1,R2* *JE 10*	*CMP R1,R2* *AND R1, [R2+5]* *INT 5* *CMP R4,R5*	*SUB R5,R6* *OUT 12, R5* *IN R7, 12* *MUL R7,6*

Mixed Testing IV	Mixed Testing V
SUB R1,R1 *INT 1F* *CMP R1,[R2+4]* *JZ 10*	*PUSH R1* *ADD R1,5* *MOV R2, R1* *POP R1*

From the results of instruction's testing above, has a result that shows that 90% of instructions are run properly. In executing instructions, simulation program still has a bug following after the execution of Jump and conditional Jump.

V. Conclusion and Sugesstion

Based on the results received from the simulation program, can be concluded that:

- Class CMemory is able to represent more of the work of memory because of the functions contained in the class used to access the data in the memory
- Simulation program is able show the flow of instruction better because of the separation of each instruction cycle
- Interrupt instruction and I/O operation can help the development of kernel system because the frequency of them being used in software development is quite often.

To develop the next research, here are some suggestions:

- Class CMemory can be developed so that it can save the data in memory to a file
- For the next research, try to add multitasking process.
- For the next research, try to enlarge the size of the register and the instructions is added to be more complete
- For the interrupt instruction, the interrupt handler to be more complete with the actual interrupt handler
- Mapping for I/O ports to be more specific, and also can display the functions of each I/O port is to access which I/O device.

Acknowledgment

Thanks to Mr. Sutrisno and Mr. Yosia who have helped this research until it's accomplished

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Analyzing Factors Influencing Behavior Intention to Use Snapchat and Instagram Stories

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***Abstract*— Snapchat, and Instagram are two social networks which recently gain their users after adopting such a feature called "Story" which allows a certain post to be disappeared after a certain time. This research takes up this technology trends analyzing the factors that probably affect the behavioral intention to use Snapchat and Instagram stories among generation Z. Factors are analyzed using Structural Equation Modeling, with basis model and variables from Technology Acceptance Model. Data collection was targeted to finished within 1 week using online questionnaire with respondent from Jakarta and Tangerang for 100 respondent that are using both Snapchat stories and Instagram Stories. There are two tools researcher usually use to analyze Structural Equation Modeling: SPSS AMOS and LISREL. In this research, researchers choose AMOS. From six hypothesis proposed for Snapchat analysis, four hypothesis is accepted, while the other two are rejected. Meanwhile, on Instagram Stories analysis, five hypothesis is accepted and one hypothesis is rejected. This study finds out the Social Presence is an exogenous variable which has a major role in affecting other variables. While Perceived Enjoyment influenced the behavioral intention to use Snapchat and Instagram Stories the most.**

***Index Terms*—Structural Equation Modeling, Technology Acceptance Model, influence, generation Z, Snapchat, Instagram**

I. INTRODUCTION

There are clear differences in behavior to use technology between each generation. Generation Z could be the generation who is exposed the most with technology, even since birth. Some researchers found that they have a preference to use ephemeral messaging to communicate with their friends and colleagues. Ephemeral messaging is a feature that allows a post or shared content will be disappeared within a certain period of time automatically. This feature is recently adopted by many social networks, including Snapchat and Instagram with their stories. Both of them successfully achieved rapid growth in the last few years.

Virtual community study is gaining the attention of many researchers lately. The use of ephemeral messaging becomes a community trend that probably interesting to be researched more. This study analyzes and proves several factors that may affect the behavior intention to use Snapchat and Instagram Stories using Structural Equation Modeling (SEM) with Technology Acceptance Model (TAM) as the base model. There are two external variables to support TAM such as Perceived Enjoyment and Social Presence. 100 people who have ever used Snapchat and Instagram Stories and resident in Jakarta or Tangerang are targeted to be the sample.

Based on the problems that render in the background, then the issues that will be discussed are:

1. How to influence Perceived usefulness against the interests of generation Z in using Instagram Stories and Snapchat?
2. How the influence of Perceived Ease of Use against the interests of generation Z in using Instagram Stories and Snapchat?
3. How are the influence of Social Presence and the Perceived Enjoyment towards interest generation Z in using Instagram Stories and Snapchat?
4. What are the most Factors influencing interest in the use of Instagram Stories and Snapchat based on the analysis of TAM and SEM?

The purpose of this research is to know the factors which affect the interest of use Instagram Stories and Snapchat among the generation Z variable by reviewing the Perceived usefulness and Perceived Ease of Use as well as Perceived Enjoyment and Social Presence as an extra variable.

II. LITERATURE REVIEW

A. *Perceived Enjoyment*

Perceived Enjoyment (PE) is defined as enjoyable and exploratory as a subjective psychological experience that is the context of information technology and computer-mediated environments [1]. High enjoyment can lead the adoption of a technology even though such technology does not increase any productivity. Some researchers often use PE as a variable because of entertainment, which is related to enjoyment, is an aspect that plays a pretty important role in the success of a technology acceptance. A large number of systems or technology is designed with the orientation on personal pleasure than productivity (hedonic information systems) and one of them is a social network. Therefore, the use of Perceived Enjoyment could be the most appropriate for analyzing user-acceptance towards social network [2].

B. *Social Presence*

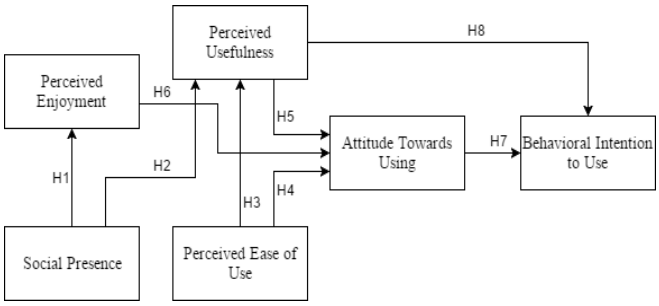
Social Presence (SP) is defined as a medium that allows the user to feel that everyone else seems psychologically present [3]. Social Presence is formed if there is an interaction between user and technology that makes him/her feel the presence of other person and human warmth. A technology with human warmth is able to bring up the communication, socialization, and sensitivity to human feelings.

Digital content such as images and text will increase the social presence, as well as physical photos and letters. In addition, the way of speaking may also build psychological closeness and warmth. The social network which is full of images, videos, text, and emoticons help improving information richness to its users. This drives Social Presence to be chosen as the examined variable in research regarding social media.

C. *Technology Acceptance Model*

Technology Acceptance Model (TAM) is the most popular research models to predict use and acceptance of information systems and technology by individual users [4]. The theory was developed by Fred Davis in 1985 with references to the Theory of Reasoned Action (TRA) which was conceived Fishbein & Azjen in 1975.

On TAM, Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are the two main latent variables that affect another latent variable Attitude towards Using (ATT) which later could influence the Behavioral Intention to Use (BIU) and the actual use. Perceived Usefulness is a degree to which a person believes that using a particular system would enhance his or her job performance [5]. Perceived Ease of Use means the degree to which a person believes that using a particular system would be free from effort. Attitude towards Using defined as a response favorably or unfavorably to an object that results in either an acceptance or a rejection. While Behavioral Intention is an eagerness to do a particular behavior due to good perception towards the object.



The basic TAM is shown in the picture below designed by Fred Davis (1989)

Fig.1 Technology Acceptance Model

III. METHODOLOGY

The research of quantitative in nature is a research that is both objective and measurable using data in the form of figures or statements that are valued and can be analyzed with statistics. The framework hypothesis used is the Technology Acceptance Model (TAM), a popular theory to analyze and prove the level of acceptance of the technology. TAM serves a base of indicators will be used in research that is Perceived usefulness, Perceived Ease of Use, attitude toward using, Behavioral Intention to Use, and actual system use.

TAM is the renewal of the two models that have been coined earlier Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB). TRA indicates the relationship between attitude and subjective norm against behavior intention. This theory is considered by some researchers give rise to ambiguity or confusion on variable attitude and subjective norm because research results often show similarities (Samaradiwakara & Gunawardena, 2014). TPB is the concept of a TRA has been updated. TPB adding that indeed there are various factors that control a behavior known as Perceived Behavior Control. However, the TPB in its application toward acceptance of the technology is in doubt because of subjective variables norm does not have significant influence and perceived behavior control need to be further specified (Samaradiwakara & Gunawardena, 2014). Thus, the resercher chose to use TAM as an approach or basic framework for this research.

A 5-point-Likert-scale questionnaire is designed to collect quantitative data. The questionnaire consists of 20 observed variables that expected to define 6 latent variables. The valid sample needed is 100 persons who live in either Jakarta or Tangerang and he/she has ever used *story* in Snapchat as well as Instagram. Those responses are then analyzed using

Structural Equation Modeling (SEM) technique with SPSS AMOS as the tools.

Two main steps of SEM are measurement model fit and structural model fit. Measurement model fits measures the relationship between each latent variable with its observed variables, while structural model fit measures the relationship between one latent variable with another.

Model and hypothesis for this study are described as follows.

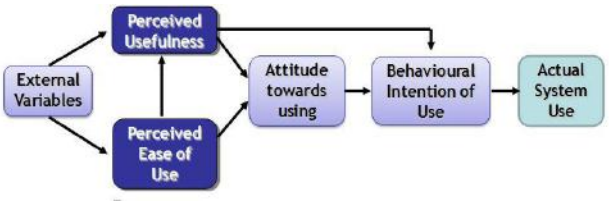


Fig.2 Model Designed for This Research

To analyze the relationship of the latent variables and variables observed required supporting methods i.e. Structural Equation Modeling (SEM). There are two tools that are commonly used when analyzing the SEM that is SPSS AMOS and LISREL. SPSS AMOS selected for use in this research because it has a user friendly display and graphic-based making it suitable for novice users.

A. Research Variables

The variables that are used for research, among other Perceived Usefulness, Perceived Ease of Use, Attitude towards Using, and Behavioral Intention to Use as well as two external variables i.e. Perceived Enjoyment and Social Presence. This variable is the sixth latent variables respectively will be defined with two or more variables observed with a total of 20 pieces. The Actual variable Usage that in fact is a basic variable TAM is not used because it is considered already able to be explained by the variable Behavior Intention to Use.

Perceived Ease of Use and a Social Presence be exogenous variable because it is not influenced by any variables but rather affect other variables. Perceived Usefulness, Perceived Enjoyment, Attitude towards Using, and Behavioral Intention to Use be an endogenous variable, because it receives the influence of other variables.

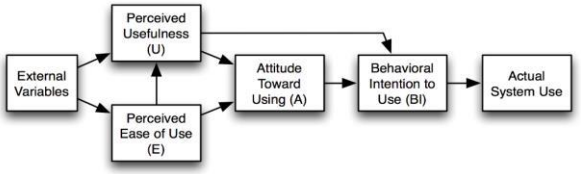
B. Research Hypothesis

TAM has been used to examine the level of acceptance of a variety of information systems and technology in the Meta analysis. Look at the growth of social networking is increasingly high, the researcher proposes some hypothesis as part of searches about the level of acceptance of Snapchat and Instagram Story. As explained there are two additional external i.e. latent variables Perceived Enjoyment and Social Presence.

The hypothesis may actually be defined themselves according to the curiosity of researchers. However, in order to be valid research surely needs to reference the earlier research. The preparation of this hypothesis refers to the two main references are:

1. Basic TAM designed by Fred Davis (1989)

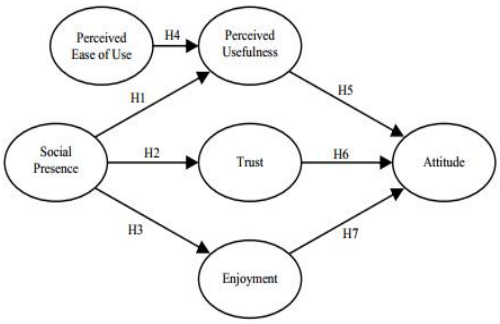
Fig.3 Basic TAM



designed by Fred Davis

2. The model designed by Hassanein (2004) about the acceptance of ecommerce sites

Fig.4 Model designed by Hassanaein



Meanwhile, the proposed hypothesis model are:

H1: High Social Presence will result in high Perceived Enjoyment

H2: High Social Presence will result in high Perceived usefulness

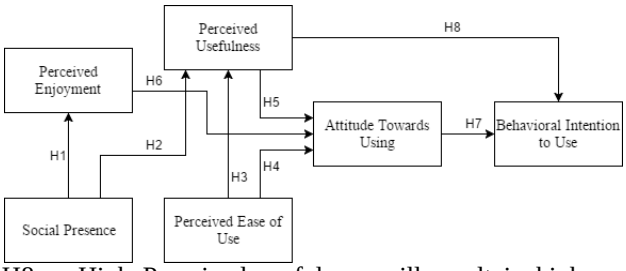
H3: High Perceived Ease of Use will result in high Perceived usefulness

H4: High Perceived Ease of Use will result in high Attitude Towards Using

H5: High Perceived Usefulness will result in high Attitude Towards Using

H6: High Perceived Enjoyment will result in high Attitude Towards Using

H7: High Attitude Towards Behavior will result in High Behavioral Intention to Use



H8: High Perceived usefulness will result in high Behavioral Intention to Use

Fig. 5 The Model Research of influence of interest in the use of Snapchat and Instagram Stories

C. *Sampling Technique*

This limited research sampling in a society that belongs to generation Z. Based on theories put forward the Grail Research (2011) and Baysal (2014), specifically the samples taken are those born in 1995 and over the next year.

The population becomes research material is a resident of Indonesia who ever used Snapchat and Instagram Stories. However, due to the number of the population belongs to is not clear or the number is too large to be recorded, it will be difficult to take samples at random and fair. The most appropriate technique is using the technique of non-probability sampling. Non-probability sampling is defined as techniques that do not give opportunities/equal opportunity for each element or member of a population to be selected into the sample (Sugiyono, 2008).

Types of Non-Probability Sampling that researcher use is Quota Sampling. Quota Sampling is a technique to determine the samples from populations that have certain characteristics to the sum (quota) of the desired. The survey will continue to be done to meet the quota of a particular sample from one of the categories or the largest.

In this study, the area that became the target of a sample are Jakarta and Tangerang. Total sample 100 people with a proportion of 50 people domiciled in Jakarta and 50 persons domiciled in Tangerang. The amount of the sample is based on the theory of minimum sample size for the processing of SEM is 10 times the number of invalid constructs complex or the dependent variable).

The **dependent variables** in the study amounted to 4 pieces, namely, Perceived Usefulness (PU), Perceived Enjoyment (PE), Attitude Towards Using (ATT), and Behavioral Intention to Use (BIU), then the minimum sample size is 40. Taking the samples was the 2-3 100 times the minimum size is quite capable of representing the results of hypothesis testing. In general, the number of samples ideal for SEM is 100-150 but the sample size is smaller does not mean not being able to define the influence of variables.

IV. Data Analysis and Results

A. *Measurement Model Fit*

Measurement Model Fit includes goodness of fit test, also validity and reliability test. The goodness of Fit Test aims to find how well a set of data or observations already fits the model. There are some parameters or criteria that need to be fulfilled so that it is called a good fit. The result of the test applied in this study shows that both Snapchat and Instagram Stories have such good models.

After qualifying for the goodness of fit test, the next step is the validity and reliability tests. The validity of a model can be seen from Average Variance Extracted (AVE). The table shows that AVE of all variables is already above the minimum value which is 0.5. High AVE means there is a high amount of variance that is captured by a construct or variable then leads strong influences between variables.

Reliability can be checked from the value of Construct of Reliability (CR). In the table, CR of all variables are also already above the minimum value which is 0.5. This indicates data used for the model has good reliability.

Table 1. Ave Value Of Snapchat And Instagram Stories

Variable	Average Variance Extracted	
	Snapchat	Instagram Stories
PEOU	0.65	0.59
PE	0.59	0.51
SP	0.67	0.54
PU	0.52	0.47
ATT	0.66	0.66
BIU	0.80	0.79

Table 2. Cr Value Of Snapchat And Instagram Stories

Variable	Construct Reliability	
	Snapchat	Instagram Stories
PEOU	0.85	0.81
PE	0.85	0.81

SP	0.86	0.77
PU	0.85	0.82
ATT	0.85	0.85
BIU	0.89	0.88

Hypothesis			C.R.	P	Result
PE	<---	**SP**	5.72	***	Accepted
PU	<---	**SP**	4.23	***	Accepted
PU	<---	**PEOU**	2.32	0.02	Accepted
ATT	<---	**PEOU**	1.28	0.20	**Rejected**
ATT	<---	**PU**	2.16	0.03	Accepted
ATT	<---	**PE**	6.56	***	Accepted
BIU	<---	**ATT**	5.12	***	Accepted
BIU	<---	**PU**	-0.26	0.80	**Rejected**

B. Structural Model Fit

Structural Model Fit is the last step in SEM analysis. If the measurement model defines the relationship between the latent and the observed ones, the structural model describes the relationship between each latent variables

Table 5. Loading Factor Of Each Relationship

Hypothesis			Loading Factor Snapchat	Loading Factor Instagram Stories
H1	PE	<--- **SP**	0.830	0.782
H2	PU	<--- **SP**	0.623	0.565
H3	PU	<--- PEOU	0.262	0.284
H4	ATT	<--- PEOU	**(rejected)**	0.303
H5	ATT	<--- PU	0.231	0.311
H6	ATT	<--- **PE**	0.733	0.460
H7	BIU	<--- ATT	0.818	0.747
H8	BIU	<--- PU	**(rejected)**	**(rejected)**

with a path diagram instead. The main part of structural model fit is hypothesis test.

A hypothesis is **true** if

p < 0.05 and CR >= 1.96 or CR < =-1.96.

The result of hypothesis test shows there are 6 hypothesis accepted and 2 hypothesis rejected on analysis towards **Snapchat**. Perceived Ease of Use seems not to influence attitude very much. While on **Instagram** Stories 7 hypothesis are accepted and 1 hypothesis is rejected. Perceived usefulness of both applications have no effect on behavioral intention directly

Hypothesis			C.R.	P	Result
PE	<---	**SP**	5.896	***	Accepted
PU	<---	**SP**	4.338	***	Accepted
PU	<---	**PEOU**	2.538	.011	Accepted
ATT	<---	**PEOU**	3.057	.002	Accepted
ATT	<---	**PU**	2.630	.009	Accepted
ATT	<---	**PE**	4.116	***	Accepted
BIU	<---	**ATT**	5.749	***	Accepted
BIU	<---	**PU**	0.861	.389	**Rejected**

Table 3. Hypothesis Test For Snapchat

*** is p<0.001

Table 4. Hypothesis Test For Instagram Stories

*** is p<0.001

How strong one variable influences another variable can be identified by its loading factor.

As seen in Table V, loading factor of SP have big enough influences towards PE and PU. This could mean human warmth feeling while using Snapchat and Instagram Stories makes the users enjoy and keep those apps.

The first hypothesis, namely Social Presence (SP) effect on Perceived Enjoyment (PE) accepted by both applications. This means aspects of Social Presence as personal interaction seems real and immediate impression and human warmth that arises from the use of Snapchat as well as Instagram is considered interesting. It also makes both application users curious to try its features and enjoy lingering social networking use. The value of standardized loading factor H1 Snapchat is greater than the value of the loading factor Instagram Stories so they can be inferred for variable SP against PE has a great influence more significant at Snapchat compared with Instagram Stories.

The second hypothesis is Social Presence (SP) effect on Perceived usefulness (PU). This hypothesis was accepted on the analysis of both social networking. The author assumes the existence of a positive influence between these two variables because indicators Social Presence is useful to increase the effectiveness in communicating with others as well as

facilitate the work or activity its users. The influence of SP towards PU larger or more significant happens on the Snapchat than Instagram Stories.

The third hypothesis is the Perceived Ease of Use (PEOU) effect on Perceived usefulness (PU). This hypothesis was adopted from the basic framework of the hypothesis of TAM. Research conducted suggests that this hypothesis was accepted in Snapchat analysis as well as Instagram Stories. The ease of use of the application apparently significant effect on the perception this application is useful, for example, in terms of the interface that are not complex (PEOU indicator) makes sharing content with others more quickly (PU indicator). But PEOU didn't turn out too great influence to the PU value considering the loading factor both for Instagram Stories and Snapchat both are in the range of 0.2

The fourth Hypothesis is the Perceived Ease of Use (PEOU) influence on Attitude Towards Using. Just like the H3, this hypothesis is also based on the framework of the TAM. This hypothesis was rejected in an analysis of the Snapchat, but accepted on the analysis of the factor effect with Instagram Stories amounted to 0.3. Ease of use Snapchat where users are not the factors influencing perception or positive Outlook against the application. However, the ease of use Instagram Stories, according to users, thus being able to pose the positive perception and the like.

The fifth hypothesis is Perceived usefulness (PU) influence on Attitude Towards Using (ATT). This hypothesis is based on the basic framework of the TAM. This hypothesis was accepted by analysis of both application, it can be concluded the benefits of the use of Snapchat and Instagram Stories as quickly in content sharing, effective communication, and up-to-date to information raises the good view and the feeling of love towards those applications. The value of loading factor for Instagram Stories higher than Snapchat which means the influence of the larger PU against ATT on the use of Instagram Stories.

The sixth hypothesis is Perceived Enjoyment (PE) influence on Attitude Towards Using (ATT). This hypothesis was accepted in Snapchat analysis as well as Instagram Stories. This shows attraction of features provided and the convenience becomes factors users feel happy and entertained with this application. Loading factor value PE against ATT in Snapchat of 0.73, larger than the loading factor on Instagram Stories worth 0.46. This means that the influence of PE at greater use of ATT Snapchat compared with Instagram Stories.

The seventh hypothesis is the Attitude Towards Using (ATT) effect on Behavioral Intention to Use(BIU). This hypothesis was adopted from the basic framework of the TAM. Analysis on both applications accepts this hypothesis which emphasizes positive attitudes and perceptions of users against Snapchat or Instagram Stories affecting intention to use the social networking or increase the frequency of its use. ATT influence on BIU quite significant because its loading factor is in the range of 0.7-0.8.

The eighth hypothesis is the Perceived Enjoyment (PE) effect on Behavioral Intention to Use (BIU). This hypothesis was rejected in the analysis of both applications, it can be inferred that the convenience of use and attractive features on both social networking is not affecting the interest to continue using both of this social networking or increase the frequency of its use at a later date.

PE is another external variable that also has great influence. Loading factor of PE towards ATT is the second highest among SP, PU, and PEOU. This shows that users get interested in the ephemeral messaging feature because it might turn them feel happy and entertained

V. CONCLUSION

SEM analysis towards an intention to use **Snapchat** with the based model of Technology Acceptance Model theory showed that 6 hypothesis is accepted and 2 hypothesis is rejected. From the accepted hypotheses, it can be inferred that PU is capable of significantly affecting the ATT which has "domino effect" influencing BIU. In addition, PE and SP are the external variables that become the factors impacting on ATT directly and indirectly. However, the rejected hypothesis shows the absence of a direct relationship between Perceived Usefulness with Behavior Intention and the relationship between the Perceived Ease of Use with Attitude. This finding actually differs from the tested hypothesis of TAM by Fred Davis (1986).

Analysis of **Instagram** Stories shows that 7 hypothesis is accepted and 1 hypothesis is rejected. From the results, it can be concluded that the PU, PEOU, and PE influences the Attitude Towards Using so that it also impacts on the intention to use. Meanwhile, Social Presence also affects behavioral intention indirectly with Perceived Usefulness and Perceived Enjoyment as mediator. This hypothesis test result is the same as the result of research conducted by Hassanein (2004).

This study finds out that Perceived Enjoyment on Snapchat and Instagram Stories **has the biggest influence** on attitude so that it drives someone's behavior intention to use them. PE on Snapchat has a stronger effect than PE on Instagram Stories as it can be seen on loading factor value. While Instagram Stories has stronger factors than Snapchat in Perceived Usefulness dan Perceived Ease of Use.

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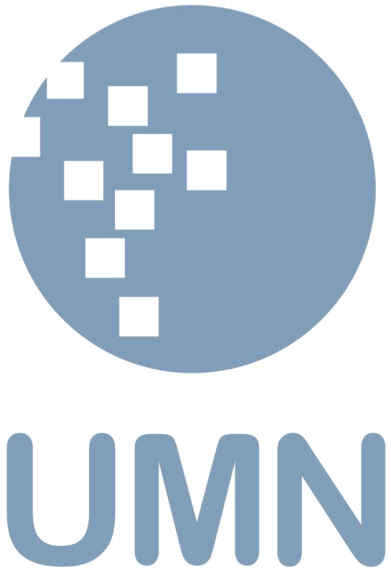

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Open Sourcing Proprietary Application Case Study: KIRI Website

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***Abstract*—KIRI, a previously closed source project, is a web-based public transport navigation application that serves Bandung and other cities in Indonesia. It was originally made for commercial purpose, but relatively unsuccessful. Rather than shutting it down, we transformed KIRI to an open source project. In this paper we explain such process of transformation.**

First, we identified technical infrastructures required by an open source project by literature review. Then, we surveyed various existing open source projects in Indonesia in terms of their completeness in technical infrastructure. Based on findings from literature review and survey, we converted KIRI into an open source project.

Finally, we checked final result of this transformation, to ensure everything worked well. There were some problems found after conversion, and had been fixed accordingly. Further research is needed to see if the open sourced KIRI can attract community participation.

Keywords—open source; indonesia; navigation; public transport

I. INTRODUCTION

KIRI (as depicted in **Error! Reference source not found.**) is a website that provides navigation between two geographical points in Indonesia using public transport. It currently serves *angkot*s (public mini-buses) navigation in the city of Bandung, as well as TransJakarta and Commuterline in DKI Jakarta province. Its advantage over similar service like Google Maps or Moovit is its ability to take angkot's characteristic of being able to let passengers board and alight at any point of the road instead of strictly at bus stops.

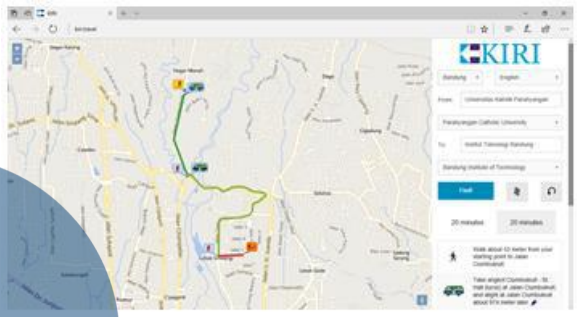

Fig 1. Screenshot of KIRI

Historically, KIRI started as an entrepreneurial startup project, with the hope of being able to monetarily independent as a company. It has been pitched to and won various mentoring and seed funding competitions, such as Mandiri Young Technopreneur 2012, Blackberry Business Plan Competition 2012, and Telkom Group's Indigo Incubator 2013. For the past three months (at the time of this paper's writing), it has roughly 1.500 pageviews from 500 users according to Google Analytics measurement. As it was designed and built for business, source code of KIRI consequently must be protected and remained closed source.

Despite stable user base and promising future (just like any other startups), KIRI was unsuccessful in terms of making money. We argue that most of public transport users in Indonesia have low or medium income, and paying for such service is too much for them. Hence, we decided to convert KIRI project into an open source software that has the following impacts to this project:

- opens up donation based funding, rather than commercial
- allow publications of KIRI's internal algorithms
- its assets must be modified such that it meets general open source software requirements and best practices

II. Literature Review

According to [4], open source projects are typically built on top by the following technical infrastructure:

- Website that is customized for those who wants to participate in the project (as opposed to website for those who wants to use the output of the project).
- Mailing Lists / Message Forum (usually not present for small projects, and can be replaced with email feature of a bug tracker system).
- Version Control to monitor and control changes of project files, including the project source code, documentation, and website.
- Bug Tracker to track and monitor bugs as well as feature requests, one-time tasks, or unsolicited patches. More formally known as issue tracker (as now it tracks more than just bugs).
- IRC / Real-Time Chat Systems where users and developers can raise questions and get answers instantly.
- Wiki, documentation website that can be contributed by various entities. Wiki is regarded as the easiest channel for people who wants to contribute.
- Q&A Forums, an advanced form of FAQ (Frequently Asked Questions) page that has real-time updates.
- Translation Infrastructure, useful for contributors who wants to translate the project into different languages, whether for the documentation, software interface, error messages, etc.
- Social Networking Services such as Twitter or Google+ channel. Rarely used, except for community needs.

III. Research Methodology

This research aims to convert the existing KIRI project into a proper open source project in terms of technical architecture. First, we will review the current architecture of KIRI. Then, we will study three open source projects that are made in or related to Indonesia. Finally, we will map the components of KIRI into the technical architecture as described in [4], potentially creating new ones that were not available before.

After conversion, we will review and check all KIRI services to ensure that they are working properly.

IV. Architecture of KIRI

KIRI is composed of several components, as depicted in **Error! Reference source not found.**.

Tirtayasa[1] is the frontend of KIRI, responsible for user interactions through web browser as well as RESTful APIs [3]. It also helps converting user inputted place names into latitude and longitude format in EPSG: 4326 system [1] (with help of Google Maps service). Tirtayasa is built using PHP and CodeIgniter Framework. However, in calculating the navigation route, it delegates the job to another component called NewMenjangan.

NewMenjangan[2] is a Java-based HTTP service that takes two coordinates as origin and destination, and outputs the best navigation route between those two coordinates using public transport. When the service is started, it loads all tracks and constructs a big graph based on those tracks. When NewMenjagan receives navigation query request, it calculates the result using slightly modified Dijkstra's shortest path algorithm, that uses Heap data structure to speed up the process [2].

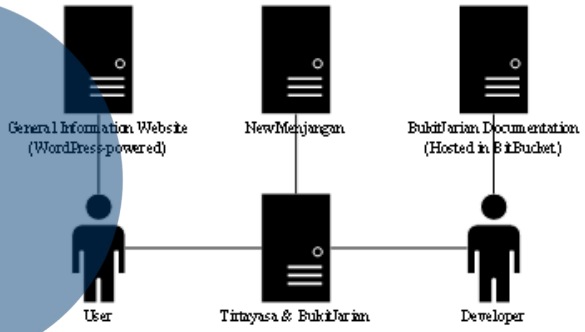

Fig 2. KIRI Architecture (before open-sourced)

BukitJarian[3] is KIRI app frontend that is directed to software developers who wants to use the KIRI RESTful API. In this frontend, developers can register for an API key that they can use to request navigation services to the KIRI engine (via Tirtayasa).

Documentation of KIRI API for web service is hosted on BitBucket[4], providing information for developers who wants to use the RESTful API as well as to use the dashboard to request an API key.

KIRI also has a Wordpress-powered website[5] that mostly serves general information about KIRI, such as "About Us" page, legal matters and feedback form.

V. Existing Open Source Projects in Indonesia

There are several open source projects that the author has found been created in Indonesia.

- Kawal Pemilu 2014 [5] is a project initiated by Ainun Najib to help citizens verify the

[1] http://kiri.travel
[2] http://newmenjangan.cloudapp.net, now obsolete
[3] http://kiri.travel/dev
[4] https://bitbucket.org/projectkiri/kiri_api/wiki/Home, now obsolete
[5] http://static.kiri.travel, now obsolete

authenticity of Indonesia's presidential election in 2014, by using the open data that was provided by *Komisi Pemilihan Umum* (General Election Commission). The usage of this web-based application has been studied from the data openness and social-politic point of view, for example in [6] and [7].

- InaSAFE [8] is a disaster mitigation application, and a product of cooperation between *Badan Nasional Penanggulangan Bencana* (National Board for Disaster Management), Australian government, and World Bank. From the open source point of view, this project is very mature and has been presented in the 4th International Symposium on Earthquake and Disaster Mitigation 2014 [9].
- Finally, SLiMS (*Senayan Library Management System*) [10] is a library management system application that has been used in various university libraries in Indonesia.

We analyzed those three open source projects, and summarized the findings in **Error! Reference source not found.**. While Kawal Pemilu 2014 has the most discussions in academic community due to its success, it is a one-time project that was built by a small team and has the source code released freely. We didn't see much open source activities after the election has ended. Among three, InaSAFE was the most mature in terms of open source quality. It has more than 40 contributors and more than 2,000 issues. SLiMS was not very popular as the other two, but it was vastly used by many libraries in Indonesia and abroad, as claimed by its main contributors [11].

Table 1. Comparison of Open Source Projects in Indonesia

Elements	Kawal Pemilu	InaSAFE	SLiMS
Infrastructure			
Web Site (for contributors)	No	Yes	No
Mailing Lists / Message Forum	No	No	Yes
Version Control	Yes	Yes	Yes
Bug Tracker	Yes	Yes	Yes
IRC / Real-Time Chat Systems	No	Yes (Gitter)	No
Wiki	No	Yes	No
Q&A Forums	No	No	Yes
Translation Infrastructure	No	Yes (Transifex)	No
Social Networking Services	Facebook	No	Facebook, Twitter
GitHub Statistics			
Number of contributors	4	41	19
Number of commits	16	14,991	578
Last Commit	9 February 2015	16 August 2017	16 August 2017
Number of open / closed issues	0 / 1	153 / 2,131	16 / 3

Table 2. KIRI Open Source Statistics

Elements	KIRI
Infrastructure	
Web Site (for contributors)	Yes
Mailing Lists / Message Forum	No.
Version Control	Yes
Bug Tracker	Yes
IRC / Real-Time Chat Systems	No.
Wiki	Yes
Q&A Forums	No.
Translation Infrastructure	No.
Social Networking Services	Facebook and Twitter (not actively maintained)
GitHub Statistics[1]	
Number of contributors	2
Number of commits	54
Last Commit	11 August 2017
Number of open / closed issues	0 / 6

VI. Open Sourcing KIRI

A. Technical Infrastructure

Based on recommendation from [4], we transformed components of KIRI into several technical infrastructures, summarized in **Error! Reference source not found.** and explained in the following subsections.

1) Website

Website that provides general information, including new section of information for contributors, is hosted in the following URL: https://projectkiri.github.io. It is a one-page website that contains all information needed. Thanks to the fact that it is backed by the GitHub Pages platform, source code of this website is also open and versioned.

Due to the nature of GitHub Pages platform, it is not possible to create a bilingual general information website. Hence, the website is written in universal language, i.e. English.

The KIRI frontend (i.e. Tirtayasa & BukitJarian) stays hosted in private cloud, and accessible through the existing URL http://kiri.travel. In addition, we also installed SSL certificate to the frontend, hence accessible too from https://kiri.travel.

2) Mailing List

We decided to not create mailing list as of now, since the cost of maintaining it outweighs the benefit.

3) Version Control

Source code of Tirtayasa and NewMenjangan are moved to GitHub, under the "projectkiri" organization[6]. The benefit of using GitHub is that most open source projects are already hosted there, and contributors can easily contribute to this project without much learning.

4) Bug Tracker

We make use of GitHub's standard issue tracking feature. We ask both users and developers to use this issue tracking system. Though it may take some time for regular user to learn how to use GitHub issue tracking system, it centralizes all feedbacks in one place.

5) Real-Time Chat Systems

We decided to not create real-time chat systems as of now, since the cost of maintaining it outweighs the benefit.

6) Wiki

Wiki is used to provide developer's documentation. It currently hosts documentation to KIRI API, but may be added with more development topics in the future. The wiki is also versioned.

7) Q&A Forums

We decided to not create Q&A forums as of now, since the cost of maintaining it outweighs the benefit.

8) Translation Infrastructure

Though KIRI is already bilingual (English and Bahasa Indonesia), we decided to not create sophisticated translation infrastructure as of now. Contributors can translate KIRI if they want, using the same method as contributing to the source code.

9) Social Networking Services

Although KIRI has already a Facebook page and a Twitter handle –both not actively maintained–, there is no plan to maintain them seriously, as the cost of maintaining it outweighs the benefit.

B. Architecture

Due to open source technical infrastructure requirements, KIRI now contains more components compared to when it was closed source. However, we also managed to simplify the architecture by making use of GitHub platform to host most of the components (known as "canned hosting" as defined in [4]).

While Tirtayasa, Bukitjarian and NewMenjangan stays the same, we moved Developer Documentation and General Information Website into GitHub. In addition, the new components, i.e. source code, wiki and issue tracker are also hosted on GitHub. Diagram of the new architecture is depicted in **Error! Reference source not found.**.

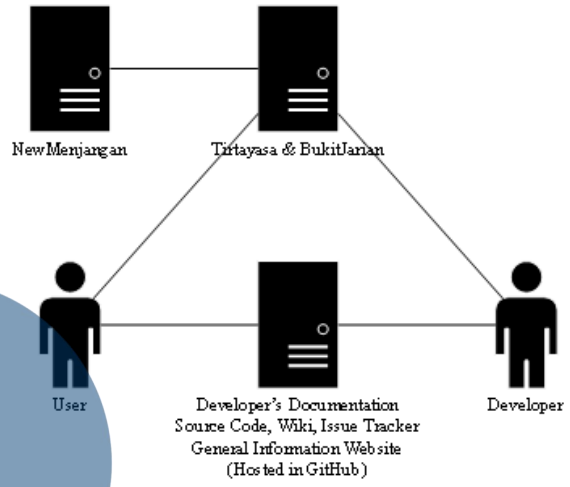

Fig 3. KIRI Architecture (after open-sourced)

VII. Result

After conversion, we checked the status of each component, and found the following result:

- **NewMenjangan** There were no significant changes in the code, aside from the fact that it was migrated to a local Virtual Private Server provider. Thanks to this migration, we found a problem that may occur during deployment, hence the code documentation was updated with a troubleshooting guide. The code for NewMenjangan is now available in GitHub[7].
- **Tirtayasa & BukitJarian** Also due to migration, we found several problems. First, we found a problem caused by file name capitalization. Previously Tirtayasa was hosted in a Windows server, where capitalization does not matter. In a new Linux server, different capitalization in file name caused an error. Secondly, apps that use old KIRI API endpoint (not HTTPS secured) no longer worked. This is because the new API use different path and secured with HTTPS. The server configuration tried to redirect HTTP URIs to HTTPS, and in the process accidentally removed some parameters. Instead of giving a workaround in the server,

[6] https://github.com/projectkiri/

[7] https://github.com/projectkiri/NewMenjangan

we decided to update the Android App[8] that we built to support the new endpoint as it is more secure. Tirtayasa & BukitJarian code is now also available in GitHub[9].

- **Developer's Documentation** there were no significant changes on developer documentation, other than some updates because the existing documentation was written many years back. The documentation is available in GitHub wiki[10].

VIII. CONCLUSION

During the process of transforming KIRI into an open source project, we examined the technical infrastructures required, as well as three relatiely popular Indonesian open source projects. InaSAFE was the most mature in terms of contributions, while Kawal Pemilu 2014 was the most researched further.

We successfully transformed KIRI into a proper open source project from technical point of view. The 3rd party environment GitHub (so called *canned hosting*) helped us simplifying the architectures.

The success of this project in terms of community involvement is not yet known at the time of this paper writing, and left as further research.

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[8] https://github.com/projectkiri/smartpublictransport-as

[9] https://github.com/projectkiri/Tirtayasa

[10] https://github.com/projectkiri/Tirtayasa/wiki

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Data Visualization Indicator Disease (Malaria, Dengue Fever, and Measles) in The Year 2012-2015

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***Abstract*— The aim of this paper are: to create a data visualization that can assist the Government in evaluating the return on the development of health facilities in the region and province area in term of human resources for medical personnel, to help community knowing the amount of distribution of hospitals with medical personnel in the regional area and to map disease indicator in Indonesia. The issue of tackling health is still a major problem that is not resolved by the Government of Indonesia. There are three big things that become problems in the health sector in Indonesia: infrastructure has not been evenly distributed and less adequate, the lack of human resources professional health workforce, there is still a high number of deaths in the outbreak of infectious diseases. Data for the research are taken from BPS, in total 10,600 records after the Extract, Transform and Loading process. Time needed to convert several publications from PDF, to convert to CSV and then to MS Excel 3 weeks. The method used is Eight-step Data Visualization and Data Mining methodology. Tableau is chosen as a tool to create the data visualization because it can combine each dasboard inside a story interactive, easier for the user to analyze the data. The result is a story with 3 dashboards that can fulfill the requirement from BPS staff and has been tested with a satisfied result in the UAT (User Acceptance Test).**

Index Terms—*Dashboard, data visualization, disease, malaria, Tableau*

I. INTRODUCTION

Currently access to health data actually already very easy to be accessed, so wider community can access these data, unfortunately, most of the data still in the form of numbers. Based on the background, there is a need to have a data visualization in order to visualize the cases.

Processing data into useful information is very important, so researchers will create data visualization to (1) compare the distribution of hospital facilities and health workers for period 2012-2015, (2) show disease indicators will be displayed in 3 dashboard, filtered by year and province in order to make the user can clearly see the level of transmission of disease cases every year in the province in Indonesia in the span of the year 2012–2015**.**

Based on the background of the problem, then the problem statement:

- How to visualize the disease indicator (Malaria, dengue fever, and measles), and the availability of hospital and medical personnel?
- How the results compared per year based on the indicators of the disease with the availability of hospital and medical personnel in the provinces of Indonesia?
- How to display the visualization dashboard diseases indicator (Malaria, dengue fever, and measles), and the availability of hospital and medical personnel?

II. LITERATURE REVIEW

A. *Health information systems*

Health information systems are the management of information across levels of Government systematically within the framework of the Organization of the service to the community. It's just that in the contents of both Decisions of the minister of health contain flaws which are both just looked at health information systems from the viewpoint of health management, not utilizing state of the art information technology and are not related to the system of national information systems. Information and communication technologies are also not yet spelled out in detail so that the data presented is not appropriate and not on time [1].

B. *Health facilities*

According to [2], the facility is everything in the form of objects or money that can facilitate and accelerate the implementation of a certain business. Based on the definition of the above it can be concluded that the health facility is anything that

provides a place to care for patients and work space for medical personnel to care for patients. The hospital was an institution of professional health care services are provided by doctors, nurses, and other health experts. The following is a task at once a function of hospitals, namely:

- Carrying out medical services, medical support services.
- Implement the inpatient service.
- Carrying out medical education.
- Implementing outpatient services or inpatient and emergency care (observation).

Hospitals type in Indonesia based on law No. 44 of 2009 can be distinguished into five types based on it's capability, namely:

1. Hospital Type-A

The hospital is capable of providing services medical specialist and extensive subspecialty by the Government designated as the highest reference (Top Referral Hospital) or also called as the Hospital Center.

2. Type B Hospitals

The hospital is capable of providing services of medical specialists and sub-specialty is limited. The hospital was founded in every provincial capital which houses the reference services in the hospital district.

3. Hospital Type-C

Hospitals that are able to provide specialist medical services limited. The hospital was founded in every capital of the Regency (Regency hospital) that accommodate service referrals from clinics.

4. Hospital Type-D

The hospital is the transition with the ability to only give general medical and dental services. The hospital accommodates reference comes from the clinic.

5. Hospital Type-E

Specialty hospital (special hospital) which hosted only one waiter of medical health course. Currently, many hospitals of this class found e.g., Hospital leprosy, Pulmonary, cardiac, cancer, mother and child.

C. *Data Visualization*

Data Visualization is a tool used to support company or an agency organization in taking a decision which is presented in the form of design charts, maps or diagrams. Data Visualization is a technology supporting visualization and interpretation of existing data and information at several points along the continuum of data processing. Data Visualization itself can display the data in the image into the form of visualizing digital, GIS (Geographic Information System), graphical user interface, virtual reality, three-dimensional presentation, video, and animation [3].

There are two main goals of data visualization according to *White Paper Principles of Data Visualization – What We See in Visual Explotary visuals* [4], namely:

a. Explain the data to solve specific problems: visualization can help users take the best decisions, answering questions in a particular delivered an information on a specific problem.

b. Explore large datasets for better understanding: exploratory visuals will provide plenty of dimension against a data set to the viewer, or compare data with other data. Exploratory visual will attract readers or users to be able to explore the visual, questions arise during the process, and answer any questions.

D. *Several type Data Visualization*

- *Multidimensional Data Visualization Tools*

Is a tool used to simulate the data into the form of a 2D or 3D, his goal users can understand more about the content of the information because it is seen from a different perspective [5].

- *Multidimensional Pie Chart*

Multidimensional Pie Chart allows users to create a visualization of one to three independent response variable at a time. Independent variable containing the Slice, Row, and Column [5].

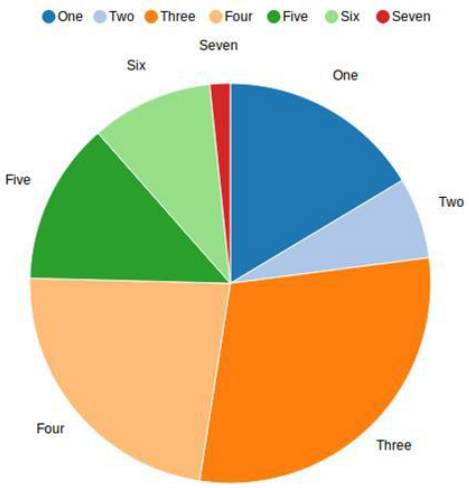

Fig. 1 *Multidimensional Pie Chart*

- *Multidimensional Bar Charts*

  Multidimensional Bar Charts allows users to create a data visualization of two to six variable at a time. One of the variables can be combined with three axes and one of three colors [5].

- *Multidimensional Histograms*

  Multidimensional Histograms allows the user to build a data visualization in the form of 3D and 2D from density data that can contain one to three independent variables, the Histogram is very suitable for the needs of large amounts of data visualization

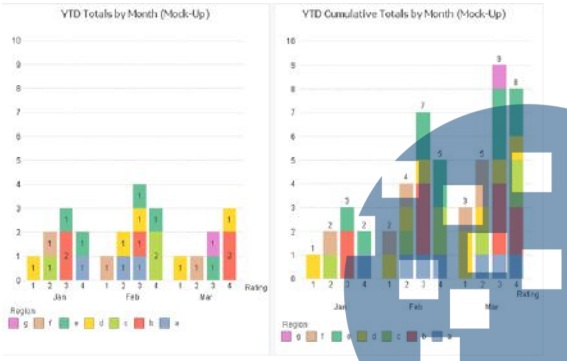

Fig. 2 *Multidimensional Bar Chart*

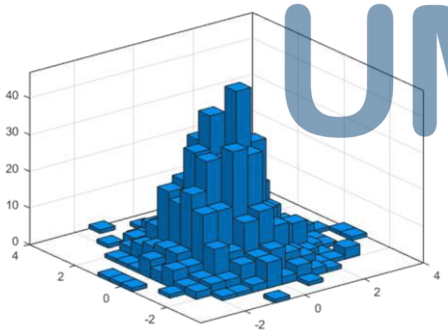

Fig. 3 *Multidimensional Histograms*

- *Multidimensional Scatter Plot*

  Multidimensional Scatter Plot allows users to perform data visualization in the form of 3D and 2D. Data can be displayed in form of a plot consisting of one or two independent variables [5].

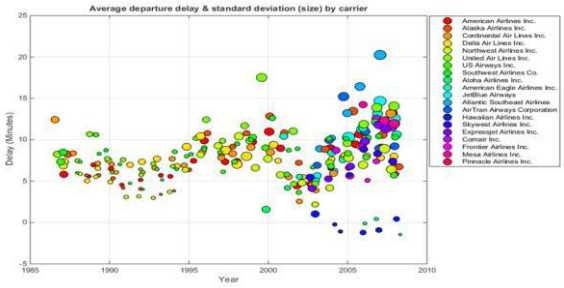

Fig. 4 *Multidimensional Scatter Plots*

E. Information Dashboard

Information Dashboard a great tool to present information at a glance, solutions for the information needs of the organization by providing the look of interface with a variety of forms such as diagrams, reports, visual indicators, alert mechanism, combined with a dynamic and relevant information [6].

F. Tableau

Tableau is a business intelligence software that lets everyone perform data integration easily wherever and whenever it can then be visualized using interactive dashboards.

Tableau Desktop is a data visualization application that can be used for easy and quick to answer the specific questions at issue. Tableau made the great amount of the data becomes much easier no matter what his needs.

Tableau Public is a data visualization application version, free service version that lets anyone can easily access and use such access for sharing information about data integration over the web. Everyone can use Tableau Public easily because it's free.

G. Visual Data Mining Methodology

Visual Data Mining is a technique that can be done with the process over and over. Visualization and data mining can be done with the intention to see the business process of a company [7].

III. RESEARCH METHODOLOGY

This research was conducted with the use of health data obtained from the official portal of the Central Bureau of Statistics (BPS) www.bps.go.id i.e. indicator diseases data (dengue fever, Malaria, Polio), the availability of hospital and medical personnel.

The Central Bureau of Statistics is a Non-Government institution the Ministry is responsible directly to the President. Based on legislation that has been mentioned above, the role of which should be run are as follows:

- Provides data for the needs of the Government and the community. This data is obtained from

the census or survey conducted itself and also from other government departments or agencies as secondary data.

- Assist the statistical activities in the Department, government body or other institution, in establishing a system of the national statistic.
- Develop and promote standard statistical techniques and methodologies, and provide services in the field of education and training statistics.
- Building cooperation with other countries and international institution for the benefit of the development of the Statistics Indonesia.

The research method used is Visual Data Mining (VDM). Visual data mining is a method used to find data that is not known in advance, the pattern of behaviour of the data that is in the company or related institutions will be very helpful in doing searches on the data used through visual technique.

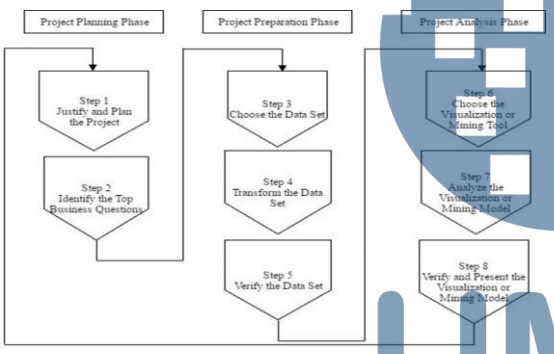

Fig. 5 ***Eight-step data Visualization and Visual data mining methodology***

There are eight steps to be done:

A. ***Project Planning Phase***

- Justify and Plan the Project
- Identify the Top Business Questions

B. ***The Data Preparation Phase***

- Choose the Data Set
- Transform the Data Set
- Verify the Data Set

C. ***The Project Analysis Phase***

- Choose the Visualization or Mining Tool
- Analyze the Visualization or Mining Model
- Verify and Present the Visualization or Mining Model

IV. RESULTS

A. Project Planning Phase

- Justify and Plan the Project

  To be able to proceed to the next steps is to determine the type of visualization project to be created. Visualization type used is a type of visual data mining pilot project aims to investigate, analyze and answer one or two questions of the purpose of the study itself.

- Identify the Top Business Questions

  The process to identify the top business questions is done by determining the question of the business must be traced further and answered. In this case, because researchers doing research on data visualization of health, questions that arise are: (1) how to display the dashboard to visualize data about medical personnel and hospitals in Indonesia (2) how to display the dashboard indicators of disease distribution maps that exist throughout Indonesia in the year 2012-2015.

B. The Data Preparation Phase

The data used in the visualization is taken from www.kemenkes.go.id and www.bps.go.id both are Government website functions as a center of public information from ministries, government agencies, local governance and the relevant agencies with regard to data on Indonesia.

The data used for modeling data visualization use data in the span of 4 years (2012 – 2015) because it has the latest updates. Data for 2016 is excluded because data related to medical personnel, hospitals, and disease indicators are not yet updated.

- Choose the Data Set

  Based on consultation with parties from Ministry of Health and BPS the data that will be included in the Dataset are:

  - Medical Personnel Data (contains Medical personnel: doctors, general doctors, physician specialist, and dentist).
  - Hospital data (contains hospital data in county, city and province, and also bed availability)
  - Disease indicator data (contains cases for Malaria, dengue fever, and measles based on IR – Incident Rate per 10,000 population)

  All of these data are in the publication format (PDF) from different websites and different URL. It then transferred into MS Excel.

- Transform Data

  Using PDF converter, the data then converted into MS Excel. Some data cannot directly converted, data has to be typed manually.

- Verify the Data Set

  Data that has been converted, not completely complete to make a map in Tableau. The data still not have latitude and longitude field.

  Using a website www.gps-coordinate.net researchers put the complete address on this website, and get return the latitude and longitude data.

  Data Cleansing. Last check before all data put into Tableau. Checking all the row and column to make sure all the necessary data already prepared, without any missing values.

C. The Project Analysis Phase

- **Choose the Visualization or Mining Tool**
  - *Visualization Model*

1. *Data connection to the Tableau Software*

   In this phase, data source from Microsoft Excel added to Tableau. The data source will be used to visualize the map. The data will be seperated into **Dimension** and **Measures**.

   Dimension used are: District Name, City, Province and Year. **Measures** used are: number of hospitals, number of beds, total hospital, total beds, number of death cases, the incident rate per 10,000 population, latitude and longitude.

2. *Visualization of Map*

   The visualization map is used to view the area with an information about how many hospitals in each region (province, district or city) in Indonesia using dimension and measures.

   To ease the visualization, filters are used for selecting the province, district, and city in one box selection, and another box selection is used to select the appropriate year with the selection of the year 2012 to 2015. By selecting the year chosen, users can see the differences of the data for each year.

3. *Bar Chart Visualization*

   The next visualization is Bar Charts. This visualization is used to see the number of the dentist, general practitioner and physician specialist in each province, district, and city.

   Dimensions used are: year and province name. The **measures** used are: number of dentists, number of general practitioners and number of physician specialist.

   To ease reading the map, color is used. Blue for a dentist, yellow for physician specialist, and red for the general practitioner.

   Using doctor category in each province and district/city, visualization is used to see the number of dentists, and physician specialists in each of the provinces and District/City in more detail by using the dimension of the year and the name of the Province.

4. *Treemaps Visualization*

   In this fourth type of visualization, treemaps are used, to classify types of hospitals in provinces in Indonesia. This visualization used to see types of hospitals in each province in Indonesia.

   Visualization of treemaps is made with 2 composition dimension (the type of the class, the name of the province) and 2 measures ((SUM) number of hospitals and (SUM) number of Beds).

- *Visualization Dashboard*

  After all of the visuals created, the next step is merging all visualization into the dashboard in order to be given an action.

  The dashboard is made in three forms (1) the dashboard map distribution of hospitals and doctors per province in 2012 – 2015, (2) dashboard map distribution of hospitals and doctors per district/city in 2012–2015, (3) dashboard map Indicator disease in Indonesia.

  The researcher also uses filter to select the Province, District/City and Years.

  In designing the dashboard, 3 column worksheet is used with the goal of keeping each sheet represents the data in the view and can be breakdown to make users easier to understand and

read the visual appearance of the data. (see fig. 6 Visualization Dashboard)

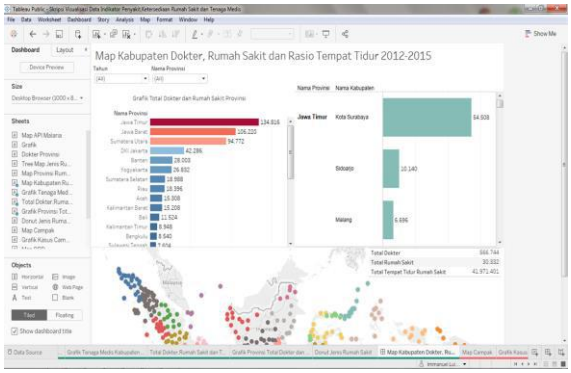

Fig. 6 *Visualization Dashboard*

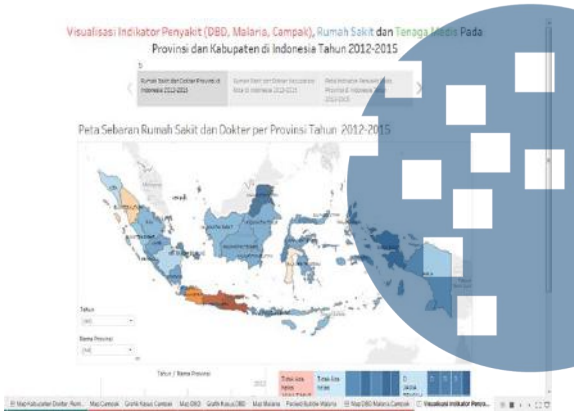

Fig. 7 *Visualization Story*

- *Visualization Story*
  A Story is a collection of every dashboard which combined to become the story. The goal of a story is to make it easier for users to access any dashboards (see fig. 7 Visualization Story)

- **Analyze the Visualization or Mining Model**

At this stage of analysis, the model visualization is done to ensure with this visualization top business questions you have in the phases of Visual Data Mining can not be missed.

1. *Dashboard map of the spread of hospital and medical personnel in the provinces of Indonesia in 2012 – 2015.*

   The primary purpose of construction of hospital distribution and visualization of medical personnel is to know the overall number of hospitals and medical personnel in each province in Indonesia.

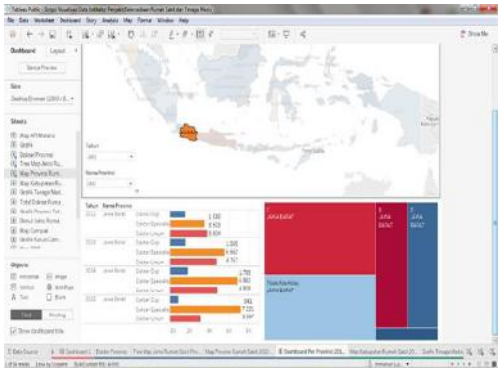

Fig. 8 *Type of Hospital in West Java Province*

2. *Dashboard distribution of hospital and medical personnel at the* district/city *in Indonesia year 2012 – 2015*

   The aim to build visualization of distribution of hospitals and medical personnel per district/city to be able to know the number of hospitals and medical personnel in more detail per district/city that exist in every province in Indonesia, as seen in Figure 8

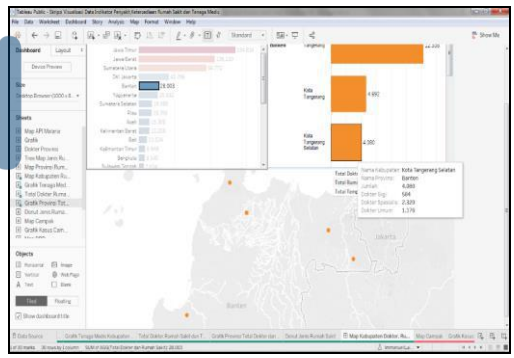

Fig. 9 Details of medical personnel and hospitals at the district/city

3. *Dashboard indicator of the disease in the province in Indonesia*

   There are 3 dashboard to represent indicator of the disease, consecutively dashboard for Malaria, Measles and Dengue. One of the dashboard for Measles in year 2015, can be seen at Figure 10 below.

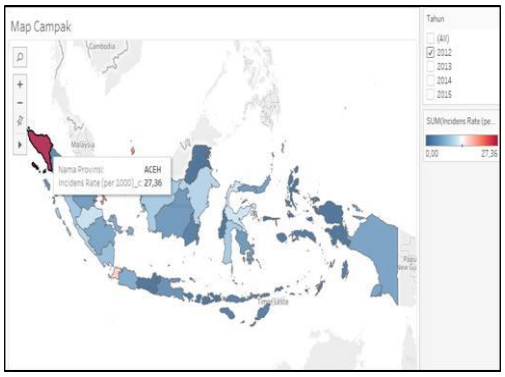

Fig. 10 ***Measles dashboard year 2015***

- **Verify and Present the Visualization or Mining Model**

  The last stage in the technique of Visual Data Mining is to do a demo against the visualization model already built using the data in compliance. The visualizations appear in accordance with the existing data, when there is an error in the visualization then it can be inferred that there is an error in the data set and should be fixed.

  The visual result is already uploaded to Tableau Public server. The visualization can be seen at http://bit.ly/diseaseindicator

V. CONCLUSION

Visualization indicator diseases, availability of medical personnel in the hospital and the provincial government, districts, and cities in Indonesia is created to provide information about the growth of the health facilities and medical personnel as well as the number of cases of infectious diseases that are in Indonesia to the community.

This visualization is made in the form of an interactive dashboard which further consolidated into a story of the dashboard so the society or users easier make an interaction with the data.

In 2012–2015 the Indonesian province of East Java Regional Hospital facility availability totaled 1,220 units. East Java province has a thick red color which means that area has a high amount of hospitals compared with another region; followed by Central Java, West Java, North Sumatera.

On the bar chart, medical personnel in 2012 – 2015 can be seen that the growth rate of human resources in the medical personnel with the highest number of both in the dentist, and physician specialists are in 3 provinces in Java: West Java, Central Java, and East Java.

In the year 2012 medical personnel for the dentist, East Java has 1,591 people, and the highest number of general practitioners found in Central Java province amounted to 4,786 people while for physician specialists totaled 4,258 people.

On **a bar chart** for district/city in 2012 – 2015 regional human resources in the medical personnel are in the city of Surabaya have a total overall 54,508 dentist 3,616 people, general practitioner, a specialist doctor 10,916 people 39,976 people. For human resources in the medical personnel, the lowest in Pasaman West Sumatra Province with a total of 20 dentists, general practitioner 88 people and physician specialist 188 people.

The indicator for the disease in the province in Indonesia is divided into 3 maps (1) map for dengue fever (2) map for Malaria and (3) Measles maps. The maps distinguished into 2 colors blue and red, with red color for the caption shows the highest number of cases in each area and the blue color indicates the lowest number of cases in certain areas.

For the entire case in 2012 – 2015 in the number of cases occurred: **on measles map**, Aceh province has the highest with 47.45 %; **on Malaria map**, Papua Province indicated has the highest API with 164.7%; **on the dengue map** with IR per 10,000 population Bali province is found highest with 637,0%.

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Detection of Irregular Behavior in Room Using Environmental Sensors and Power Consumption of Home Appliances Learning in HMMs

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***Abstract*— We propose a human behavior detect method based on our development system of multifunctional outlet. This is a low-power sensor network system that can recognize human behavior without any wearable devices. In order to detect human regular daily behaviors, we setup various sensors in rooms and use them to record daily lives. In this paper we present a monitoring method of unusual behaviors, and it also can be used for healthcare and so on. We use Hidden Markov Model(HMM), and set two series HMM input to recognize irregular movement from daily lives, One is time sequential sensor data blocks whose sensor values are binarized and splitted by its response. And the other is time sequential labels using Support Vector Machine (SVM). In experiments, our developed sensor network system logged 34days data. HMM learns data of the first 34days that include only usual daily behaviors as training data, and then evaluates the last 8 days that include unusual behaviors.**

***Index Terms*—multifunctional outlet system; behavior detection; hidden markov model; sensor network; support vector machine.**

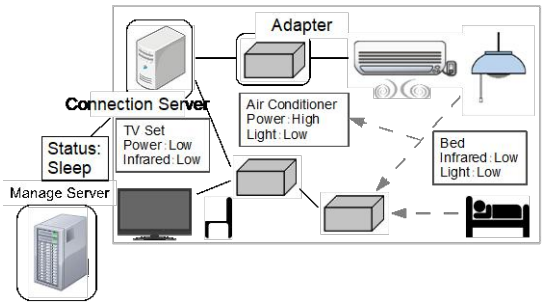
I. INTRODUCTION

For saving power consumption we built multifunctional outlet system using adapters that include relay switch circuit between home appliances and outlets [1], and that also include power control functions using sensors. This system can control appliance's power by switching on/off automatically and monitor its power consumption. Our multifunctional outlet system is constructed from three parts: Adapter unit, Communication Control unit and Management Server unit. (1) Adapter unit connect with appliances to control power supply and monitor surrounding environment.(2) Communication Control unit sends data from Adapter to Management Server. (3) Management Server unit analyzes sensor data and create parameters for auto-control.

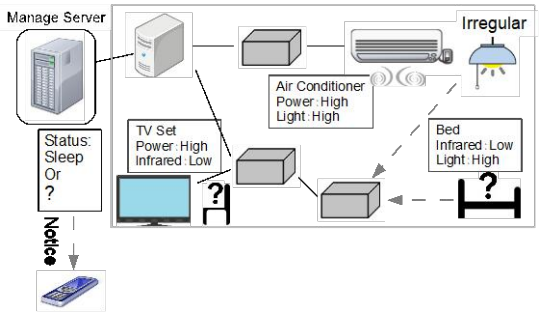
Low-power sensor network system is not a new theme, and there already exist various systems. Such as house setting care system [2], unusual behavior detection system monitored elderly live alone [3] [4] [5] and so on. Most of them need to have users put wearable devices on their body. In our research we propose a method to use environment sensors instead of wearable devices, because the sensors on our multifunctional outlet system can monitor appliances status and human in-room status. Using these status, we try to alert accidents for health care at home without wearable sensors. There are 3 steps: (1) Log time sequential human's in-room daily living patterns, (2) Recognize regular behaviors time sequential, and (3) Detect irregular behavior from regular behavior patterns using the HMM(Hidden Markov Model) that is the stochastic time sequence recognition framework.

II. MULTIFUNCTIONAL OUTLET SYSTEM

A. Behavior Detection



(a) Regular detection



(b) Irregular detection

Fig. 1. An example of irregular behavior detection

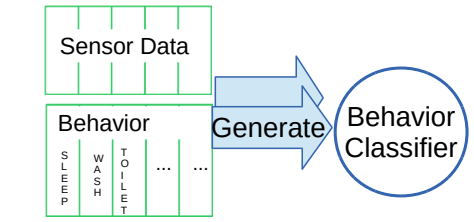
Fig. 1 shows the system structure and behavior detection example. The system estimates "sleep status" from sensors around bed and TV. On the other hand, when sensor variables change to unexpected patterns, the system cannot estimate behavior clearly. Then it sends notice to the user's smart phone, such as "irregular" that means unknown status. This behavior detection method constructs a feasible system of irregular notation.

In this paper, we propose two methods of using time sequential statuses instead of single status recognizing method mentioned above. These time sequential statuses are HMM input data. Statuses generate from sensor data, finally detect irregular behavior from HMM output, the comparison result between "training data" and "test data".

The goal of this paper is to detect the human regular and irregular behaviors using sensors of multifunctional outlet system. The sensor data of this system used to log a user's status of in-room lives and home appliances. Sensor data logs of a few days were used as "training data" that only include regular behavior, and sensor data logs of other a few days were used as "test data" that include irregular behavior. We check the trained HMM unit can detect these irregulars in "test data" or not.

B. HMM

HMM is used in many fields such as voice recognition and statistical translation. We used Baum-Welch algorithm implemented in GHMM [6] to log the sensor data. When the user's action changes, it will make large fluctuation of sensor variables, and we divide sensor data into blocks. In this research, there are two ways to input time sequential statues into HMM.

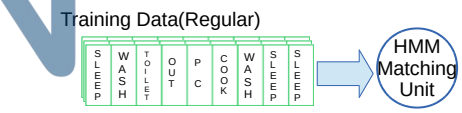


(a) SVM learning from sensor data

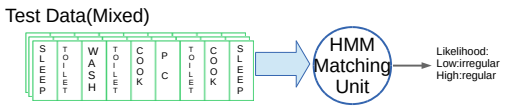
(b) Sequential behaviors generation processing

Fig. 2. Sequential behaviors generation using SVM

As one of the method to recognize the irregular behaviors, we input time sequential labeled behaviors. First, sensor data were clustered by Ward's method [7], and result clusters were classified using SVM in this stage. Fig. 2 shows the process of sequential behaviors generation using SVM. Sensor data with sequential behavior (such as cooking, meal, toilet and so on) are logged by HMM. Then, if we input the sensor data without sequential behavior, identification classifier will output the sequential behavior automatically, and let HMM log them. If the user's daily behaviors are exist in "training data", that is a regular, and if not, we consider it as a irregular behavior.



(a) Learning using training data



(b) Input test data and output likelihood

Fig. 3. Input and output of HMM Matching unit

Fig. 3 shows input and output of HMM unit. In the first stage, we input sequential labels of "training data" and let HMM unit learn these patterns, then we input sequentially labels of "test data", HMM unit will feedback the likelihood value, the comparison result of " training data " and " test data ". Since we used minus likelihood this time, if it outputs a large likelihood value, that means regular and the other

No	Behavior	Assumed Behavior	Actual Behavior
①	Repetition of Behavior	Number of Toilet Increase	Toilet at 20 minute intervals
②	Days order of action change	Day and Night Reverse	Living in the reversal
③	Movement Times Increase	Looking for Things	Room Move for 2 Hours
④	Fall	Consciousness Lost	Not Sleep in Usual Place
⑤	Continuous of Same Behavior	Rest in Sickness	Stay in Bed All Day

means irregular. But if these irregular behaviors are pretty much as similar as regulars that cannot be detected by this method.

As for other method to recognize the irregular behaviors, we input time sequential binarized sensor data blocks to HMM Matching unit. Sensor data were splitted by changes of sensors variable.

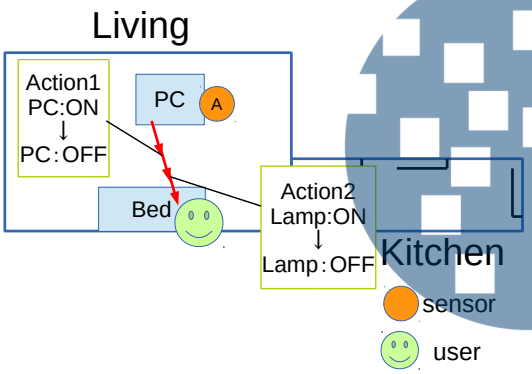


Fig. 4. Sensor data blocks generation using sensor value change

As shown in Fig. 4, sequential behaviors of a single apartment are splitted by the large changes of sensor value. In Action 1, electric current sensor value changed to zero, which means a user turned off the PC's power. In Action 2, light sensor detected lamp's be turned power off, which means a user went to sleep. In this case, we input 3 sequential data blocks into HMM that were divided by these actions.

III. EXPERIMENTS

In this experiment, we use two methods to get input data, and compare these results. One is data using Ward's method and SVM labeling, and the other is binarized sensor data splitted by light and electric current sensor value.

The system above was operated for about a month to monitoring a person living in an apartment. First 26 days data are used as "training data", and the last 8 days are used as "test data" that include reproduced irregular behaviors. Mounted sensors layout is shown in Fig. 5. Sensor A and B setup are the wall, Sensor D is on the bed. Sensor A, C, E are on air conditioner, TV and PC's outlet.

Since irregular daily behavior data is not enough, we reproduce irregular behaviors in last 8 days as shown in Table 1.

Table 1 : Reproduced unusual behaviors

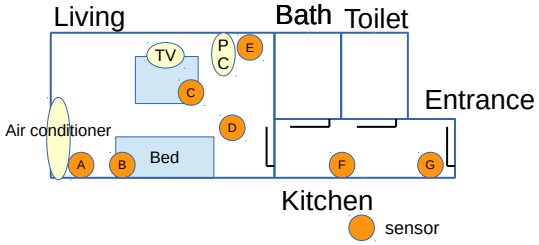


Fig. 5. Sensor layout

A. Test Using Ward's Method and SVM Labeling

In this section we use time sequential labels of one day as HMM input using Ward's method and also use SVM from sensor data. The results are shown in Fig. 6. Likelihoods were low totally. The lowest ① and lower behavior ④ were recognized correctly, but 15th was not.

Because labels are all depend on user's behaviors and the sensor's arrangement, these input sequence have some incorrect labels. To evaluate the effect of this problem, the results using completely correct labels that were recorded by the user in Fig. 7. ①, ③, ④, ⑤ were able to be detected as irregular,② was treated regular, and 15th was a irregular.

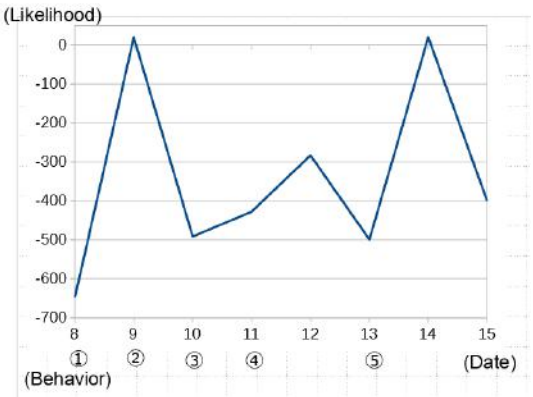


Fig. 6. Likelihood using SVM

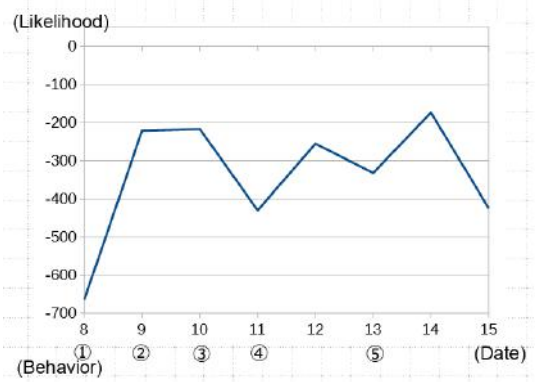


Fig. 7. Likelihood using user recorded labels

According to the user's recorded labels, 15th was a usual day, but that sensor patterns not include in "training data". Likelihood of 15th was so low that it was detected as a irregular behavior.

B. Test Using Binarized Sensor Data

In this section, sequential sensor data blocks were used as HMM input. In these blocks, each sensor variables binarized to 1/0 (it means high/low). For example, power on/off, light on/off, temperature hot/cold and so on. If we divide the sensor data into all kinds of sensor value and let HMM learn, that will become a large scale data that HMM cannot afford. So, in this research, we only detect by the appliance power on/off caught by electronic current sensor, infrared sensor, and light sensor's action. The first test is for electronic current sensor and light sensor divided value detection test. And second test is for a infrared sensor divided value detection test.

Fig. 8 shows the result of division by light and current sensors. since the number of divisions of action differs every day, the daily divided in the Fig. 8 is not constant. The likelihood was the lowest on 8th, 11th and 13th. when they were recognized as ①, ④, ⑤. Based on the above, it was detected as irregular behavior in 6 behavior out of 6 behavior.

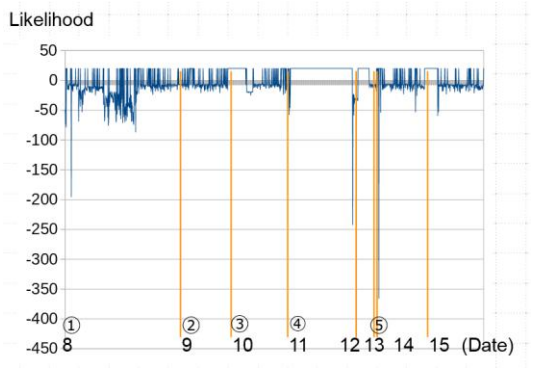


Fig. 8. Likelihood using data blocks (division by light and current sensor)

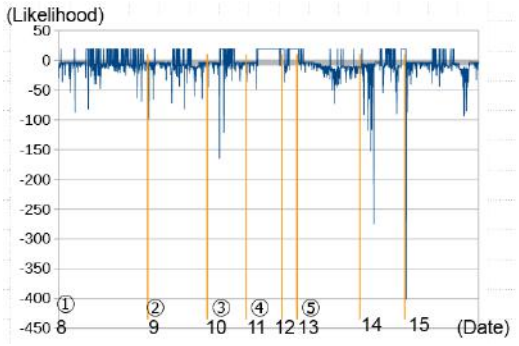


Fig. 9. Likelihood using data blocks (division by infrared sensor)

Fig. 9 shows the result of division by infrared sensor value. In the majority of action ④ and part of 12th, the unlearned statutes continued. The day which the likelihood were the lower 3, the normal day 12th, 14th and the day when action ⑤ occurred. From these results, 3 behaviors of 6 behaviors were able to detect irregular behavior.

IV. CONCLUSION

In this paper we propose the irregular behavior detection method. Most of irregular behaviors were recognized when sensor data were sliptted by light and electronic current sensor variables. The other way was not so abnormal recognition. However, if the sequentially behaviors are confirmed, they can be detected that it was possible to detect irregular behavior. Through the two methods reproduce in the experiment, the percentage of correctness were 83% using sequential behaviors generation label and 63% using spirited sensor data. In future works, we aim to reduce erroneous detection of irregular behavior and clarify validity of regular and irregular behavior.

ACKNOWLEDGMENT

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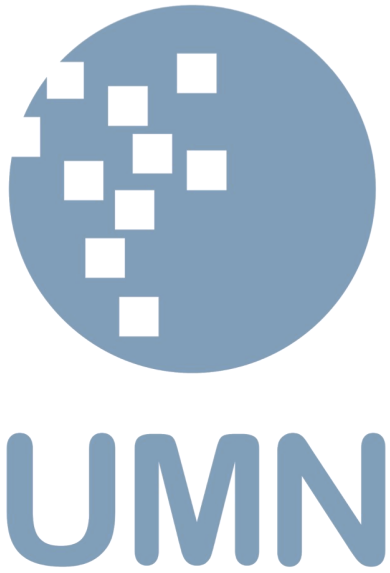

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E-Health as a Service Software of Medical System in UML Modeling

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***Abstract*--Information system at Clinical health center is an information system that has several activities, such as registration, medical record, health care, and reporting. Day to day operation, Clinical health service, is using process manually. It is cause the stack of service. Sometime, the patient has to wait within several times. For Further, the patient did not know that the queuing is full. In order to help the problem, this paper wants to show about E-Health as service software. The research is completed by conveying the model like UML diagram. The UML diagrams are consisting such as use case, class, activity, and component. The sequence of system construct is using Prototype Methodology. The result is the software which has ability to service patient start from registration, medical check, medical prescription, until reporting. As an impact for Clinical health service is the service more efficiency. The system is able to control the medicine and reporting on day to day operation.**

***Index Terms*—health, services, medical, system, prototype**

I. INTRODUCTION

The districts / municipalities are responsible for health in their working areas. They are known as Clinical health service. Clinical health service plays a role of health efforts to increase the healthy life of every citizen to reach optimal health status.

Every Clinical health service provides two policies that consist of Health Compulsory and Health Development Efforts. Compulsory Health Effort provides enormous leverage to the successful development of public health through the improvement of Human Development Index (HDI), as well as global and national agreements. Compulsory Health Efforts consists of Health Mother and children (KIA), Family Planning (KB), Environmental health and others. Meanwhile, Health Development Effort is a health effort that has been determined based on local Clinical health problems and adapted to the ability of health Clinical service. The services consist of dental and mouth health efforts, mental health efforts, eye health, traditional medicine, and health public care. In order to run all these efforts, Clinical health service needs to be supported by auxiliary units that have specific task and one of them is medical record unit.

E-Health on Clinical Health Service has used application that provided by ministry of health services. The application is an application that supports the service for patient. The application has developed by BPJS (Board of Social Insurance Organizer in Indonesia). The application can be accessed through the internet. However, it is just for patient who have JKN card (Insurance Card) and have permitted to access. In fact, many patients still not have JKN card. Consequently, the registration must be recorded by manual paper. This evidence was made task in frequently.

The problem in existing, the patient did not recorded in insurance program that provided by government. So, it caused trouble when search the data. Meanwhile, the Clinical Health Service must be recording for every patient who has check for his health. The other problem, when they did not recorded in the database on application that provided by government, then it has to register first using the form registering. The form used in registering, can add the time for services. If the occurrences continuous till to the doctor and making the recipe, will cause many papers that have to provide. It is not good to the services, and has to improve the process. The task repeat cannot be avoided in that case. The human error is the other problem that gives the failure in procedure. For example, when documents submitted into reference hospital, the documents can be lost or broken.

Research conducted by Gunawan Susanto in Medical Record Information System at Regional General Hospital (*RSUD*) Pacitan Web-Based aims to design medical record information system with web-based computer technology [1]. So, the system that has built is helping to reduce the duplicate of patient medical record and time for searching of medical record status [1]. Bayu Nugroho, Sri Hariyati Fitriasih, and Bebas Widada in Medical Record Information System at Masaran Public Health Center Sragen, aims to design a system using computer system that can be

used as one in data processing. Data processing of medical record system was developed using Microsoft Visual Basic 6.0 program and Microsoft SQL SERVER 2000 [2]. Gilar Gumilar Ulung Bagja in Building Health Information System of *Puskesmas* Cibaregbeg, aims to facilitate the recording of health service, to determine medical record number on patient registration, to accelerate report making, and to facilitate search process both patient and employee [3]. M. Herdy Ariansyah, Mgs. M. Amran Aulia and Dien Novita in Design of Medical Service Information System at Sungai Dua Health Center, aims to assist the management and retrieval of medical record data, registration data, report, and medicine use. So, it can facilitate the doctor to view of medical record data of patients who have had previous treatment [4]. Jenie Sundari in Web-Based *Puskesmas* Service Information System aims to design an application to solve problems in registration system and queue number retrieval for patient, doctor scheduling and medical record. Thereby, it is increasing the effectiveness and efficiency in terms of service, time and cost at *Puskesmas* [5].

II. METHODOLOGY

Methodology used is prototype method with the several stages and in accordance with the problem manner. At the figure 1 shows steps of prototype development [6]. In modeling, this research has used UML (Unified Modeling Language). UML is way to visualize the system architecture's blueprint in diagram [7]. UML is two parts that can visualize the system through static and behavior concept. The static diagram, we used use case diagram, class diagram, and object diagram. Besides that, we drawn too behavioral diagram such as activity, component diagram. To complete the diagram, we only used three diagram, that is use case diagram, class diagram, and component diagram.

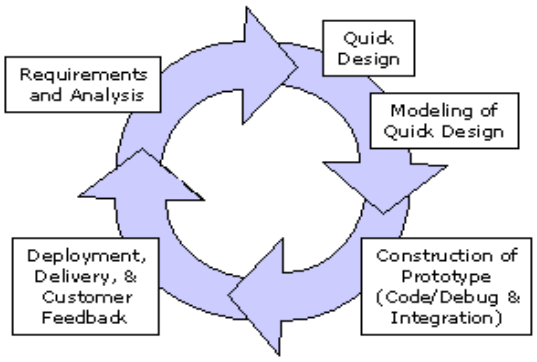

Fig 1. Prototype Methodology [6], this prototype has been taken from Roger S Pressman. It has five stages to transforming the logic into implementation.

A. *Requirements and Analysis*

The first phase is requirement and analysis users. Analysis is done to see the various components that runs include hardware, software, network, and human resources. The requirement users should define the specific system of inputs, outputs, processes, data sources handled, and control. The system requirements are require an evaluation to determine the ability of the system. The evaluation that has been defining, is what should be done by the system, and then determines the criteria that must be met the system. Some of the criteria that must be met are the achievement of objectives, speed, cost, quality of information generated, efficiency and productivity, accuracy and validity, and reliability. On this stage, to receive the requirement, we can use the survey and interview the person in charge. Result on this stage is serial of document and describing the procedural that is running.

B. *Quick Design and Modeling*

The second phase is system design. This step is determined how the system will achieve the goal. The system design consists of design activities that produce functional specifications. System design can be viewed as interface design, data processing, with the aim of producing specifications that correspond to user interface products and methods, database structure and processing, and control procedures. Result of this stage is the shape of interface or menu, Use case diagram, use case scenario, class diagram, and activity diagram. The example for each diagram, it can be seen at figure 2.

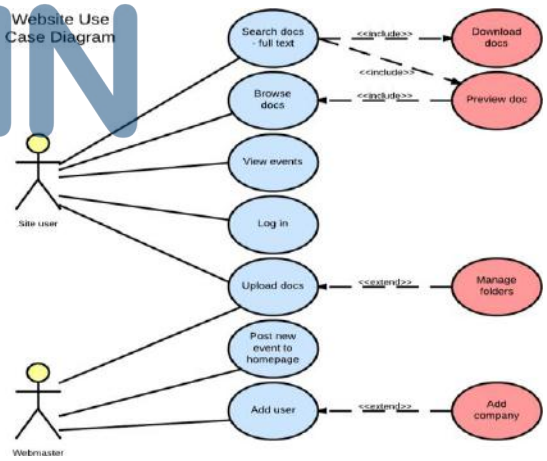

Fig 2. Example of Use Case Diagram [7].

C. *Construction of Prototype*

The fourth phase is constructing the software. This step is done with the report of test, implementation, evaluation, and modification until it is acceptable to the users. System testing aims to find the errors that occur on the system and make system revisions. This stage is important to ensure that the system has been implemented is error-free.

D. Deployment, Delivery, and Customer Feedback

The fifth stage is development, delivery, and customer feedback. This step is run after the prototype is accepted. It means, the software is ready to run without any addition and error. After operated, the software has to maintenance. The software that has provided has to report in order to add some addition and enhance the software ability. The reporting can also give summarize about running of the software used. This activity can give the learning, and make difference between the old software and new software. The weakness and strength the software have to report too. The reporting has to included technology, operational evaluation, user interactions, system, and information technology.

III. Result

Research, in accordance with the study and analysis of existing systems, can be obtained from business processes that are translated into web applications. The business processes can inheritance from the procedural activity in that Public Health Services. Process has defined such as business process of registration, business process of medical check, business process of medical record, business process of receiving medicine. In order to align between design and implementation, so we have to design the whole process. This research is aided by several UML diagram. There are several diagrams like use case diagram, activity diagram, class diagram, and component diagram to shape the software activity [7].

A. Use case Diagram

Use case diagram is a diagram showing the relationship between actors and use cases. The use case diagram has taken from enrollment the business process. In the process of analysis, the modeling has been found many business processes in medical process. In practical, the research cannot implement whole business process, because limited by the problem boundary. Mainly business process can be seen at the table 1. Drawing diagram for use case was intended to focus in business process and their inheritance. In the other hand, use case diagram must have the actor who can trigger the case and receive the case. At the table 2, shows the amount of case and actor that inter correlate between them. Afterward, the use case diagram can be seen at figure 3.

Table 1. Correlation between Business Process of Medical System and Implementation in PHP Language

Business Process	Name Of Component (PHP[a] Language)
Registration Process	*Dashboard_admin.php*
Medical Check	*Dashboard_dokter.php*
Medical prescription	*Dashboard_petugas_obat.php*
Report	*Menu_laporan.php*

[a] Programming Hypertext Processor (PHP) as a software generator for web application. The software has to run in the server mode or localhost. We have built every modul in business process by writing code in PHP Language [8].

Table 2. Actor and Case in Use Case Diagram

Actor Name[a]	Use case Name
Pasien	*Cek Kartu Berobat* *Pendaftaran Poliklinik* *Pemeriksaan* *Pengambilan Obat*
Petugas Admin	*Pendaftaran Pasien* *Pembuatan Laporan*
Tenaga Medis	*Pemeriksaan* *Menambah rekam medis* *Pembuatan Resep Obat*
Petugas Obat	*Pengambilan Obat*

[a] Actors who interact to the system directly are admin officers, medical officers and medicine officers. For the patient is only questioned by other actors and does not interact to the system directly.

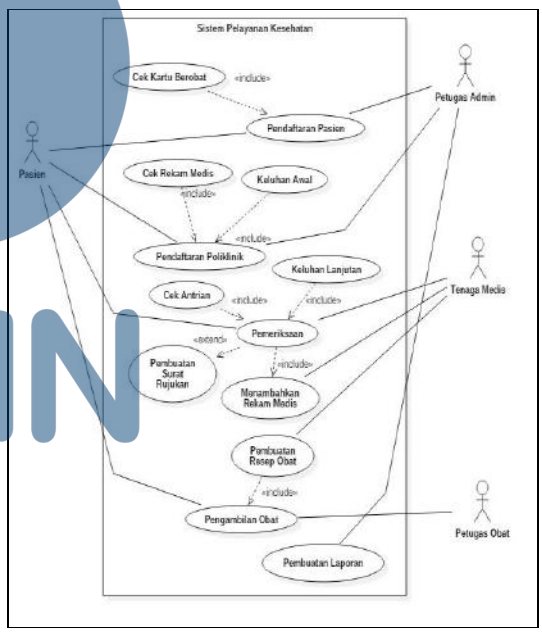

Fig. 3. Use case diagram. The diagram was taken from logical analysis at table 1 and table 2. The diagram has drawn is follows rule of UML [7]

B. Activity Diagram

Activity diagrams are flow diagram that describes the various streams of activity on the system designed. The flow will give the meaning like start activity, the decisions that may occur, and finished actitvity [7]. The following shape at figure 4 is an example of activity diagram.

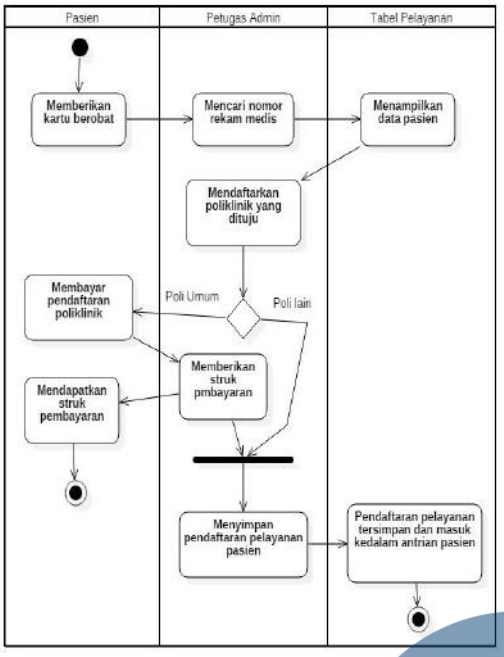

Fig. 4. An Example activity diagram about the process of registration patient in polyclinic. The diagram is following rule of UML [7].

C. *Class Diagram*

Class diagrams describe the structure of the system. Classes have what are called attributes (variables belonging to a class), methods, and operation/method (functions belonging to a class). The classes that exist in the system structure must be able to perform the functions in accordance with the needs of the system. At figure 5, we can be seen the result of class diagram.

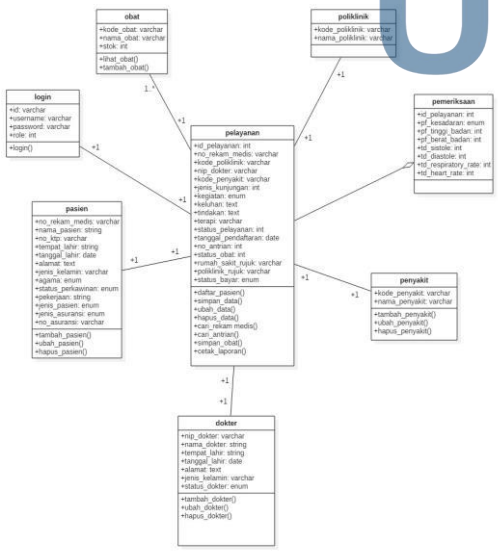

Fig. 5. Class diagram Medical System. The rule depicting diagram is taken form UML structured [7].

D. *Component Diagram*

At the figure 6 shows component diagram among components. This component was built inherentance from business process on the medical system. The components are classified by activity among doctor, officers, and nurse.

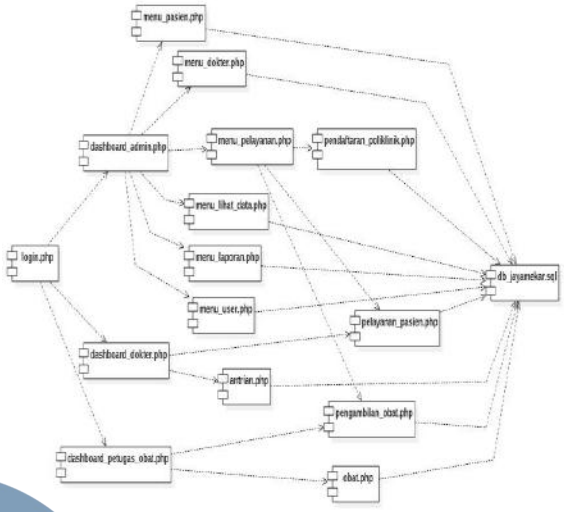

Fig 6. The implementation of Business Process is visualized by Component Diagram Model UML. The component diagram shows application link among component which has built in PHP language. The components are consisting of 16 applications that transforming from logic into application [7].

E. *Construction Prototype*

In the fourth stage of the prototype, the designer is required to create a prototype to see which software is implemented. In the following figure 7, 8, 9, and 10 are examples of interfaces that have been done and used.

Fig 7. Form Registration for business process of registration patient. Registration form is used for registering medical check the disease.

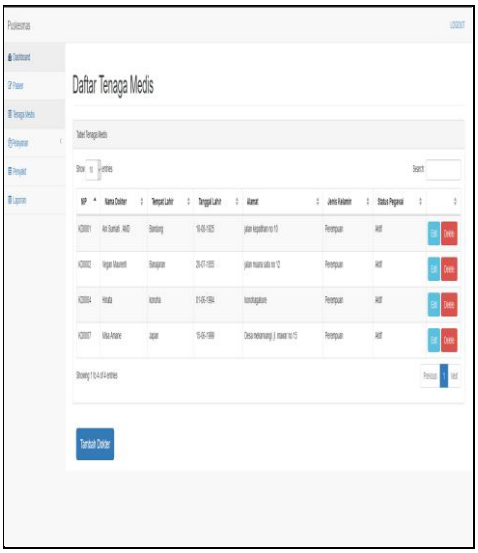

Fig 8. Form of doctor list. This form is available to see the responsibility doctor in special manner. The doctor is person who has strong knowledge about disease. The different of disease will handle to the doctor responsibility.

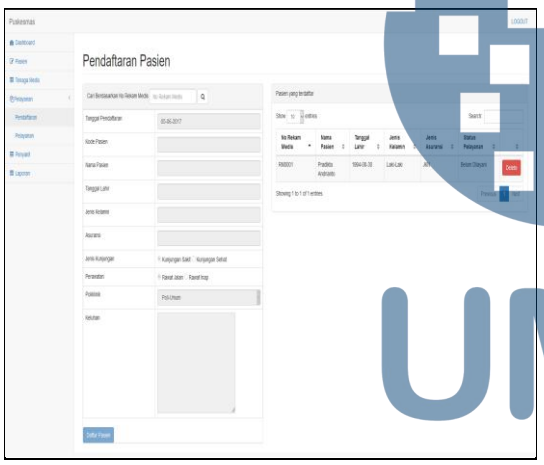

Fig 9. Form Medical Record for business process Medical Check. Its form used for recording every patient who has completed the medical check. The doctor must manually entry into medical record file by this form.

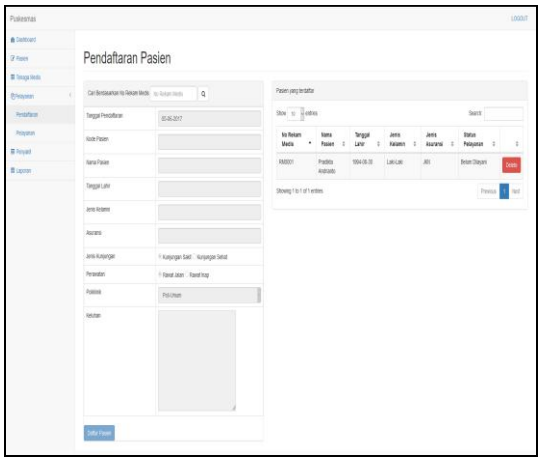

Fig. 10. Form Registration Patient. There are two registrations. First for BPJS Member, and second for Non BPJS Member.

IV. DISCUSSION

In the results of research that has been shown, it can be seen that the business process on medical checks consists of four major business processes. In studies [1, 2, and 3] about medical checks or medical information systems, it is known that the main business processes must involve patient registration, polyclinic registration, and physician checks. In the stage of analysis and design of prototype, the results are shown in the form of use case diagram as in Figure 1. Other results are activity diagrams, class diagrams, and component diagrams in figure 3, 4, 5, and 6 [7].

In the use case diagram, the actor who defined was proposed by previous research [1]. Existing actors are admin officials, medical officers, patients, and medicine officers [2, 3]. So, in this study, the actors used are actors who already exist in the governance of Clinical health service. Each actor is defined, has the task according to the name. The prototype created is the result of analysis and design on the results already delivered. This result is not only an application, but in the form of tables as a storage of transaction data and master data. The following tables describe about data that created by SQL language.

Table 3. An Example of SQL Language

Table name	SQL[a]
dokter	CREATE TABLE (`*dokter*` `*nip_dokter*` varchar(10) NOT NULL, `*nama_dokter*` *varchar(50) NOT NULL,* `*tempat_lahir*` *varchar(50) NOT NULL,* `*tanggal_lahir*` *date NOT NULL,* `*alamat*` *text NOT NULL,* `*jenis_kelamin*` *varchar(10) NOT NULL,* `*status_pegawai*` *enum('Aktif','Tidak Aktif')* NOT NULL, `created_date` datetime DEFAULT NULL, `updated_date` datetime DEFAULT NULL, `created_by` int(11) DEFAULT NULL, `updated_by` int(11) DEFAULT NULL, PRIMARY KEY (`nip_dokter`)) ENGINE=InnoDB DEFAULT CHARSET=latin1

[a]SQL language as a standard query language in database

As continuously activity to the implementation of the software, a test is required. Testing is an important part of software development. Testing is employed to ensure the quality of applications that have been made. Another purpose in this test is that the application runs properly without error and allows it to be rebuilt. Testing for this application is using black box testing method. Black box testing is not necessary to knowing how the application was made. Testing only rely on input and output process. The test used in this software is the equivalence partitioning method which is an ideal test case in expressing an application error. The table 6 shows about testing that has been done with equivalence partitioning. [6].

Table 4. An Example Testing with True Case and Data Test

Testing scenario[a]	Test case	Expectation result	Testing Result	Conclusion
Fill all attributes correctly and press the login button	Username ="admin"	Log into the dashboard menu	Displays the dashboard menu	Accepted

[a] Testing scenario is needed to try and check about attribute which enter into login form. Every login, we must have an username and password. After login, the process will deliver information what the entry is correct or wrong. If correct, we can be concluded this string is accepted by the system [6].

V. CONCLUSION

On the research that have completed; we are concluded that the e-health software can consist of several process. The process is collecting of activities in the Clinical health services. We had found some process like registration, polyclinic process, medicine, recipe, and schedule of doctor. All the process is integrated with other process. So, every patient who will take medical check can register with only one registration. Next, the patient just waiting until called. In the prototype modeling, we had successful applied the steps. We concluded that prototype modeling is the appropriate and simple model to construct the software. We did not wait until the end of step to get the software. Even, in early step, we can deliver the software, so the client can be seeing the software. Thus, the building of software can be supervised by the owner aims directly. In sequence, we can conclude, is the software is aligned within owner aims or not.

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Development of Web-based Matrix Operations Calculation as a Learning Media

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***Abstract*—Learning media stimulate and support the students in learning process, especially in matrix cases. Many students poses the difficulties in learning due to the usage of non-interactive learning media, such as books or lecturer notes. This study aims to build a web-based matrix operations application that support the students learning process as a learning media. This learning media is built using prototyping model process. The process is divided into four main stages, namely communication, quick plan, quick design, construction, and deployment. The result of this study is a web-based matrix operations application that has basic features of addition, subtraction, multiplication, determinant, and transpose matrix.**

***Index Terms*—learning media, matrix, prototype model, web-based**

I. INTRODUCTION

Based on some observation in the particular class at Kalbis Institute, many students are having a difficulties in learning matrix. Students is supported with several learning resources such as books and lecturer notes. These learning resources are categorized as non-interactive learning media, since the media does not cover the dynamic input and explanation as well. Students lack their initiative about their misunderstanding.

The potential learning media is about the media which connected to computer technology [1]. Computer technology equipped with the intelligent support system able to identify the student's individually, perform calculation operations, and provide stimulants. Utilizing computer technology facilitate students in learning because it provides a visual representation [2] [3].

The matrix operations application in this study cover basic features such as operation of addition, subtraction, determinant, and transpose matrix. Meanwhile the other features are displaying the steps of calculation algorithm and the theories of matrix. The application calculating matrix with the maximum size is about 3 x 3 matrix.

II. METHODOLOGY

A. State of the Art

Earlier study, creating a learning media application use Android based learning application which is built by using Software Development Life Cycle method [4]. The learning media from this study is intended for users of Primary School at 1st to 3rd grade. Further, the study of developing multimedia based mathematics learning media application by using Multimedia Development Life Cycle [5] was intended for Primary School at 6th grade. Themed learning application based on multimedia. [6], and also Android based mathematics learning application game using Waterfall method by [7] were intended for Primary School at 6th grade. Whereas the application intended for the college or high school students is still required.

B. Prototyping Model Process

Prototyping models is commonly used to develop software. There are five main stages of prototyping model displayed in Fig. 1.

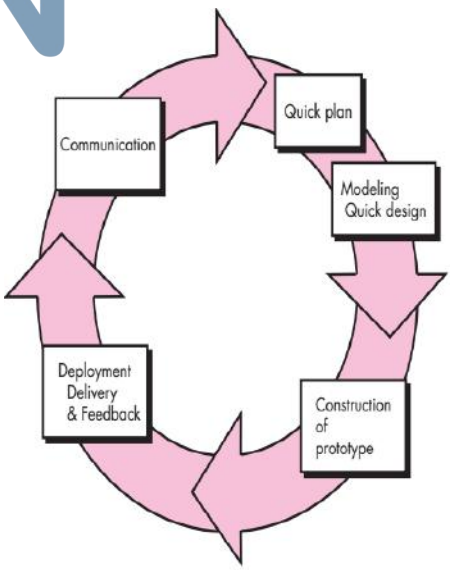


Fig. 1. Prototyping model process [8]

The prototyping model process has the following steps [8]:

- **Communication**. At this step, the researchers analyze the system by conducting interviews with the research object and studying the literature correspond to the research.
- **Quick plan**. The researchers plan the application briefly and quickly.
- **Modelling** quick design. The researchers perform modelling of application design using modelling tools.
- **Construction** of prototype. Build the prototype and perform testing.
- **Deployment** delivery. The application is launched and installed.

C. Framework Design

The framework design is shown at Fig. 2.

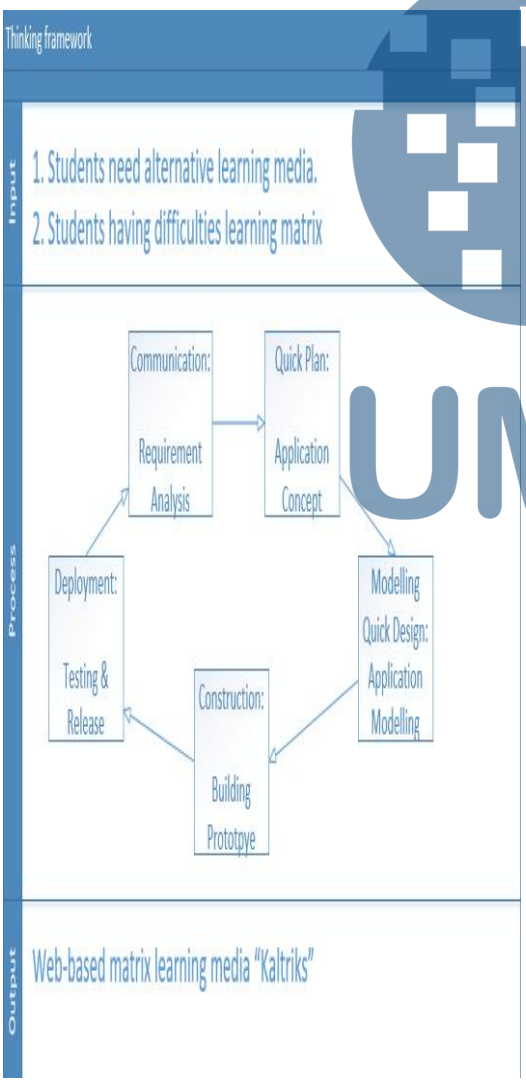


Fig. 2. Thinking framework

This study is motivated by the need for matrix learning application for college students or high school student. The study will be processed using prototyping model which is divided into five main stages, namely communication, quick plan, modelling quick design, construction, and deployment. This application will produce a web-based matrix operations calculation application called "**Kaltriks**".

At the communication stage, the researchers discussed the tools and equipment needed during the study, and determine user requirement. After the communication phase completed, then proceed to quick plan stage. At this stage, the researchers design and plan the concept of the application. From this concept, the researchers able to build the model of the application. The modelling is using Unified Modelling Language (UML) such as use case diagram and sequence diagram. This application model will be constructed into prototype and will be tested. Once the application tested, further it will be released.

III. DISCUSSION

This study is using prototyping model process. In this chapter the researchers will discuss the results of each stage of the prototyping model process.

A. Communication

At this stage, the researchers create the need of user requirement and the system requirement. The user requirement of this application are:

- The application able to calculates matrix operation such as addition, subtraction, multiplication, determinant, and transpose.
- The application displays the calculation steps.
- The user might enter numbers into the matrix and might use the matrix operations button.
- The application provides the theories of matrix.
- The application provides a notification of matrix calculation terms.

The system requirement of this application are:

- Minimum Windows XP Operating System.
- Has an internet browser.
- Minimal RAM is 512 MB.
- Connected to the internet.

B. Quick Design

This application is categorized into two main functions, namely calculate matrix operations and displaying the calculation steps. Displaying calculation step consider as the support to the student to be able to understand about how the calculation work. This learning media is designed to calculate

matrix operations from the number entered into the corresponding field by the user.

The result of matrix operation will be displayed on the result matrix, while the operation steps will be displayed in the blank space below the result matrix. The menu button of this application is shown on Table 1.

Table 1. Application Menu Button

Menu Button	Description
⊕	Performing matrix addition operation
⊖	Performing matrix subtraction operation
Ⓧ	Performing matrix multiplication operation
Ⓓ	Performing Determinant matrix operation
Ⓣ	Performing matrix transpose operation
DELETE	Delete matrix element
Addition	Displaying matrix addition theory
Subtraction	Displaying matrix subtraction theory
Determinant	Displaying Determinant matrix theory
Multiplication	Displaying multiplication matrix theory
Transpose	Displaying matrix transpose theory
Benefit of Matrix	Displaying the benefit of matrix
EXAMPLE_A	Entering random numbers into matrix A
EXAMPLE_B	Entering random numbers into matrix B
DELETE ALL	Delete the entire matrix and annotations
EXAMPLE ALL	Entering random numbers into matrix A and matrix B at once

C. Modelling Quick Design

Based on outcome of quick design phase, further the modelling stage is conducted by using use case diagram. The prototype will be built from this model. The matrix learning application use case diagram is shown in Fig. 3.

The users use this application to perform matrix operations calculation. Users must enter numbers into the matrix provided, Matrix A and Matrix B, meanwhile Matrix H is disable since it is used as a result display matrix. The matrix operation menu button provided are addition, subtraction, multiplication, determinant, and transpose.

Users able to view the matrix theory by choosing the button marked as: Addition, Subtraction, Determinant, Transpose, and Benefit of Matrix. The explanation will be displayed in the column of matrix theory.

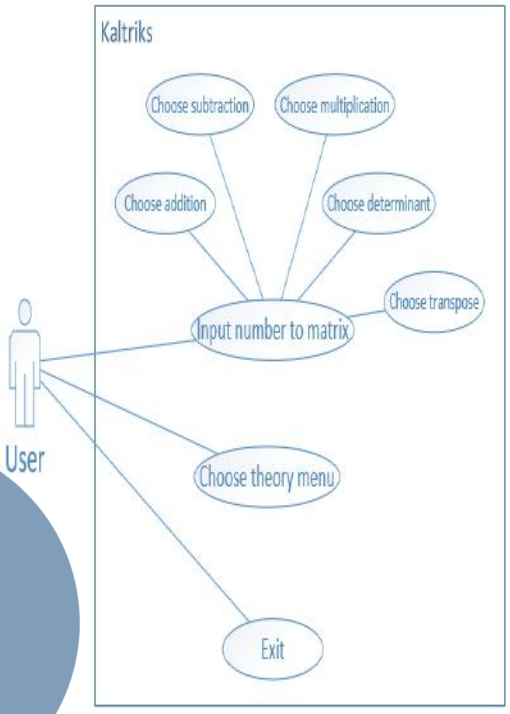


Fig 3. Matrix application use case diagram

D. Construction of Prototype

The construction stage generates a paper prototype. A paper prototype is a set of mock ups of the application on each action. Some of the mock ups are shown in Fig. 4 and Fig. 5.

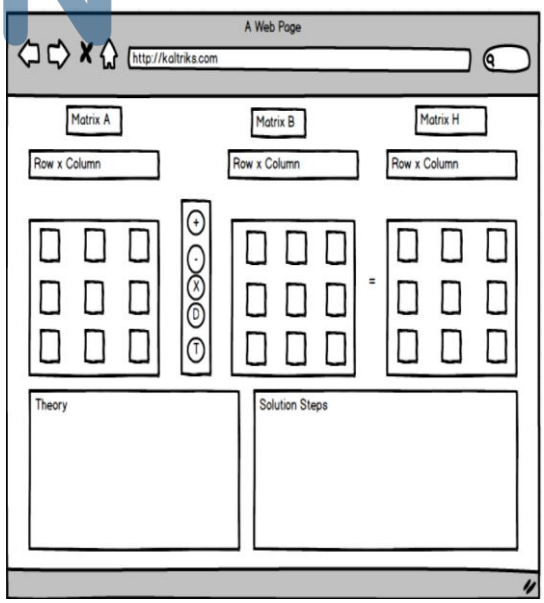


Fig. 4. Home page application

Fig. 4 shows the home page of matrix learning application. There are 3 matrix called: “Matrix A”, “Matrix B”, and “Matrix H”. “Matrix H” shows the displays of the matrix operation result.

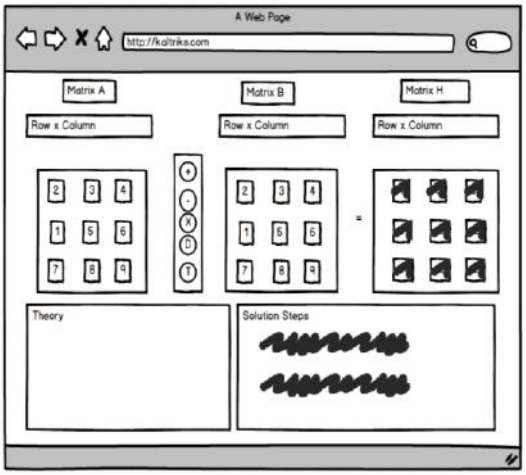


Fig. 5. Matrix addition operation

Fig. 5 shows the matrix addition operation. The result will be displayed on “Matrix H”, while the explanation the operation is shown at the column “Solution Steps”.

E. Deployment

The application is tested and released in this stage. The application is tested by black box testing to ensure that all the features in application is completed and perform user experience testing to obtain the feedback.

1) Kaltriks Matrix Calculation Application

The matrix learning application is already released thus students or public users can accessed the application on url http://kaltriks.net. The Kaltriks application home page image is shown in Fig. 6.

Fig. 6. Kaltriks home page

The application has feature to calculate determinant, multiplication, addition, subtraction, and transpose. The result of these operations are shown in Fig. 7 to Fig. 11.

Fig 7. Addition result

Fig. 7 shown the result of Matrix A and Matrix B addition. The result shown in Matrix H,

meanwhile the solution steps are shown in "Solution Steps" column.

Fig. 8 Multiplication result

Fig. 8 shows matrix multiplication result between Matrix A and Matrix B. The matrix multiplication can only be calculate if matrix A's column dimension is equal to matrix B's row dimension. Fig. 9 shows the notification if matrix multiplication is not operable. Matrix A is 3x2 and Matrix B is 3x2, the column dimension of Matrix A is not equal to the row dimension of Matrix B, therefore the matrix is not operable.

Fig. 9 Multiplication notification

Fig. 10 shows determinant of Matrix A, the determinant belongs only to the square matrix (row and column dimension are equal).

Fig. 10 Determinant result

The determinant of Matrix A is displayed in Matrix H. The solution explanation is displayed in "Solution Steps" column. Fig 11 shows the notification if the matrix has no determinant. In Fig. 11, Matrix A is 3x2, therefore Matrix A has no determinant.

Fig. 11. Determinant notification

The transpose calculation of Matrix A is shown in Fig. 12. Transpose is to change the dimension of the matrix into column × row.

Fig. 12. Transpose result

2) Black Box Testing

The application has been successfully tested using black box method. The result is shown in Table 2.

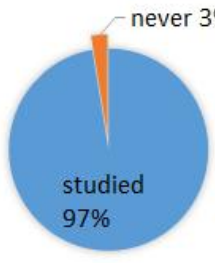
Table 2. Black Box Testing Result

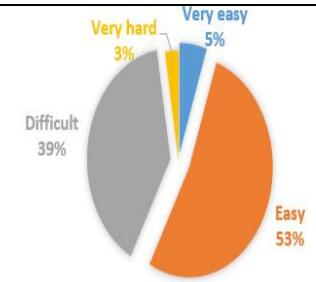
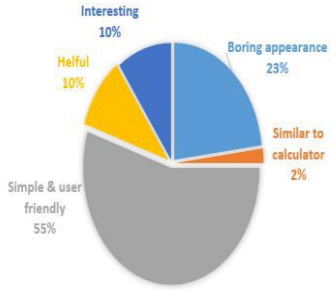
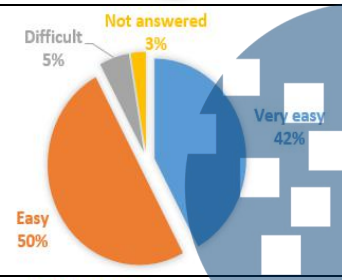
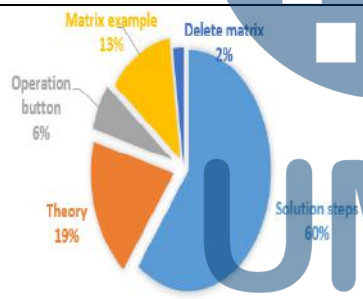
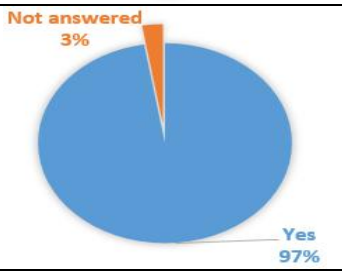
Test Description	Expected Result	Actual Result
The numbers entry into Matrix A and Matrix B	The number can inserted into Matrix A and Matrix B	The number can successfully inserted into Matrix A and Matrix B
Run addition operation	Matrix A and Matrix B can operate if the orders of both matrix are the same	Matrix A and Matrix B can be summed and get the correct result then shown in Matrix H
Run subtraction operation	Matrix A and Matrix B can operate if the orders of both matrix are the same	Matrix A and Matrix B can be subtracted and get the correct result then shown in Matrix H
Run multiplication operation	Matrix A and Matrix B can operate if the column order of Matrix A is equal to the row order of Matrix B	Matrix A and Matrix B can be multiplied and get the correct result then shown in Matrix H
Run Determinant operation	Calculates the Determinant of matrix A if it is a square matrix	The Determinant of Matrix A gets the correct result then shown in Matrix H
Run transpose operation	Form the transpose matrix of Matrix A	Transpose Matrix A can be formed and displayed on Matrix H
Run theory menu (Addition, Subtraction, Determinant, transpose, multiplication, benefit of matrix)	Displays theoretical explanation on the matrix theory column	The theoretical explanation is successfully displayed on the matrix theory field
Solution steps feature	Displays the solution steps of selected matrix operation	The solution steps are displayed in the Solution field
Pressing the "Delete" button	Delete the matrix element	Matrix element deleted
Operation notification	Displays a notification if the matrix is not operable	A notification message appears if the matrix does not meet the operating criteria

3) User Experience Testing

The matrix application has been tested by 38 respondents who mostly are the first year college students who will study matrix in particular course. The summary of user experience testing is shown in Table 3. The respondents are student of Kalbis Institute.

Table 3. User Experience Testing Result

Question	Result
Have you ever study matrix?	

Question	Result
Is matrix easy to learn?	
How the matrix application user interface?	
Is the application easy to use?	
What is the most interesting feature of the application ?	
After using this application, do you become more understanding about the matrix?	

After the 38 respondents finished the test, respondents gave feedbacks. The feedbacks are:

- Change the application color.
- Added matrix dimension.
- Added image or animation to solution steps.
- Added other matrix operations.
- Make the navigation menu bigger.

IV. CONCLUSION

It can be concluded the following:

- From 38 respondents in user experience testing, 50% of respondents (19 respondents) stated that the matrix application is easy to use, 42% of respondents (16 respondents) stated the matrix application is very easy to use, 5% (2 respondents) stated the matrix application is difficult to use, while the rest, 3% (1 respondents) leave the empty answer.
- 60% of 38 respondents (29 respondents) stated that the solution steps feature is the most interesting feature of the matrix application.
- After using the matrix application, 97% of respondents (37 respondents) stated that they are improving their understanding regarded matrix operation.

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Android Remote Access Application Using Short Message Service

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***Abstract*—Android has been updating the system of every version it releases. The addition of Application Programming Interface (API) is done every time Google releases a new Android operating system. The availability of APIs for third-party applications provides opportunities for developers to be able to monitor Android smartphones. Just like Google Device Manager which can instruct Android smartphones over the internet network, however, it still has a deficiency that is if the target smartphone in a state of inactive internet. In this research, the author utilizes SMS media to be able to process instructions and access the system API for remote purposes. The results of this research is by using SMS then user can instruct Android smartphone to take photos, get current location, ring, delete smartphone files, set screen protection, and backup contact with higher messaging reliability. This application can run well on Android Lollipop 5.1 (API Level 22) or above because it has enough API to support system functionality.**

***Index Terms*—Android, Remote Access, Application Programming Interface (API), SMS, GPS**

I. INTRODUCTION

Android is a collection of open source software that includes operating systems, middleware, and key applications along with a set of Application Programming Interface (API) for writing mobile applications that can shape the look, feel and function of a mobile device [1] . Android has been updating the system of every version it releases. For example, Android Marshmallow (API 23) has provided fingerprint recognition API support that allows users to use their fingerprint to open devices, Play Store authentication, and third-party application authentication. With these features will make users more "aware" of the activities undertaken by the application in the Android system.

Although on the Android operating system has available API to run the functionality of a mobile device, a problem that often arises is when the Android device is lost or left somewhere. Possible action to help locate the presence of device left behind somewhere is by remote access using apps that can access Android APIs like Android Device Manager provided by Google. However, these methods still have weaknesses in remote access that is when the device is in a state of inactive data packet internet then Android devices will be more difficult to reach by the user.

Based on the results of data processing questionnaires about behavior patterns in using smartphones distributed to 70 respondents, it is known 32.85% of respondents actively use internet data packets when the device is used only. From this it can be concluded some people limit his smartphone in receiving communication messages. And to monitor Android devices using third-party applications required at least internet connection. Various studies have been done before to deal with such weaknesses as research conducted by Kumar and Qadeer [2], Zhang, Hui, Qizhen, and Kim Tai-hoon [3], Kuppusamy and Aghila [4], Rohitaksha, Madhu, Nalini, and Nirupama [5], Punjabi, Pooja, Mantur, and Sneha [6], Gupta and Reddy [7], Dave and Welekar [8], Chandran [9], using Short Message Service (SMS) service to control distance Much as did Rayarikar, Sanket, and Pimpale [10], and Jongseok and Kim Howon [11]. However, in the research done by Kumar and Qadeer [2] and Zhang, Hui, Qizhen, and Kim Tai-hoon [3] the message used to perform the remote has not been using encryption so it must include the password and the keyword plain text. Then in the research Kuppusamy and Aghila [4] have been using the process of encryption and decryption in the system, but not using the server so that the response that can be accepted by the user only in the form of text-based information.

Another problem can also arise when a smartphone is lost. Someone can turn off the power of the smartphone. This happens because the system on Android allows the action to power off directly by using the power off physical button. If the smartphone has been in a state of death then someone can just change the SIM card or even factory reset. If the SIM Card is replaced it will be a problem because the smartphone can not be monitored either using the internet or via SMS.

Thus, the applications to be built in this study are expected to be able to overcome the limitations of the Internet in conveying remote access instructions so as to help improve the reliability of information delivery using SMS services.

II. LITERATURE REVIEW

A. Android

Initially Google Inc. Buy Android Inc. Which is a newcomer who makes software for mobile / smartphone. Founders of Android Inc. Worked on Google to start building the Android platform more intensively, including Andy Rubin, Rich Miner, Nick Sears, and Chris White. On November 12, 2007 Google with Open Handset Aliance (OHA) released Google Android Software Development Kit (SDK). SDK packages released for developing applications are operating systems, middleware, and major applications for mobile devices. With the release of the SDK opens opportunities for developers to develop an Android-based app [12].

B. Android Application Components

The Android app is written in the Java programming language. Java code is compiled together with the data files required by the application where the process is packaged by tools called "apt tools" into the Android package so as to generate files with apk extension. Apk file is what we call the application and can later be installed on mobile devices. There are four types of components in the Android app that is activity, service, broadcast receiver, and content provider.

Activity will present User Interface (UI) to user so user can do interaction. An Android app may have only one activity, but most applications have many activities that depend on the application's purpose and the design of the app itself. To move from one activity to another activity can be done using a trigger such as click the button on the application screen.

Service does not have a Graphic User Interface (GUI), but the service runs in the background. For example in playing music, the service may play music or retrieve data from the network, but each service must be in its parent class. When a music player is playing a song from an existing list, the app will have two or more activities that allow the user to play while selecting a new song. To keep music running an activity can run the service.

Broadcast receiver functions to receive and react to deliver notifications. Examples of broadcasts such as timezone notifications have changed, batteries are weak, images have been taken by the camera, and others. Applications can also initialize a broadcast such as providing information on other applications that there is data that has been downloaded to the device and ready for use.

Content provider creates a specific set of application data so that it can be used by other applications. Data is stored in system files such as SQLite database. Content provider provides a way to access data required by an activity.

C. Java

According to Budi Raharjo, Imam Heryanto, Arif haryono [13] java is a programming language that can be run on various computers including mobile phones. This language was originally created by James Gosling while still at Sun Microsystems is currently part of Oracle and released in 1995. This language adopts many syntaxes found in C and C ++ but with a simpler object model syntax and support of lower-level routines That is minimal. Java-based applications are generally compiled into p-code (bytecode) and can run on various Java Virtual Machines (JVM).

D. SMS Service

SMS Service (SMS Service) is a non-real-time service where a short message can be submitted to a destination regardless of whether the destination is active or not. If detected that the destination is inactive, the system will delay delivery to destination until the destination is active again. Basically SMS system will guarantee the delivery of a short message to get to the destination. Temporary delivery failures such as inactive objectives will always be identified so that short message retransmissions will always be made unless a rule is imposed that short messages that have exceeded a certain time limit must be deleted and failed to deliver. [14].

E. RSA (Rivest, Shamir, Adleman)

In 1978, Rivest, Shamir, and Adleman made an algorithm for the numbering theory of a public key cryptosystem. This algorithm is known as RSA cryptosystem. RSA is one of the most commonly used public key cryptosystems. Encryption and decryption of this model data lies in the difficulty to factarize the enormous modulus n.

In general, RSA method algorithm has three procedures, namely the creation of keys, encryption, and decryption. In the key creation procedure is generating public keys and private keys. The public key will be used for the encryption process, while the private key will be used for the decryption process. In the encryption procedure, the public key will determine how the text transformation in the encryption process takes place. In the decryption procedure, the private key will determine how the text transformation in the decryption process takes place.

III. RESULTS AND DISCUSSION

In this chapter contains the stages of research conducted. The stages consist of system overview which will be explained in system block diagram, system analysis and design, remote access method analysis using sms, and use case remote access system diagram.

A. Overview

An overview of the application to be made can be seen in Figure 1.

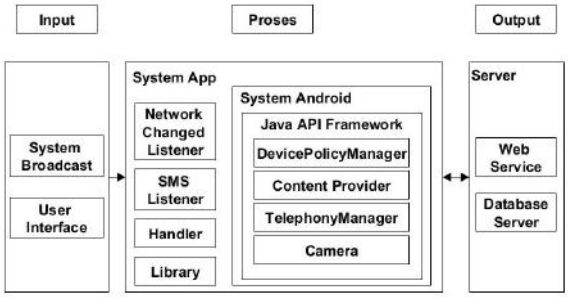

Fig 1. System Overview

In general the workings of Android smartphone remote access system using SMS can be explained as follows: input comes from user interface (user interface) or from active Android system broadcast message. Upon receipt of input, the application system will communicate with the Application Programming Interface (API) on Android smartphones aimed at accessing camera resources, contacts, GPS, and others to process inputs. After successfully processing the input, when generating data output then the data will be sent to the server.

B. System Analysis and Planning

The system to be built is the application of remote access Android smartphone using Short Message Service (SMS) service. The system to be built can be seen in Figure 2 below.

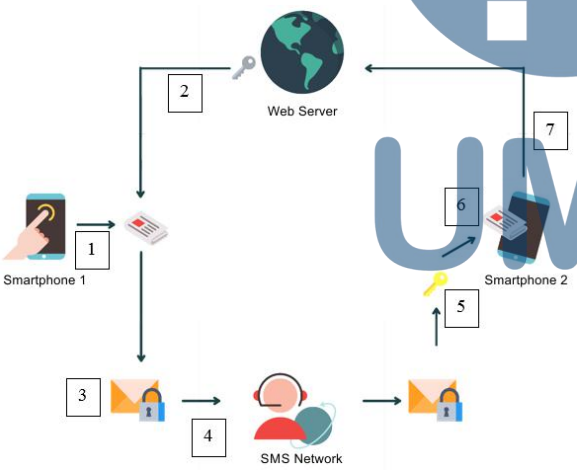

Fig 2. The Concept Of The System To Be Built

The system model built has the following stages to monitor Android smartphone using SMS service:

1. Stages of choosing instruction. Users will choose the features provided by the system and then will be formed plain text in the form of URL with parameters.
2. The public key reading process of the server that the user gets when logging in using his smartphone.
3. The plaintext encryption process becomes ciphertext using a public key that has been previously obtained. After encryption is done the addition of the '$$' validation symbol at the beginning of the text to recognize whether the SMS is an instructional SMS or not.
4. The process of sending SMS encrypted instructions via SMS network. The built system will charge the cost of sending SMS to the users as much as one SMS.
5. The ciphertext decryption process uses the private key obtained simultaneously with the public key when the user logs into the system. If the message is decrypted with a different key pair then the system can not execute the remote instructions.
6. The process of reading the parameters that exist in the URL stored in the plaintext to then executed the command.
7. The process of uploading content when remote instructions is to capture photos, current location, or back up contacts.

C. Analysis of Remote Access Method Using SMS

The remote access method of the built application is divided into several stages which will be explained below.

1. Selection of remote access instruction menu

In the system to be built there is an instruction menu that can be used for remote access process Android smartphone. The list of instances that can be used to remote Android smartphones can be seen in Table 1 below.

Table I. List of Remote Access Instructions

Instructions	Explanation
action_ available_ camera	Access the available camera to take photos.
action_current_ location	Search for the latest Android smartphone location.
action_ringing	Draining Android smartphone.
action_erase_ external	Delete the files stored in the external directory.
action_wipe	Perform wipe on Android smartphone.
action_lock	Locks the Android smartphone according to the settings applied by the user.
action_lock_ new_password	Resetting user's Android smartphone protection.
action_get_ all_contacts	Back up smartphone contacts
action_get_ sim_contacts	Back up the contacts stored on the SIM Card smartphone

Instructions	Explanation
sim_card_ changed	Used to detect the change of SIM Card

2. List of system authorization requirements

Each feature provided has different resource requirements. At this stage is to define what access is required for system functionality to run. The need for system permissions can be seen in Table 2 below.

Table 2. List of Instruction Access Requirements

Instructions	Access Requirement
action_ available_camera	Access camera hardware, internet data packets, storage
action_current_ location	Access GPS, internet data packets
action_ringing	Audio access
action_erase_ external	Storage access
action_wipe	Device admin access
action_lock	Device admin access
action_lock_ new_password	Device admin access
action_get_ all_contacts	Access contacts reading, internet data plan
action_get_ sim_contacts	Akses baca kontak, paket data internet
sim_card_ changed	Access read contacts, access send SMS messages

3. Formation of Instruction Objects

The instruction will then be formed into a resource accessible object. The object form used in the system is using the URL format so that it can accommodate the parameters. These parameters will be filled by the type of instructions and messages the user wants to convey to the target smartphone. In Table 3 the following are instructions that have been formed into URL objects.

Table 3. Example of URL-Based Instructions

Instructions (URL Format)
https://catch.id/?action=action_available_camera
https://catch.id/?action=action_current_location
https://catch.id/?action=action_ringing
https://catch.id/?action=action_erase_external
https://catch.id/?action=action_wipe
https://catch.id/?action=action_lock
https://catch.id/action= action_lock_new_password&msg=pass
https://catch.id/?action=action_get_all_contacts
https://catch.id/?action=action_get_sim_contacts

After the instruction is converted into a form that is accessible to the resource then the next step is how to secure the instruction. One way that can be used is to use cryptography. In this research cryptography method used is RSA (Rivest, Shamir, Adleman). The RSA method works using asymmetric keys that can be used for systems involving multiple parties for the encryption process. In the system built using RSA 512 bit method which can accommodate plaintext along 64 characters. In Table 4 is an example of ciphertext output from the image capture instruction generated through RSA 512 bit encryption method that is as follows.

Table 4. Example of Instruction Encryption Process

Instructions (URL Format)	*Cipher Text*
https://catch.id/?action=action_available_camera	NjqsFhXSZN5JF/QdsavWYqJKNrAzLV4ymOuMpePcA/lwIqR+BlRmAYekshbKIcaPXO2+IgIum/oZ5RMzMEEWUQ==

Cipher text in Table 4 is not directly sent to the target smartphone. Cipher text will be inserted symbol "$$" in advance so that SMS validation can be done. If this is not done then the system will try to decrypt on every incoming SMS. In Table 5 is an example of the final instruction to access the front camera ready to be sent to the target smartphone.

Table 5. Sample Results End Message Instructions

The symbol "$$" + *Cipher Text*
$$NjqsFhXSZN5JF/QdsavWYqJKNrAzLV4ymOuMpePcA/lwIqR+BlRmAYekshbKIcaPXO2+IgIum/oZ5RMzMEEWUQ==

D. Event Listener Analysis On Remote Access System

When the system on Android receive incoming SMS messages then actually the message will be broadcasted to all applications that use SMS listener feature. Furthermore, the application will try to sort whether the SMS message has something to do with the system built or not. If the SMS contains the symbol "$$" it will be decrypted SMS messages starting from the third letter after the symbol "$$". Decryption is done using private key so as to generate plain text in the form of URL which can be accessed by its resources. The system will try to read what parameters are attached to the URL of the decryption and then process according to the algorithm of each instruction.

The same is true for the SIM card replacement notification feature. When there is a change in smartphone status such as from airplane mode to be connected to the internet then the Android system will broadcast messages to all applications that can listen to the event. Next the application will try to read the unique ID on the SIM card and compare with previous data to know whether there is a change of SIM card or not. As in Table 6 it discusses the listener on the system.

Table 6. Event And Listener On Remote System

Event	*Listener*
action_available_camera	1. Indexing the number of cameras available. 2. Open camera hardware access 3. Take a photo 4. Save the photos on external storage 5. Upload photos to the server 6. Repeat step 1 until the entire camera is accessed.
action_current_location	1. Check the GPS status. 2. Make a connection using GoogleApiClient and search for coordinates now 3. Upload information to the server in the form of latitude and longitude if available.
action_ringing	1. Play the ringtone from the system
action_erase_external	1. Take the external directory 2. Perform a recursive deletion
action_wipe	1. Check whether there is admin device permissions or not 2. Do wipe if it is known to have obtained permission
action_lock_now	1. Check whether there is admin device permissions or not 2. Lock the smartphone if it is known to have obtained permission
action_lock_now_new_password	1. Check whether there is admin device permissions or not 2. Update the password if it is known to have obtained permission
action_get_all_contacts	1. Read smartphone contacts 2. Create a file and fill it with read contact data 3. Upload file to server
action_get_sim_contacts	1. Read contact data on SIM Card 2. Create a file and fill it with read contact data 3. Upload the file to the server
sim_card_changed	1. Read the ID on the SIM Card 2. Compare with previous ID 3. In case of change then send notification to the trusted number if available

E. Use Case Diagram Remote Access System

Use case diagram of remote access system consists of 19 use case that is make account, help signing in, log in, log out, edit profile, create sms monitoring instruction, scan QRcode, show remote monitoring result, broadcast receiver filter, SIM card change notification, reset password, wipe smartphone, smartphone key, ringing, delete directory files, take photos, back up contacts, get current location. The use case diagram can be seen in Figure 3 below.

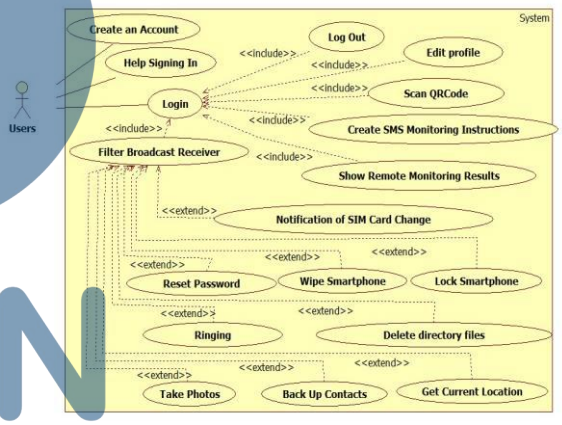

Fig 3. Use Case Diagram Remote Access System

F. System Implementation

Implementation stage is the stage where remote access application of Android smartphone using Short Message Service (SMS) service is ready to be operated. This step will also explain the implementation of hardware, software implementation, and implementation of applications and system interfaces.

F.1. Hardware Implementation

The hardware used to test the application is as follows in Table 7:

Table 7. Hardware Implementation Testers

No.	Hardware	Specification
1.	Processor	Quad-core with 1.2 GHz speed
2.	RAM	3 GB

No.	Hardware	Specification
3.	Screen	5 *inch*
4.	Storage	40 MB
5.	Camera	16 MP & 3.7 MP

F.2. Software Implementation

The software used to test the application is as follows in Table 8:

Table 8. Software Builder Implementation

No.	Software	Specification
1.	Computer Operating System	Windows 8.1 Pro
2.	Android Studio	Versi 2.3.2
3.	Android SDK	Level 22 and above
4.	Programming language	Java, PHP, JSON
5.	Database	*MySQL*
6.	Operating System Smartphone	Android Lollipop 5.1 (API Level 22) and above

F.3. Application Implementation

Remote Android smartphone application using Short Message Service (SMS) service requires installation process through Google Play Store on android smartphone. Users then log in using the same account for multiple smartphones so the remote access process can be done.

F.3.1 Interface Implementation

The interface is a means for users to interact with a system. Implementation of the interface of the Android smartphone remote access application using Short Message Service (SMS) service is as follows.

1. Main Display Interface

The main display interface is used to log into the system using a username and password. Once successful, a homepage display is used to view the results of remote access in the form of images, locations, and contacts.

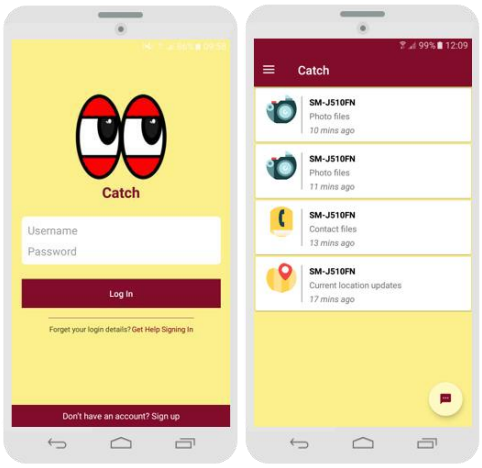

Fig 4. Main Display Interface

2. Create SMS Instruction Interface

This interface is used to select what instructions and choose which smartphone to monitor.

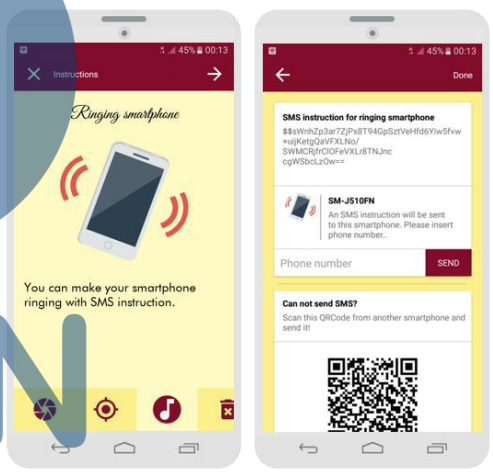

Fig 5. Create Sms Instruction Interface

G. System Testing

Testing is done in order to find errors and deficiencies in the software being tested. With the testing then it can know whether the software is made already meet the criteria in accordance with the purpose of software design. Testing is done by black box testing techniques that focus more on finding functional fault program.

Black box testing is performed for authentication functional components, broadcast message filters, SMS instruction making, profile editing, SMS sending, settings, and QRCode image scans. In this test is done by using seven different smartphone to measure the accuracy of application success. The percentage of success of applications on different devices can be seen in Table 9 below.

Table 9. Results of Tests Against Smartphones

Smartphone	API Level	Success
Samsung A3 2017	23	100%
Sony E5	22	98%
Xiaomi Redmi 4	23	100%
Samsung J5 2016	23	100%
Sony C4	23	100%
Xiaomi 5	23	100%
Samsung J7 Prime	23	100%

Based on the results of testing of several android smartphone it can be concluded that the application can run on different smartphones of the type, it's just that there are weaknesses of the Sony E5 smartphone is not supported with a complete API on its Android Lollipop operating system which causes the application to crash when reading Contact information. In addition to the shortcomings it was found that all functional applications can run well on seven android smartphone used when testing.

In addition, testing was also conducted in August 2017 by distributing questionnaires to 17 respondents using smartphones with the Android operating system Lollipop (API Level 22) and above. Respondents provide varied answers, but from the average value obtained can be concluded that the respondents agree with the existence of this application facilitate in remote access its Android smartphone.

Table 10. Beta Test Results

The first question: Does the presence of remote access application Android smartphone using SMS service can facilitate you in access Android smartphone?				
SS	S	RR	KS	TS
8	8	1	0	0
Average = (75/85) *100% = 88.2%				
The second question: Is the presence of remote access application Android smartphone using SMS service can facilitate you in getting notification of change of SIM card (SIM Card)?				
SS	S	RR	KS	TS
3	12	2	0	0
Average = (69/85) *100% = 81.1%				
The third question: Does the remote access application of Android smartphones use this easy SMS service when in use?				
SS	S	RR	KS	TS
4	13	0	0	0
Average = (72/85) *100% = 84.7%				
The fourth question: Does the remote access application of Android smartphones using this SMS service have an appealing look?				
SS	S	RR	KS	TS
3	11	3	0	0
Average = (68/85) *100% = 80%				

Based on the results of beta test calculations that have been presented in Table 10 it can be taken some conclusions of test results are :

1. Users find it helpful in remote access their Android smartphone. Due to the presence of this application then the limitations of internet media in interacting with smartphones for remote access purposes can be equipped.
2. Users feel helped by the notification change feature of his Android smartphone. Due to the presence of this application then the replacement of an unwanted SIM Card can be avoided.
3. This application is easy to use because it uses the same concept as making SMS in general
4. This app has an interesting look.

IV. CONCLUSION

The conclusions and suggestions obtained from the results of this study are :

A. Conclusion

Based on the results of research, analysis, system design, and implementation and system testing, the following conclusions can be drawn :

1. Applications that have been built to facilitate users in performing remote access Android smartphone because with the presence of this application then the limitations of internet media in interacting with smartphones for remote access purposes can be equipped.
2. Applications that have been built can help in providing a notification when there is a change of SIM Card so that the replacement of unwanted SIM Card can be avoided.

B. Suggestion

In this research needs to be done further development and refinement in order to improve system security and user privacy involved in it. The suggestions on the development of this application for the future is as follows :

1. The application development on smartphones that have Android operating system architecture is different from that unveiled by Google because the app is not fully suiTable for some Android devices on the market.

2. An adjustment is required if a new operating system has been released because the app may find it hard to reach an API that works to access Android smartphone hardware.

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Information of Tourism and Creative Industry Using Mobile Application Technology

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***Abstract*— Creative industries and tourism is one sector that is easiest to improve the condition of the economy of a region. This study discusses the information distribution service usage model of mobile application technology using Location Based Service (LBS) and Global Positioning System (GPS) in the development of creative industries through integration with products of tourist destinations. By using the technology of location-based services and global positioning system that will be developed and implemented on the application of geographic information systems and web-based mobile android, then the those creative industries would be material and guidance in utilizing information technology as a means to promote the business of creative industries it has to be more effective and efficient.**

***Index Term*—Geographic Information Systems, Creative Industries, Mobile Android, GPS, LBS.**

I. INTRODUCTION

The development of technology has grown very rapidly, especially information and communication technology. With the development of information and communication technology, the use of smartphones in the world today is growing very rapidly. This is due to the high will communication needs to obtain information that can be fulfilled with the smartphone. In the society of creative industries and tourism, their business will not be separated from the information technology that is used when the process of sale transaction [1].

Bandung Raya area consisting of Bandung City, Bandung Regency, West Bandung Regency and Cimahi City, from the past until now has been known by the public in Indonesia as a city of tourist destinations and producers of creative industries.

Currently near the tourist destination, also there are also places that provide souvenirs. This is because every tourist who has been traveling, also most certainly buy souvenirs. Lots of results from the creative industry into a souvenir product. Usually for the creative industry products contained in the tourist location of Bandung Raya area is produced by local communities or creative industrial centers of Bandung Raya region itself.

Most of the tourists who visit tourist sites, not knowing some of the products of creative industry businesses are also sold well it was right where the sights, or are located close to the tourist sites [2]. That is because the main goal is still a destination tourist destinations, not creative industries. In addition, the lack of information that is delivered to the tourists linked several creative industries can also be found and obtained at the location of tourist attractions, means that the creative industry businesses are still based on the arrival of tourists to the location of tourist destination.

At this time almost every smartphone is equipped with features Global Positioning System (GPS) sensor. The function of that GPS itself is a system where it is useful to determine the position of a location. With this feature, many people use it both to know the route of the road as well as find an alternative way or the latest road conditions whether stuck or not. Many are also using GPS to find information about tourism or creative industries in certain cities, especially in Bandung Raya area.

This research will create an application web and mobile android where the application is used to facilitate the tourists to know the good information about the object of tourism in Bandung Raya area along with the creative industries located adjacent to the tourist attraction. In addition, this research can also help the tourists and search by the results of the creative industry in terms of searching the desired location using android smartphone and web-based.

This application can also indirectly help increase the promotion of the tourism sector of an area as well as the creative industries generated by the community. It is also expected to improve the welfare of the community from the sale of creative industries and increase the level of tourist visits.

II. LITERATURE REVIEW

A. Creative Industry

Based on the trade department of the Republic of Indonesia, the creative industry is an industry that is derived from the utilization of creativity, skill, and talent of individuals to create wealth and jobs through the creation and utilization of creativity and inventiveness of the individual.

The government of the Republic of Indonesia through the Ministry of Tourism and Creative Economy has identified the scope of the creative industry includes 15 sub-sectors. Sub-sectors, namely advertising, architecture, market art, crafts, design, fashion, video, film and photography, interactive games, music, performing arts, publishing and printing, computer services and software, broadcasting, research and development, and the last is culinary.

B. Systems Theory

According to research Fanny and Eko [3], there are two groups of approaches in defining the system. There is emphasis on the procedure and there is an emphasis on the component or element Turban [4], including: "The first opinion stressing the system components. "The system is a collection of elements that interact to achieve a certain goal". A second opinion on the procedure stressed system. "The system is a network of procedures that are interconnected, gathered together to perform an activity or to accomplish a particular goal."

C. Information Theory

Information is data that has been organized so that gives meaning and value to the recipient. Meanwhile, according to Jogiyanto [5], information is data that is processed into a form that is more useful and more meaningful for those who receive. It can be said that the data is the raw material, while the information is so material or material which is ready to use. Indicators that can be used to measure the quality of information is the relevance, timeliness and completeness [6], accurate [7], and understandability [8] [9] of the information produced.

D. System Design

The design of the system is a stage in building a system after the stage of system analysis and system development cycle. This stage defines the functional requirements and describes a system to be built. In designing a system can use a structured modeling using graphs or charts, or using the concept of object-oriented.

E. Location Based Service

Location Based Services (LBS) is an information service that can be deployed using mobile devices over the internet and mobile networks and utilize the ability of the locator on mobile devices. LBS works to utilize the location of the device to provide information about the location using the Global Positioning System (GPS).

F. Global Positioning System (GPS)

Global Positioning System (GPS) is a navigation system or a satellite-based positioning. This system is designed to provide information on the position and time continuous throughout the world, regardless of time and weather. GPS positioning is described using X and Y coordinate values where the value longitude and latitude. This system is used to determine the position on the surface of the earth with the help of 24 satellites that transmit microwave signals to Earth.

GPS systems work is to transmit signals from GPS satellites to devices that may be present on a smartphone that already has a GPS feature. GPS requires transmission of three satellites to obtain two-dimensional information of latitude and longitude, and 4 satellites to three-dimensional (latitude, longitude, and altitude). Because GPS satellites rely on the work, so its use is recommended in the open. The use indoors at a place that hinder way satellite, the GPS will not work accurately and optimally. Location Based Service (LBS) is an information service that can accessing use mobile devices through the Internet.

III. RESULT AND DISCUSSION

A. Architecture Design Analysis Model

The analysis aims to identify the system architecture that will be built based on two subsystems web and mobile. The system architecture in this research can see in figure 1.

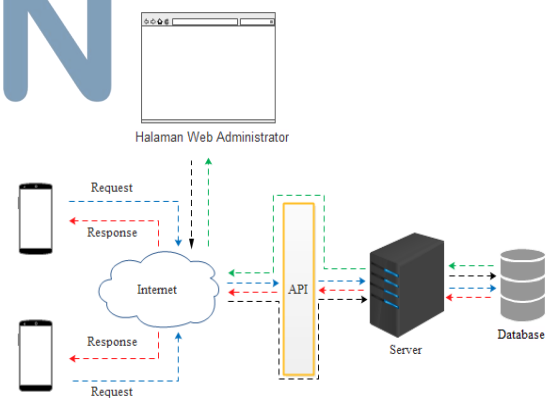

Fig 1. Overall Architecture Systems

The explanation of fig 1 system architecture above, namely:

a. The web sub admin system requests data requests to the server via the internet network.
b. The server receives a request for data requests and retrieves data on request from the database.
c. The server sends the requested data over the internet to the admin computer.

d. Mobile device users request data to the server via the API.
e. The server receives the request data from the server and determines the requested type of request.
f. If the server receives a data request then the server will retrieve the data in the database.
g. Once the server receives the requested data the data will be returned in JSON form for the user-processed mobile device.

B. Design Non Functional Requirement Analysis

Analysis of non-functional requirements on these systems includes software analysis, analysis of hardware and thought.

1. Product Requirement

Here are a non-functional requirements based on product classification requirement.

a. The system built has two subsystems: web and mobile.
b. The system is built using a minimum of android operating system version 4.0 Ice Cream Sandwich and built with minimum software requirements :

a) Operating System (platform independent).
b) Web server version 1.1.7 XAMPP
c) The code editor such as Notepad ++.
d) Android Software Development Kit as a framework android

C. Model Functional Requirement Analysis

Functional needs analysis system will be discussed in this research is divided into two parts, namely the functional requirements analysis web and mobile.

C.1. Web Requirement Analysis

Functional needs analysis this site includes data flow diagram to explain the flow of processed data. Explanation of the data flow diagram in this study can be seen in Figure 2 below:

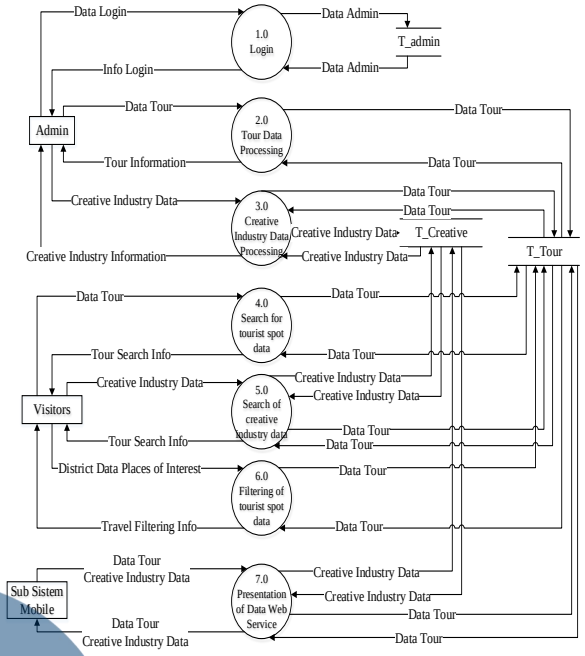

Fig. 2 Data Flow Diagram

The data flow diagram in Figure 2 describes the functionalities of the website based backend system. The website system can be used to view tourist information and creative industries in Bandung Raya, also can be used as the backend system for master data processing applications, such as tourism data processing, creative industry data processing, and user processing. Website application is used by an administrator who in this research is the officer from Tourism Department from every region.

C.2. Mobile Android Requirement Analysis

Functional needs analysis mobile android is represented by Use Case diagram can be seen in figure 3 below:

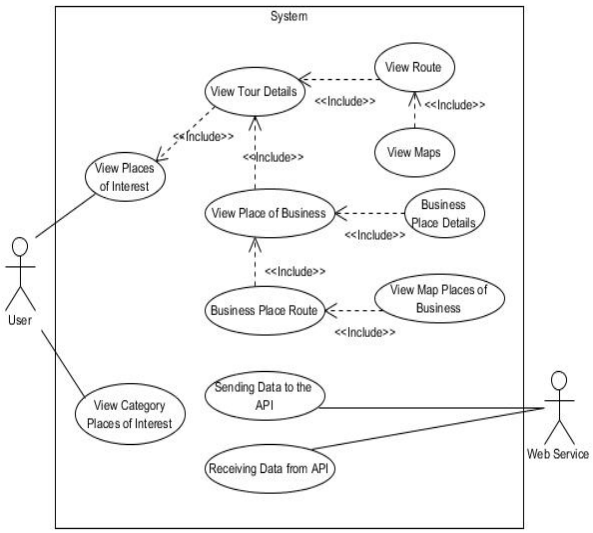

Fig 3. Use Case Diagram Mobile Android

The actor's explanation of the use case diagram is that the user actor has the authority to use functionality at the user interface level, whereas the actor web service as the provider of the data source API and runs in the background. Android system users can only view the data only, cannot perform the process of data processing as can be done on the website.

As for the definition of a use case diagram in figure 3 above are shown in table 1.

TABLE I. Use Case Diagram

No	*Use case*	Description
1	View Places of Interest	The system displays a list of tourist attractions and can be selected by the user.
2	View Category Places of Interest	The system displays categories of attractions.
3	View Tour Details	The system displays details on selected sites users.
4	View Route	The system displays the service road to the tourist attractions of the user's location.
5	View Map	The system displays the map location of tourist attractions.
6	View Places of Business	See Business Sites
7	Business Place Route	The system displays the detail businesses that have been users
8	Route Place of Business	The system displays the service road to the place of business of the user's location.
9	View Map Places of Business	The system displays a map of the business location.
10	Sending data to the API	The system sends the data via the API web service
11	Receiving Data from API	Receiving Data from API Web Service

D. System Implementation

A scenario from an explanation of system implementation in this research is divided into three parts, that is website implementation for the visitor, website implementation for administrator and implementation of android mobile for society.

D.1. Implementation of Website System For Visitors

Users as a public can open url address http://bandungraya.umkmbandung.com on the browser. The initial view of the main page of the website for the end can be seen in figure 4 below.

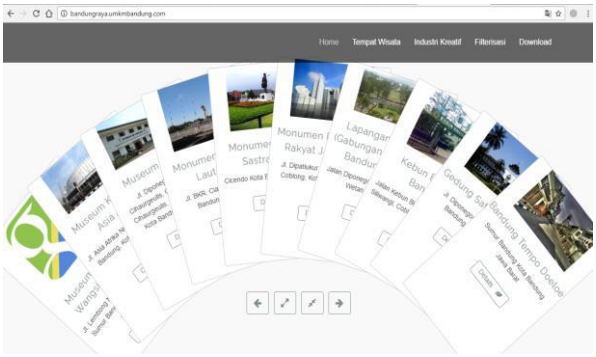

Fig 4. Main Website of Visitors

On the website, visitors can see other menus such as tourist attractions, creative industries and filtering information in accordance with the wishes. An example of the result of information filtering can be seen in figure 5.

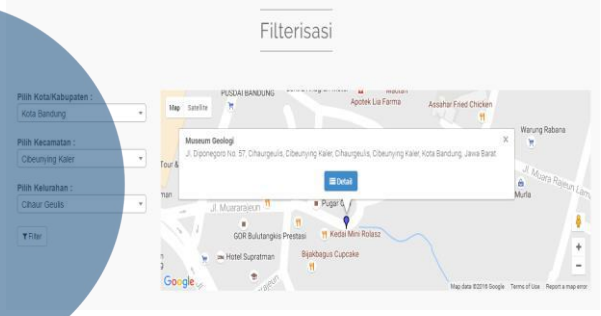

Fig 5. Filtering Information

D.2. Website System Implementation For Administrators

The website page for this administrator is used by an administrator who is an employee of the department of tourism or employees of the department of industry to perform data processing on the website. The discussion on the system page for administrators consists of login, admin data processing, tourism data processing, and creative industry data processing.

Before entering the administrator page, the system requires to log in first as shown in figure 6 below.

Fig 6. Administrator Login page

If the login is successful, it will automatically be directed to the dashboard administrator page as in figure 7.

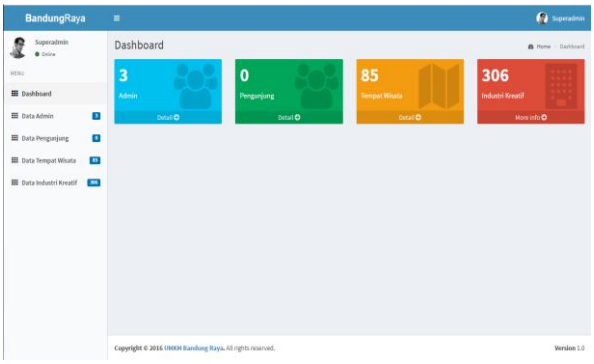

Fig 7. Dashboard Administrator Page

One of the facilities that can be done by the Administrator is to do the detailed processing of tourist attractions as in figure 8.

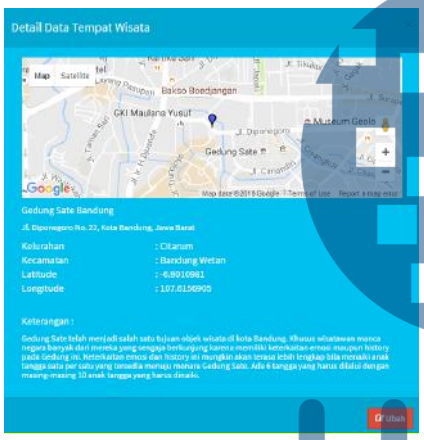

Fig 8. Processing details of tourist attractions

D.3. Implementation of Android Mobile Application System

Applications built in addition to web-based, also built with mobile-based android. This is due to the need for a Global Positioning System (GPS) sensor feature that can only be accessed through a smartphone. The following will explain the use of android mobile system that has been built.

Examples of implementation results on mobile android is a detail page of the tour that can display detailed information about the sights and information about the location of the nearest creative industries from selected tourist sites. The appearance can be seen in figure 9.

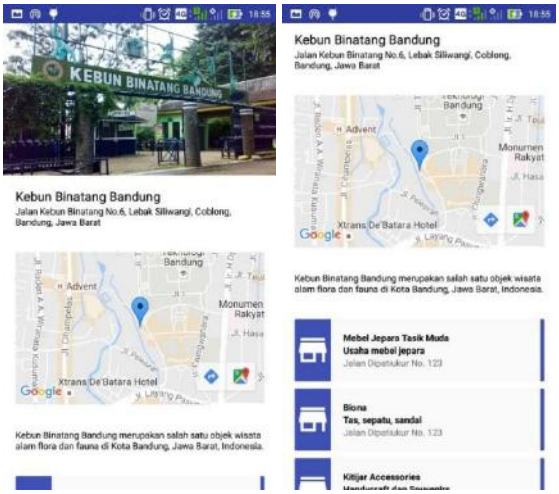

Fig 9. View Details of Places of Interest

In the android mobile applications are also provided facilities for detailed routes that can be taken if you want to go to the destination. The route for example can be seen in figure 10.

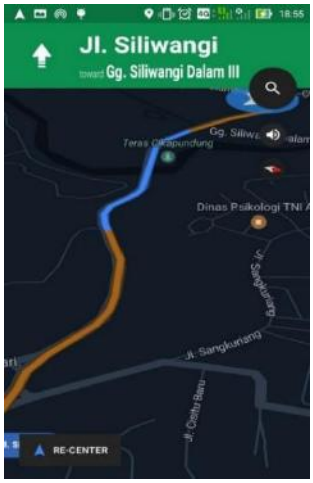

Fig 10. View detail route

E. System Performance Testing

This test is done to determine the speed of data retrieval and data transmission of applications that have been built. Testing is done with the help of Apache JMeter support device. With this application, we can simulate how many users will connect to the application. In this test, it is assumed that there are 20 users. Where the pause between users accessing the app is 1 second. Figure 11 describes the performance of data transmission in the form of graphics delivery and data reception from mobile android to web service that has been built.

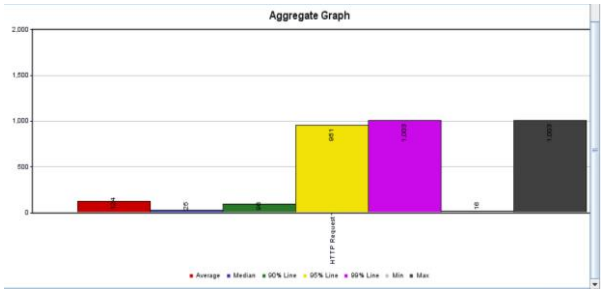

Fig 11. Web Service Graph Performance

It can be seen in the graph that the average speed of response is 124ms. For the minimum time or the fastest is 16ms and the maximum time is 1.003ms. it can be concluded that the performance of data delivery to web service that is built is good.

IV. CONCLUSION

The conclusion that can be taken in this research that is has implemented the website and mobile android based system as a service of information and creative tourism industry spread in Bandung Raya area to help the people for find information about creative industry and tourism in Bandung Raya area.

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Implementation of Analytical Hierarchy Process On Airplane Ticket Booking Application Selection With Software Quality Requirements and Evaluation ISO/IEC 25010:2011

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***Abstract*—Decision-making is the process of selecting alternative actions to achieve a particular goal. Increased movement of the number of passengers using air transportation mode, making the growth of ticket booking application also increase. A system judgment is required to determine which airplane ticket booking application to use. This research discusses the process of choosing an airplane ticket booking application using Analytical Hierarchy Process (AHP) method by using Systems and Software Quality Requirements and Evaluation ISO / IEC 25010:2011 criteria measurement of quality in use. The processed data is obtained from the geometric average of three respondents ie representatives from information technology experts, the public and travel agent. Analysis and data processing using expert choice tools. This research assesses the software quality of the three airplane ticket booking applications. All application names are not displayed. This is because it is feared to have a negative effect on the existing business competition. This research has generated the sequence of applications that have the highest value so it is recommended to use.**

***Index Terms*— AHP, E-Ticket, Expert Choice, ISO/IEC 25010:2011, Software Quality.**

I. INTRODUCTION

Decision-making is the process of selecting alternative actions to achieve a particular goal or goal. Many approach methods can be used in Decision Support Systems. One method that can be used is by using Analytical Hierarchy Process (AHP) method. AHP is an excellent and accurate tool in making decisions [1].

Several other studies have also implemented the AHP method. Koç and Burhan's research, [2] uses AHP to help locate stores, whereas Magdalena [3] has selected digital library applications for college environments using AHP methods. In the field of management, AHP can help determine the residual results of operations in one of the civil service cooperatives [4], assisting the Culture and Tourism Office in revitalizing the cultural heritage [5], strengthening the performance of red pepper agribusiness [6] and lecturer performance assessment [7]. In addition, AHP is also implemented in human resource fields that can be used in the selection of employee recruitment [8], determination of promotion [9], and according to Tanti [10] AHP can also be used in the selection of outstanding employees.

This research needs to be done because the people in Indonesia who use airplane transportation has increased. The high number of people who use air transportation also has an impact on the use of air ticket service providers, either through travel agents or airline ticket online. Currently a lot of application service provider website to make airplane reservations. Based on information from Alexa Internet, the most frequent order from airplane ticket booking service website in April 2017 in Indonesia is Application A with sequence 91, Application B sequence 197 and Application C order to 288.

Providers of online airplane ticket booking in Indonesia are quite a lot and will increase in the future. It will also confuse the people to choose which applications are recommended to use. A system assessment is required to determine which ticket booking application to use. To make the selection of air ticket booking application that best suits the needs, certainly not necessarily can be easily determined.

The quality measure in the use of a system or application in Systems and software Quality Requirements and Evaluation (SQuaRE) can use standardization of ISO / IEC 25010: 2011 metrics measurement of quality in use. ISO / IEC 25010: 2011

can be used to determine the quality of ERP systems to be selected [11], while Rafique [12], describes the data quality framework in ISO.

II. LITERATURE REVIEW

According to Saragih [13], Decision Support System (DSS) is an interactive information system that provides information, modeling, and manipulating data. Turban decision support system in Arbelia research [9] is a computer-based information system that combines models and data to provide support to decision makers in solving semi-structured problems or dependency issues involving the user in depth.

According to Saaty in his research Rochmasari et al. [13] Analitycal Hierarchy Process (AHP) is a comprehensive decision-making model taking into account the qualitative and quantitative aspects.

In solving the problem with AHP there are several principles that must be understood, here are the basic principles of the AHP method based on some research conducted by Andri [14] as well as Sestri's research [7] of which are creating hierarchies, criteria and alternatives assessment, determining logical priorities and consistency.

The steps of the AHP method according to Ebedia [15], Dimas [5], Rosmawanti [16] are:

1. Define the problem and determine the desired solution
2. Create a hierarchical structure
3. Determining the priority of the elements
4. Calculate the consistency ratio test

AHP can also be used in a group so it is not required that the source of its input value be from one person only. For more than one respondent, the calculation results should be combined using geometric or geometric mean [17]. Riyanto [18] explained that brainstorming and sharing ideas and insights often resulted in better understanding and understanding of the problem, rather than on a single decision maker.

The final value obtained is then performed the average geometric assessment (geometric mean). To calculate the average value of the geometry, the value must be multiplied, and from this result is then drawn the same rank root as the number of the person who gave the judgment. Here is the equation of the geometric mean.

$$G = \sqrt[n]{X1.X2.X3 \dots Xn} \quad (1)$$

Where :
G = Geometric average searched
X1, X2, Xn = Assessment of respondents to 1, 2 to N
n = Number of a respondent component of the assessment.

The model used to assess software quality is the ISO / IEC 25010: 2011 model. ISO / IEC 25010: 2011 is one of the international standard methods used to assess the quality model of a software released by ISO / IEC. ISO / IEC 25010: 2011 is actually a revised document of ISO 9126-1: 2001. The ISO / IEC 25010: 2011 model can be used to evaluate software quality based on two common dimensions: quality in use and product quality.

To assess an application based on metrics quality in use, there are several characteristics that are viewed from the perspective of a user, among others effectiveness, efficiency, satisfaction, freedom for risk and context coverage. While in the product quality dimension, where the process refers to the characteristics of a software product, it has several elements that include functional suitability, reliability, operability, performance efficiency, security, compatibility, maintainability, and portability.

Quality in use or quality of use is the level at which a product or system can be used by a particular user to meet their needs in achieving a particular goal with effectiveness, efficiency, freedom from risk, and satisfaction in the context of the intended use. A quality model of system usage composed of five characteristics, where further subdivided into sub-characteristics that can be measured/tested when a product is used/implemented in real terms.

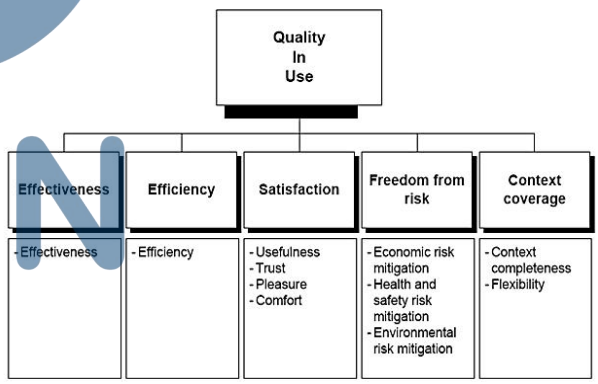

Fig 1. Quality Model of System Usage

Currently a lot of application service provider website that has been working with airlines to make airplane reservations. Based on information from Alexa Internet that is a provider of website traffic information, obtained the order of the top of the ticket booking service website in Indonesia for the period of April 2017 frequented by Internet visitors, namely Application A with sequence 91, Application B sequence 197 and Application C sequence 288. In addition to these three websites, of course, there are many other website providers, but the website is still in position on the order of the number thousand.

The ticket is a valid proof for passengers to be able to use the mode of transportation in accordance with

the mode of transportation and travel time. Electronic ticketing (electronic ticketing) or commonly also e-mailed into E-Ticket is an online ticketing system. Figure 2 is an example of an electronic ticket obtained from one of the ticket booking apps.

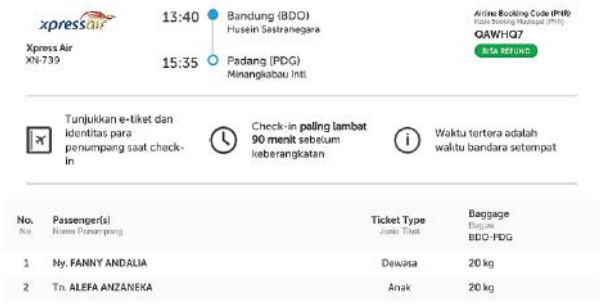

Fig 2. Example of E-Ticket

III. RESEARCH METHODS

This research uses Analytical Hierarchy Process to make decisions in the selection of airplane ticket booking applications based on several criteria of assessment. The research framework used in this research can be seen in Figure 3 below.

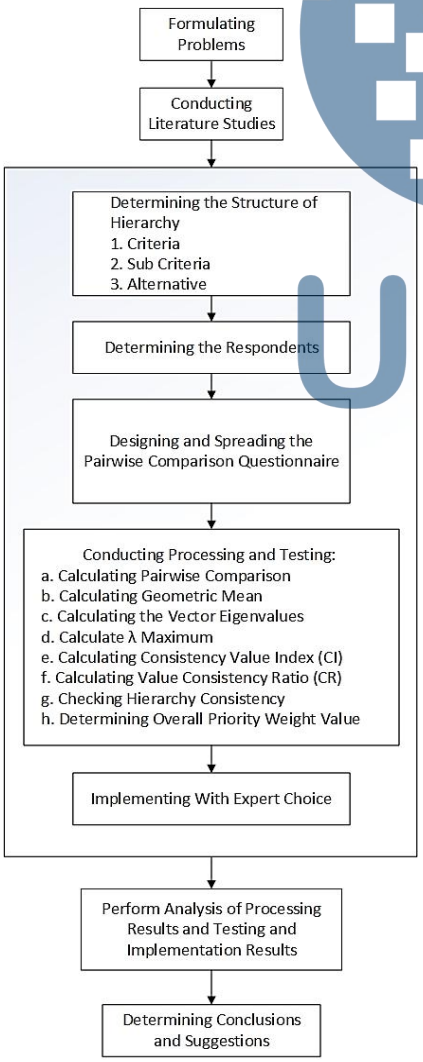

Fig 3. Research Framework

The hierarchical structure used in this research can be seen in Figure 4.

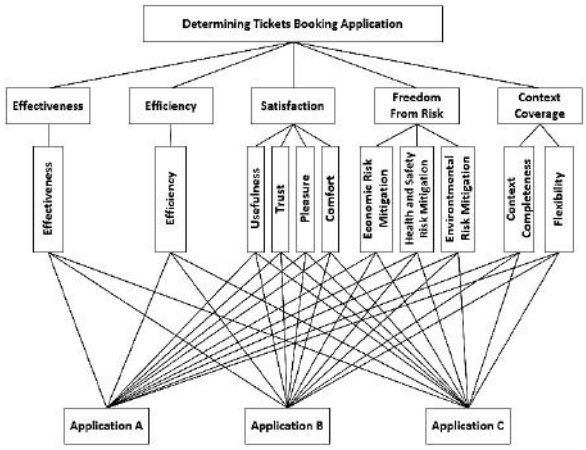

Fig 4. Structure of Research Hierarchy

IV. RESULT AND DISCUSSION

Sources of data obtained in this research came from three respondents who can represent several contexts and understandings. To be specific from the three respondents can be seen in table 1 below :

Table 1. Research Respondents

No. Respondents	Skills / Capacity
1st respondent	Representatives of information technology experts
2nd respondent	Representatives from the community of user representatives of airplane ticket booking applications online
3rd respondent	Representative of travel agent

The results of the assessment of the three respondents then processed and analyzed by using Expert Choice tools. The result of computation with a geometric mean of the three respondents, the merger value is then calculated eigenvalues for each criterion.

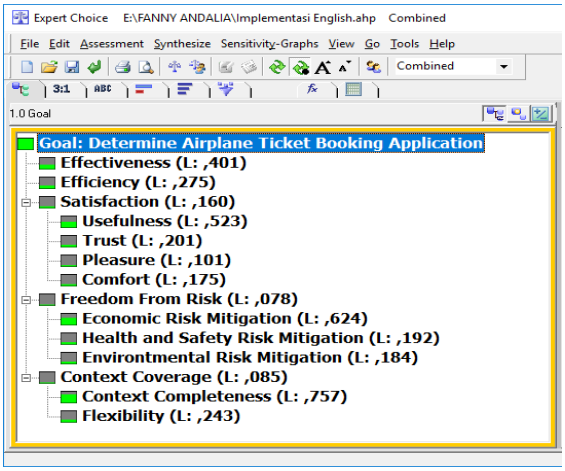

Fig 5. Eigen Value Calculation Result

The weight of each alternative based on the criteria and subcriteria of the geometric mean using Expert Choice can be seen in figure 6 to figure 10.

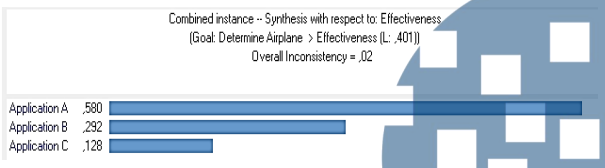

Fig 6. Weight Value of Any Alternative Based on Effectiveness Criteria

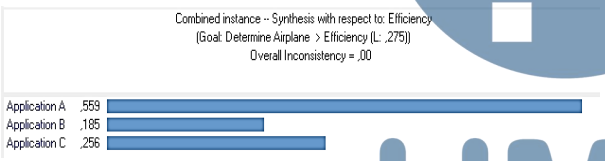

Fig 7. The Value of Each Alternative Weight Based on Efficiency Criteria

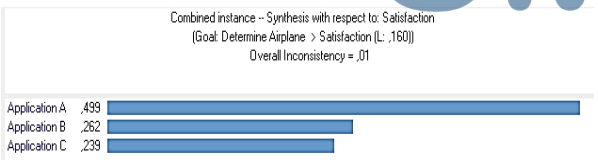

Fig 8. The Value of Each Alternative Weight Based on Satisfaction Criteria

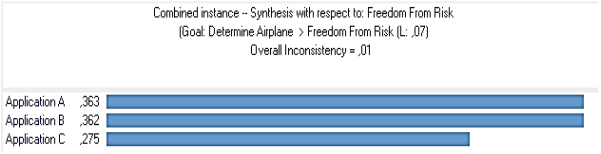

Fig 9. The Value of Any Alternative Weight Based on Freedom From Risk Criteria

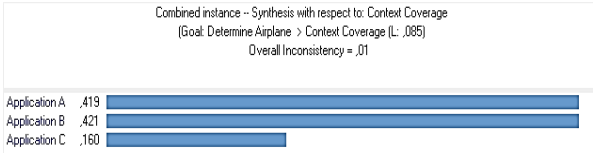

Fig 10. The Value of Each Alternative Weight Based on Context Coverage Criteria

The final assessment of the value of each alternative based on the weight of each criterion and subcriteria can be seen in Figure 11.

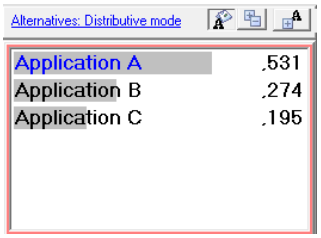

Fig 11. Final Evaluation Results of Each Alternative

Based on figure 11, the results obtained from Expert Choice analysis process that Application A has the highest position with a value of 0.531. The second alternative sequence is Application B with the value of 0.274 and the third alternative order is Application C with value 0,195.

The data source on the AHP method should have a Consistency Ratio (CR) value below 0,1 so that the hierarchy assessment results are performed consistently. Based on the results of the calculation using Expert Choice found that the value of the three respondents, as well as the results of the combined assessment using geometric mean, all have values below 0,1 so that the results considered consistent. The value of the Consistency Ratio (CR) can be seen in Figure 12 below.

PID	Name	Overall	Goal: Determine Airplane Ticket Booking Application
		#Factors	5
0	Facilitator	,0000	
1	Combined	,0087	,0080
2	Responden 1	,0219	,0214
3	Responden 2	,0173	,0138
4	Responden 3	,0187	,0153

Fig 12. Consistency Ratio Value

Based on Figure 13 it is known that all the criteria, sub-criteria and alternatives obtained have consistent Consistency Ratio (CR) value because the value of the item overall inconsistency = 0.01.

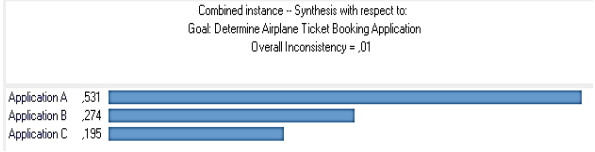

Fig 13. Final Values and Overall Consistency Ratio

V. CONCLUSION

Based on the results of research conducted, can be taken some conclusions :

1. Analytical Hierarchy Process (AHP) method in this research can provide a recommendation for us in making the decision to determine the application of airplane ticket booking.
2. Based on the software quality assessment using AHP and ISO / IEC 25010: 2011 metrics quality criteria used, it has generated the sequence of applications that have the highest value so it is recommended to use.
3. ISO / IEC 25010:2011 may be used to assess software quality in terms of quality in use rating criteria.

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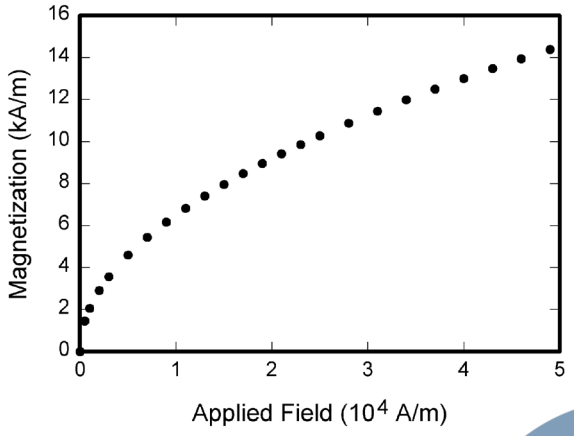

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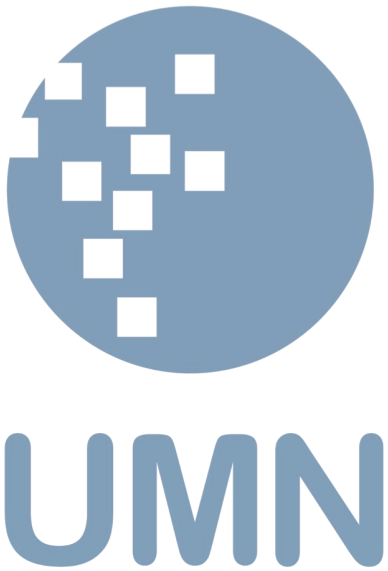
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