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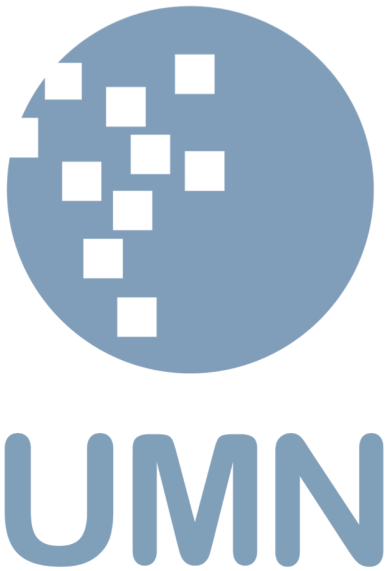
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A Simple Method for Cost Estimating and Controlling

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***Abstract*—Based on software project survey from Standish Group's "CHAOS Report", 29% of software projects in large enterprises can be delivered on time and not over budget, 53% of software project was over budget or had some problem with the schedule, and 18% of software project was failed. This means that cost management is very important to prevent the possibility of project's failure. Therefore, in this paper, we provide and recommend some methods and technique to do cost estimation and cost controlling as the crucial part of project cost management. We recommend Activity-Base Costing method for cost estimation and Earned Value Analysis for cost control. As the result of this paper, these two methods can be applied properly to the real project and ease the project manager to estimate and control the cost of the project**

***Index Terms*—Activity-Based Costing, cost controlling, cost estimating, cost management, Earned Value Analysis**

I. INTRODUCTION

One major component of project management is cost management. Since the total cost of a project is not known in advance, it must be estimated. The cost has to be broken down and assigned to work packages and controlled in the course of the project. When variances from the budget are detected, corrective actions must be taken. Cost management has become a critical problem in project management [1].

One of widely respected survey of software projects in industry and government, the Standish Group's "CHAOS Report" estimated only 29% of software projects in large enterprises succeeded (project delivered on time and on budget), 53% were challenged (project over budget or had some problem with the schedule), and 18% were failed (cannot deliver any usable result) [2]. This paper was written to propose a simple method to manage the cost of a project.

Most of the challenged projects in the Standish Group's "CHAOS Report" had an average over budget around 56% [2]. That number is quite large and represents a serious and crucial problem in enterprise's financial.

Effective project cost management of construction enterprises is an important guarantee for profits [3]. Effective cost management has six steps as the process, including [4]:

- Understand how we get the cost and revenue from the business
- Understand and decrease the complexity of the function related to each other.
- Provide the tools to manage costs
- Involve employees in decisions
- Increase the costs and the effectiveness
- Measure the decision of the strategic business plan

The objective of this paper is to provide a simple method as a way to help the project manager to manage the project costs. The process to manage this project cost involves cost estimating and cost control. This paper recommends Activity-Based Costing method for estimating the cost and Earned Value Analysis method for controlling the cost of cost management.

II. LITERATURE REVIEW

Project management is the way how we can achieve specific goals and targets with specified budget and cost using the power of knowledge, tools, skills, and techniques [5]. Project management has seven major components. They are integration management, scope management, time management, cost management, quality management, human resource management, communications management, risk management, and procurement management [6]. In this paper, we will discuss one of the components, namely project cost management.

A. Project Cost Management

Project cost management is a method that uses technology to measure cost and productivity through the full lifecycle of enterprise level projects [6].

According to the Project Management Institute (PMI), cost management can be divided into three stages [7]–[9], as follows:

- Cost Estimating, the stage during which the cost of the resources exploited for the project is forecasted, to estimate the overall cost of the project.
- Cost Budgeting, the process of establishing a budget by summarizing the estimated costs of the work packages, optimizing this budget in relation to the available amount of money and finally defining the baseline.
- Cost Control: once the project has started, the progress of expenditure is monitored, for analyzing the variances from the budget in real time.

B. *Cost Estimating*

The objective of cost estimating is to develop estimates and measurement of costs needed to complete project tasks and activities [10], [11]. Brinke et al. (2007) stated that to be effective, cost management requires information that covers the whole process [12]. To produce an effective estimate, the project manager needs to master techniques in multiple facets of the estimation process [10], as follows:

- Communication
- Being Realistic
- Uncertainty
- Big picture
- Technique in tandem

The innovative approach of cost estimating in project management which in turn are based on Activity-Based Costing (ABC) techniques.

C. *Activity-Based Costing (ABC)*

ABC was created in response to the traditional technique used for calculating the full cost of a product (or project or work contract) and based on the division of indirect cost on a single base or multiple bases [7].

Cost Estimating in Project Management adopts the ABC approach to calculate the full cost of a project, but in this case the technique is used to estimate the costs of a project or a work order, and not of a product [7].

D. *Cost Controlling*

Cost controlling includes the process of managing and controlling factors that change or affect the budget [10]. Cost control deals with the cost performance of a project. Cost control includes the measurement of the project performance and forecasting future project developments, their cost implications [6]. It is important to provide team members with all the information they require to recognize what happened historically, what is happening currently and to accurately forecast the future [10].

E. *Earned Value Analysis (EVA)*

Earned value analysis has been used for more than forty years by Department of Defense [13]. Earned value analysis is a project controlling method as well as a forecasting approach. It can be used to:

1. Measure work accomplished
2. Quantify the impact of known issues
3. Use this data to forecast estimates at completion

The Earned Value (EV) of these completed work packages can be compared to actual costs and planned costs to determine project performance and predict future performance trends [14].

There were some reasons that make earned value analysis is worth to use. First, Earned value analysis combines the analysis of actual cost and schedule performance, so that plan will be complete. Second, earned value analysis is an early warning system that alerts on future issues. Therefore, a project manager will be able to predict the negative kind of risk before that risk happened because. And the last, earned value analysis provides a standardized unit of measure [10].

III. RESEARCH METHODOLOGY

Methodology that used in this project consist of two processes. First, estimate cost using Activity Based Costing (ABC). Second, controlling cost using Earned Value Analysis (EVA).

A. *Cost Estimating using Activity-Based Costing*

There are therefore two stages in Activity-Based Costing techniques [7]. First, assign the cost of resource to the activities (First stage: Resource drivers). And second, the activities are linked to the products or projects (Second stage: Activity drivers)

The resource drivers of this method is the resources for entire duration of the activity, they can be proportion to its duration such as work hours require, but it must be compatible when allocation. When estimating the human resources, it's better to include cost of calling or exploiting. The activity driver of this method is duration of activity in project (use Work Breakdown Structure). Activity-Based Costing architecture is shown in Figure 1 [7].

B. *Cost Estimating using Earned Value Analysis*

The method that this paper used to controlling the cost in cost management process is Earned Value Analysis (EVA) concept. To use EVA, ensure that few fundamental project management activities must happen with every project [6].

There are, ensure that we had divide the project into package or manageable parts of authorized work. One kind of technique that can be use is establishing the Work Breakdown Structure (WBS).

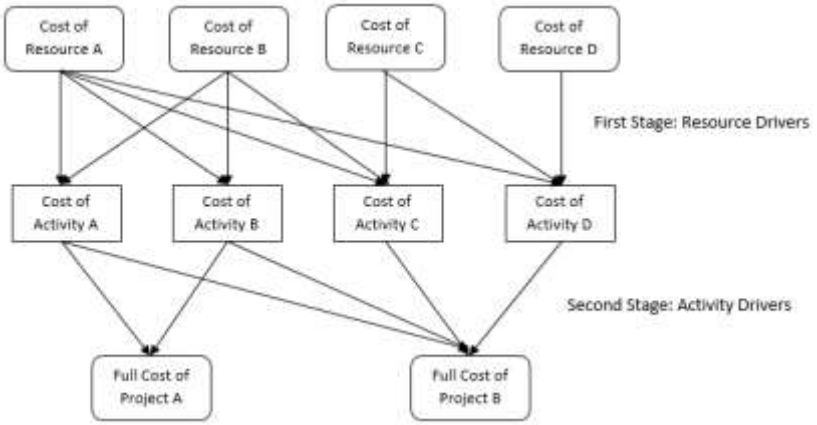

Figure 1. Activity-Based Costing Architecture

Then, ensure that all the packages are defined in order, so each activity can be allocated with duration of time and cost completely. And the last, make sure that we have set cost and effort to all parts across the entire project.

After we make sure that the project management activities work properly with that role, the process steps can be executing [10], as follows:

- Update the declination based on the current progress.
- Update the actual costs related to the current progress.
- Calculate and graph key values, variance, and ratios.
- Anatomize the results and improve the actions.

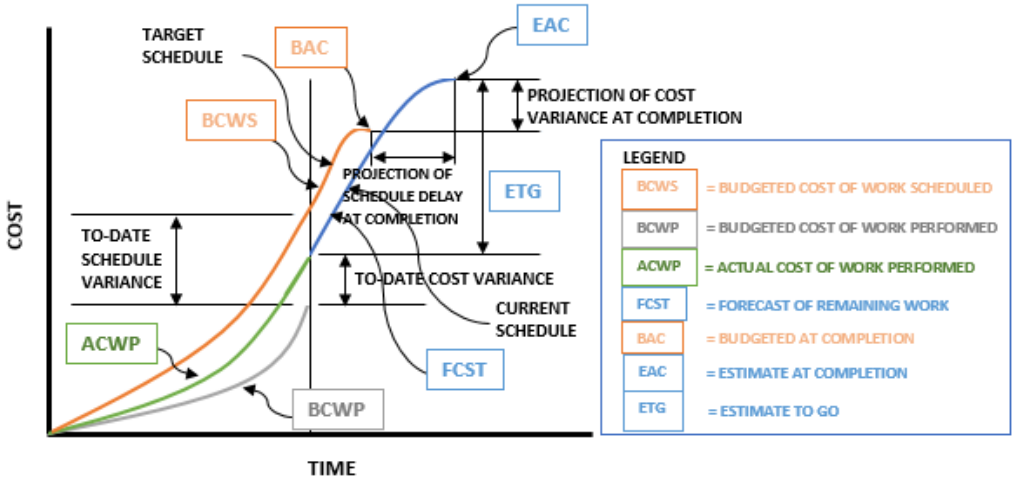

Figure 2. Earned Value Analysis Example

A graphical representation of key value, variance, and ratios is shown in Figure 2 [10]. The formula is:

- Budgeted Cost of Work Scheduled (BCWS)

$$BCWS = baseline\ cost \quad (1)$$

- Budgeted Cost of Work Performed (BCWP)

$$BCWP = work\ completed(\%) \times budgeted\ cost \quad (2)$$

- Actual Cost of Work Performed (ACWP).

$$ACWP = actual\ cost \quad (3)$$

- Schedule Variance (SV).

$$SV = BCWP - BCWS \quad (4)$$

- Cost Variance (CV).

$$CV = BCWP - ACWP \quad (5)$$

IV. RESULTS AND ANALYSIS

The evaluation of the methods that this paper provide has been is shown in Figure 3 and Figure 4. We see that for estimate the cost, we use Activity-Based Costing that separate the cost of resource and activity. This method will ease the project manager to maintain cost.

Task Name	TBC	1	2	3	4	5	6
Resource A	12500000	5000000	7500000				
Resource B	10000000		4000000	6000000			
Activity A	7500000			3500000	4000000		
Activity B	14000000			2000000	3000000	4000000	5000000
Activity C	6000000					2000000	4000000
Total Budgeted Cost	50000000	5000000	11500000	11500000	7000000	6000000	9000000
Budgeted Cost of Work Scheduled (BCWS)		5000000	16500000	28000000	35000000	41000000	50000000
Actual Cost of Work Performance (ACWP)		4920000	15570000	26010000	28210000		
Budgeted Cost of Work Performance (BCWP)		3750000	11875000	17375000	39750000		

Figure 3. Cost Estimating

According to Figure 3 and Figure 4 we can see that the earned value before the activity and after the process has finished. We can predict the possibility of over budget there in 4th month by looking at the current progress of work and the remaining budget.

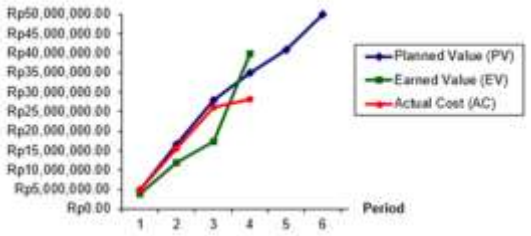

Figure 4. Earned Value Analysis Graph

Therefore, by looking at that possibility, a project manager can allocate other remaining budget to be allocated to the other progress or activity that has a possibility to over budget. So, this graph will help project manager to avoid the over budget of the project.

V. CONCLUSION

The conclusion of this paper is that Activity-Based Costing and Earned Value Analysis can be applied to real project. And these two recommended methods can be useful for project manager and ease the project manager to do cost management.

Even though these two methods can be used to manage the cost of the project, the cost management still not complete. Therefore, in the future work, we will provide method for cost budgeting as the part of cost management process. So, the cost management as the part of project management will be more effective and efficient because all process of cost management already covered.

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Supply Chain Management Implementation on Snacks Production Process

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***Abstract*—PQR's company is a company that located in Citeureup Tasikmalaya. The company is engaged in the production of snacks such as "mie lidi" or lidi noodles. It was found some problems that happened in this company such as purchasing department have a problem to determine the number of raw material requirements to the supplier. It happened because of the uncertain demands from the distributors. Besides a problem in the upstream, there was some problem in the downstream that was shipping department was difficult to make a schedule of product shipping. Based on the problems, so the company needs the development of the system with by supply chain management approach. A strategy that used in the production process is made to stock. The method that used is forecasting method single moving average based on sales data. The inventory calculation of the safe limits of raw materials and products use safety stock method. After testing has done, then it gets the conclusion from the result that this information system is making easy purchasing department to determine the number of raw materials for procurement process to a supplier and it is making easy shipping department to make a schedule of product shipping for distributors.**

***Index Terms*— supply chain management, make-to-stock, single moving average, safety stock**

I. INTRODUCTION

Dokum QR's company is a company that located in Citeureup Tasikmalaya and the business is engaged in the production of snacks such as "mie lidi" or lidi noodles. This company organizes the activities from upstream until downstream. Activities in the upstream are the activities with their suppliers, such as procurement of raw materials. The activities in the downstream are all activities like a sending product to customers [1].

After conducting an interview with the head of purchasing section in August 2017, it was found that at this time the company in the upstream activities in the procurement of raw materials to suppliers made based on sales reports the previous month. Then on the production activities of the company, he explained that the company made the production process before the request of the distributor (customer).

However, the company encountered problems when there was uncertain demand from distributors. If the demand rises, then the vacancy for some raw materials. Conversely, if the demand falls, it results in the buildup for some raw materials. Known in April 2017 there was an increase in product demand by 31% from the previous month.

At that time, product demand from distributors was 10.076 packs of noodle stick. However, the company experienced a shortage of raw material stocks in which the stock of raw materials owned by the company is only able to meet the demand from distributors as much as 7.155 packs of lidi noodle. Meanwhile, in May 2017 there was a decrease in product demand from distributors by 29% from the previous month. When the product demand from distributors is 7.460 packs of noodles, the company has a stockpile of raw materials in which the raw material stock owned by the company is able to fulfill the demand of the products from the distributors of 10.433 packs of noodles. So the problems that occur in the upstream part of purchasing has difficulty to determine the amount of procurement of raw materials to suppliers.

After conducting an interview in the same month as the delivery chief, he explained that the downstream activities are receiving product orders and then sending them to distributors. Distributors order products through the marketing department, then the product will be delivered to the distributor by the shipping department using the company's private vehicle. The delivery department often has difficulties in determining the capacity of the vehicle to be used for the shipping process as well as the difficulty in conducting the monitoring process during delivery as there is no system that can monitor the shipment process.

Both problems occur because there is no system that can manage supply chain information. A supply chain is a system where the organization distributes its products and services to customers [2]. With the development of supply chain management information system is expected to be the right solution to solve the problems that occur.

The single moving average has been used in some previous research. Haryanto [3] implements it for the

provision of medicines in hospitals, while Ricky et al [4] implement a single moving average for the forecasting process of stock items at bookstores. Based on these studies, the single moving average is suitable when use data is stationary.

II. LITERATURE REVIEW

A. *Supply Chain Management*

A supply chain is a network of companies involved in supplying raw materials, producing goods, or sending them to the final supplier. Supply Chain Management (SCM) is a method, tool, or management approach. It should be emphasized, however, that SCM requires an integrated approach or method based on the spirit of collaboration. SCM is not only oriented to the internal affairs of a company but also the external affairs that involve relationships with partner companies [5]. There are three chain components in SCM: upstream supply chain management, internal supply chain management, and downstream supply chain management [6].

B. *Safety Stock*

Safety stock serves to protect errors in predicting demand during lead time. Lead time is the time required between the raw materials ordered to arrive at the company. The amount of safety stock value depends on supply and demand uncertainty [5]. The formula for calculating safety stock is as follows.

$$Safety\ Stock = Z \times Sdl \quad (1)$$

Information:

Z = Service Level

Sdl = Uncertainty of Demand and Lead Time

Reorder point is when the inventory reaches the point where ordering is required. The formula for determining the reorder point is as follows.

$$Sdl = \sqrt{(d^2 \times sl^2 + l \times sd^2)} \quad (2)$$

Information:

d = Average Usage

sl = Standard Deviation Lead Time

l = Lead Time

sd = Standard Deviation of Average Usage

C. *Forecasting*

Forecasting is to forecast what happens in the future. While the plan is a determination of what will be done in the future. By itself, there is a difference between forecast and plan. A forecast is forecasting what will happen, but not necessarily can be implemented by the company. Forecasting aims to obtain forecasts or predictions that minimize errors in forecasts that are usually measured by mean square error, mean absolute error.

Forecasting is widely used for a wide range of scholarship and purposes, such as for data calculations [7], weather forecasting [8] and also used in foreign exchange [9].

D. *Forecasting Method of Single Moving Average*

The single moving average method uses a number of actual data of new requests to generate prediction value for future demand. This method will be effectively applied if we can assume that the market demand for the product will remain stable over time. This method has two special properties that are to make forecasts require historical data within a certain time period, the longer the moving average will result in a smoother moving average. The moving average system can be calculated by the equation.

$$S_{t+1} = \frac{x_t + x_t - 1 + \cdots + x_t - n + 1}{n} \quad (3)$$

Information:

St + 1 = Forecast for period t + 1.

Xt = Data in period t.

n = Time Moving Averages

E. *Measurement of Forecasting Error*

Measurement of forecasting errors can use mean absolute error, mean square error, mean absolute percentage error. Here is an explanation of forecasting errors.

Mean Absolute Error (MAE)

Mean absolute error (MAE) is the average absolute error value of predictor error (positive and negative values are not seen) can be seen in the following equation.

$$MAE = \frac{\sum |x_t - F_t|}{n} \quad (4)$$

Mean Square Error (MSE)

Mean square error (MSE) is the mean forecasting error squared. Can be seen in the following equation.

$$MSE = \frac{\sum (x_t - F_t)}{n} \quad (5)$$

Mean Absolute Percentage Error (MAPE)

MAPE is a relative error measure. MAPE specifies the percentage of error forecasting results against actual demand over a given period which will give the error percentage information too high or too low. Systematically, MAPE can be seen in the following equation.

$$MAPE = \frac{100}{n} \sum |A_t \frac{F_t}{A}| \quad (6)$$

III. RESULT

A. *Problem Analysis*

Problem analysis is a process to learn some system problem that has identified in an identifying process. Problem analysis from this running system are:

1. Purchasing department has difficulty in determining the number of raw materials to suppliers because of the number of requests from an erratic distributor.
2. Shipping department has difficulty to do shipping schedule of a product because often experience delays in shipments caused by product stock shortages.

B. Supply Chain Management Analysis

Supply chain management analysis was used to apply supply chain management approach to the information system that will be built.

Supply Chain Management Model

Supply chain management model explains the activities in the company from upstream until downstream. In a running of activities, the company not only have a relationship with the internal department but it has a relationship with several partner of the company. Figure 1 is a supply chain management model at the PQR's company. The detail description can be seen in figure 1.

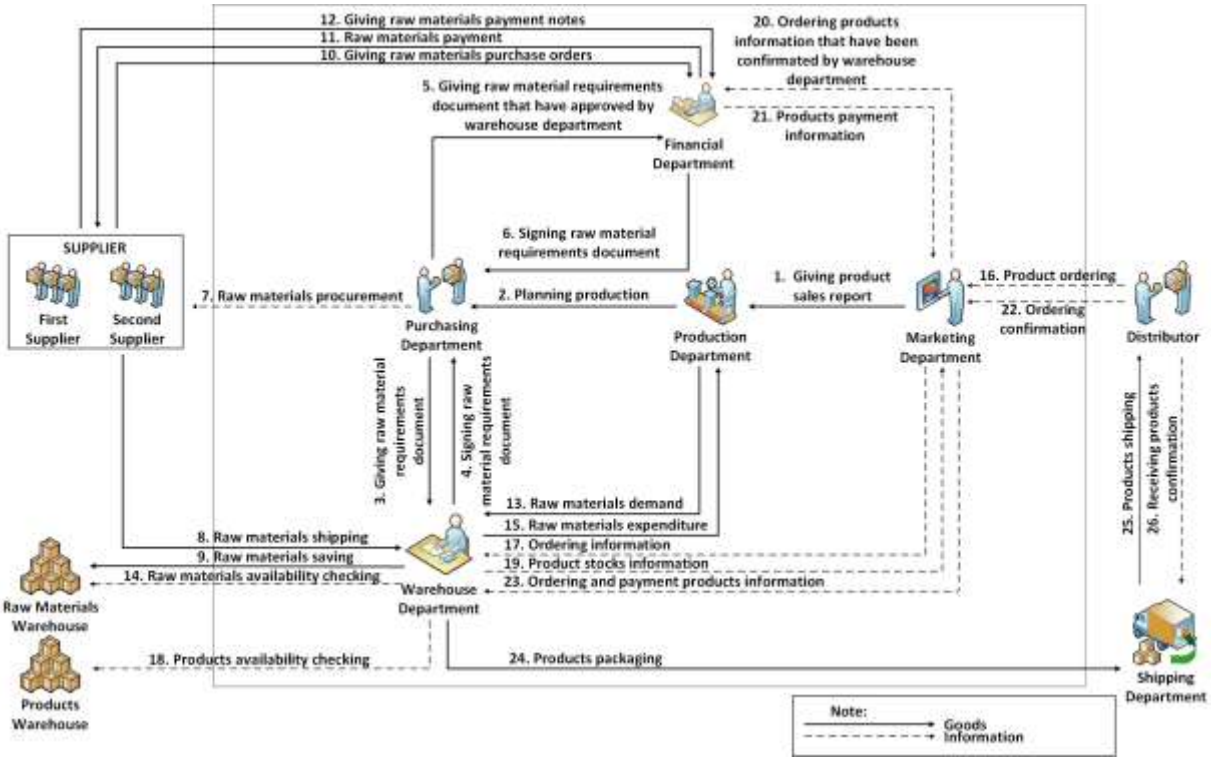

Figure 1. Supply chain management model at PQR's company

Supply Chain Analysis at PQR's Company

Supply chain analysis was done to describe information system of supply chain management that will be built at the PQR's company. Steps of supply chain analysis that will be doing are:

a. The amount of raw materials order analysis.
b. Inventory (monitoring) analysis.
c. Production analysis.
d. Procurement of raw materials analysis.
e. Shipping products analysis.

a. The Amount of Raw Materials Order Analysis

The determining the number of raw materials that must be ordered to a supplier, at the first step is purchasing department must be forecasting of product sales. Then the result of it will be used to forecasting the number of raw material requirements to be knowing the number of raw materials that must be ordered to a supplier. So, when the distributor has ordered, the amount of product that has ordered by the distributor can be completed because there were doing certain determine the number of raw materials in a procurement process.

Forecast method that used is a quantitative forecast method with time series model analysis. It was chosen based on histories data and projecting it to the future [3]. Forecast method that is used a single moving average based on comparison with single exponential smoothing and weighted moving average method. And the sample data were used is raw lidi noodles because it was the best seller in February until July 2017 than another product. Table 1 is a sales data of raw lidi noodles. The detail description can be seen in table 1.

Table 1. Sales data raw lidi noodles

No	Period	Product Sales Data Raw Lidi Noodles
1	February	3.032 packs
2	March	2.286 packs
3	April	3.010 packs
4	May	2.112 packs
5	June	2.356 packs
6	July	2.365 packs

From the data in table 1, it can be made a graphic to determining method will be used on forecasting with the pattern of data. Figure 2 is a graphic of sales data raw lidi noodles. The detail description can be seen in figure 2.

Figure 2. Product sales data raw lidi noodles

Based on the pattern of data above, so the next step was forecasting with single moving average method. The period of moving average value used is 3 monthly and 5 monthly period because in the third and fifth months there is considerable fluctuation. The calculation of forecasting is as follows.

Calculation for n = 3

The forecast result for n = 3 is obtained by entering Xt 3 months before the month to know the forecast result. Here are the calculations to determine to forecast in August 2017.

$$St_{August} = \frac{Xt_{May} + Xt_{June} + Xt_{July}}{n}$$

$$= \frac{2112 + 2356 + 2365}{3}$$

$$= 2278 \text{ (Rounding results)}$$

Calculation for n = 5

The forecast result for n = 5 is obtained by entering Xt 5 months before the month you want to know the forecast result. Here are the calculations to determine to forecast in August 2017.

$$St_{August} = \frac{Xt_{March} + Xt_{April} + Xt_{May} + Xt_{June} + Xt_{July}}{n}$$

$$= \frac{2286 + 3010 + 2112 + 2356 + 2365}{5}$$

$$= 2426 \text{ (Rounding results)}$$

Based on the results of the previous calculation, all the forecasting results with the method of single moving average can be seen in table 2.

Forecasting used can be measured accuracy in predicting it by calculating the accuracy of the error rate, one of them with the MSE (Mean Square Error) method. Table 3 is the calculation of the mean square forecasting error. A more detailed explanation can be seen in table 3.

Table 3. Sales forecast result raw lidi noodles

Period	Sales Data	3 month	5 month
February	3.032	-	-
March	2.286	-	-
April	3.010	-	-
May	2.112	2.776	-
June	2.356	3.704	-
July	2.365	2.493	2.559
Forecast Result on August		2.278	2.426

Based on the calculation in table 3, then obtained the smallest MSE from forecasting results period 5 monthly with a value of 37636. Then it can be concluded that for the month of August 2017, the company recommended to procuring raw materials for raw noodle products as much as 2426 packs.

The next step is to calculate the number of raw materials to be ordered based on forecasting results by multiplying the forecast results for a 5 monthly period with the amount of composition of each raw material. Table 4 is the raw material composition of crude noodle noodles. A more detailed explanation can be seen in table 4.

Table 4. Raw material composition raw lidi noodles

Product	Raw Materials	The Number of Raw Materials
Raw lidi noodles	Wheat	1 kg
	Cooking Oil	100 gram
	Salt	40 gram
	Food Coloring	4 ml
	Red Onion	0,048 kg
	White Onion	0,032 kg

Table 2. Calculation mean square forecasting error

Period	Sales Data	3 Monthly			5 Monthly		
		Forecast Data	Error	Quadratic Error	Forecast Data	Error	Quadratic Error
February	3.032	-	-	-	-	-	-
March	2.286	-	-	-	-	-	-
April	3.010	-	-	-	-	-	-
May	2.112	2.776	664	440.896	-	-	-
June	2.356	3.704	1.348	1.817.104	-	-	-
July	2.365	2.493	1.28	16.299	2.559	194	37.636
MSE		**758.100**			**37.636**		

Having known the composition of each raw material, it can be seen the calculation of the number of raw materials that must be ordered by the company in accordance with forecasting results period of 5 months. Table 5 is the amount of raw material to be ordered. A more detailed explanation can be seen in table 5.

Table 5. The amount of raw materials must be ordered

Raw Material	Calculation	The Number of Raw Materials	The Number of Raw Materials Must be Ordered
Wheat	2.426 x 1	2.426 kg	97 sacks
Cooking Oil	2.426 x 100		242.600 gr
Salt	2.426 x 40	97.040 gr	388 packs
Food Coloring	2.426 x 4	9.704 ml	10 bottles
Red Onion	2.426 x 0,048	116 kg	116 kg
White Onion	2.426 x 0,032	78 kg	78 kg

b. Inventory Monitoring Analysis

After determining the number of raw materials will be ordered, the next step is doing inventory monitoring of raw materials and products with using safety stock method.

Inventory monitoring is used to determining safety limit inventory of raw materials and products that must available at the warehouse. The example of calculation raw materials inventory based on products inventory.

Safety Stock Calculation

Forecasting amount of August 2017 = 2426 packs
The number of working days in a month = 26 days
Lead Time procurement to supplier (l) = 5 days
Average monthly procurement (d)
= 2426/26 = 93.31
Standard Lead Time Deviation (sl) = 0.5
Standard Deviation Booking (sd) = 2.6
Service Level 95% (Z) = 1.64
Safety Stock = Z x Sdl
Sdl = $\sqrt{(d^2 \times sl^2 + l \times sd^2)}$
Sdl = $\sqrt{93.31^2 \times 0.5^2 + 5 \times 2.6^2}$
Sdl = $\sqrt{2210.5}$
Sdl = 47.01
Safety Stock = 1.64 x 47.01
Safety Stock = 77.1
Safety Stock = 77 (rounding)

Based on the calculation of safety stock, the company must provide raw material stock in accordance with the safety stock of raw noodle products, which are 77 packs for each raw material. Table 6 is the raw material stock of raw lidi noodles. A more detailed explanation can be found in table 6.

Table 6. Safety stock of raw materials lidi noodles

Raw Materials	Calculation	Result	*Safety Stock*
Wheat	77 x 1	77 kg	77 kg
Cooking Oil	77 x 100	7.700 gram	10 liter
Salt	77 x 40	3.080 gram	3 kg
Food Coloring	77 x 4	308 ml	308 ml
Red Onion	77 x 0,048	4 kg	4 kg
White Onion	77 x 0,032	3 kg	3 kg

After doing inventory monitoring of product. The next step is a doing inventory monitoring of product. Table 7 is an example inventory monitoring of raw materials. The detail description can be seen in table 7.

Table 7. Product inventory monitoring

Product	Stock	*Safety Stock*	Status
Raw lidi noodles	1.080	77 packs	Safety

After monitoring the product inventory, then it will be monitored raw material inventory. Table 8 is an example of monitoring raw material inventory. A more detailed explanation can be seen in table 8.

Table 8. Raw materials inventory monitoring

Raw Materials	Stock	*Safety Stock*	Status
Wheat	150 kg	77 kg	Safety
Cooking Oil	125 lt	10 lt	Safety
Salt	50 kg	3 kg	Safety
Food Coloring	289 ml	308 ml	Not Safety
Red Onion	2 kg	4 kg	Not Safety
White Onion	4 kg	3 kg	Safety

c. Production Analysis

In this step, production department does planning production process to determining the amount of product that will be produced every day based on the result of forecasting calculation divided with the amount of the workday on month.

d. Procurement of Raw Materials Analysis

Procurement of raw materials is used by purchasing department to suppliers than it has ordered will be sent by suppliers and it was received by warehouse department when it arrived at the company. Based on an inventory of raw materials, when raw materials stocks have not safety status, so the company must do procurement with the number of raw materials that be ordered based on the forecasting result plus safety stock than reduced warehouse stock. The procurement process is doing to suppliers that have relation with a company in the form of investment. For the first supplier with the amount of highest investment have a percentage of purchases raw materials at about 70%. However, 30% purchases raw materials will be completed by the second supplier.

e. Shipping Products Analysis

Shipping products analysis has proposed to determining the amount of transportation capacity on shipping product and it will be doing monitoring process while shipping happened. So, the company can be knowing a product that is ordered by distributor have arrived or not to them.

C. Data Flow Diagram

DFD level 1 in information system with using supply chain management approach at the PQR's company describes on general about all process that is happened on the system. Figure 3 is a DFD Level 1 information system supply chain management at PQR's company. A more explanation can be seen in figure 3.

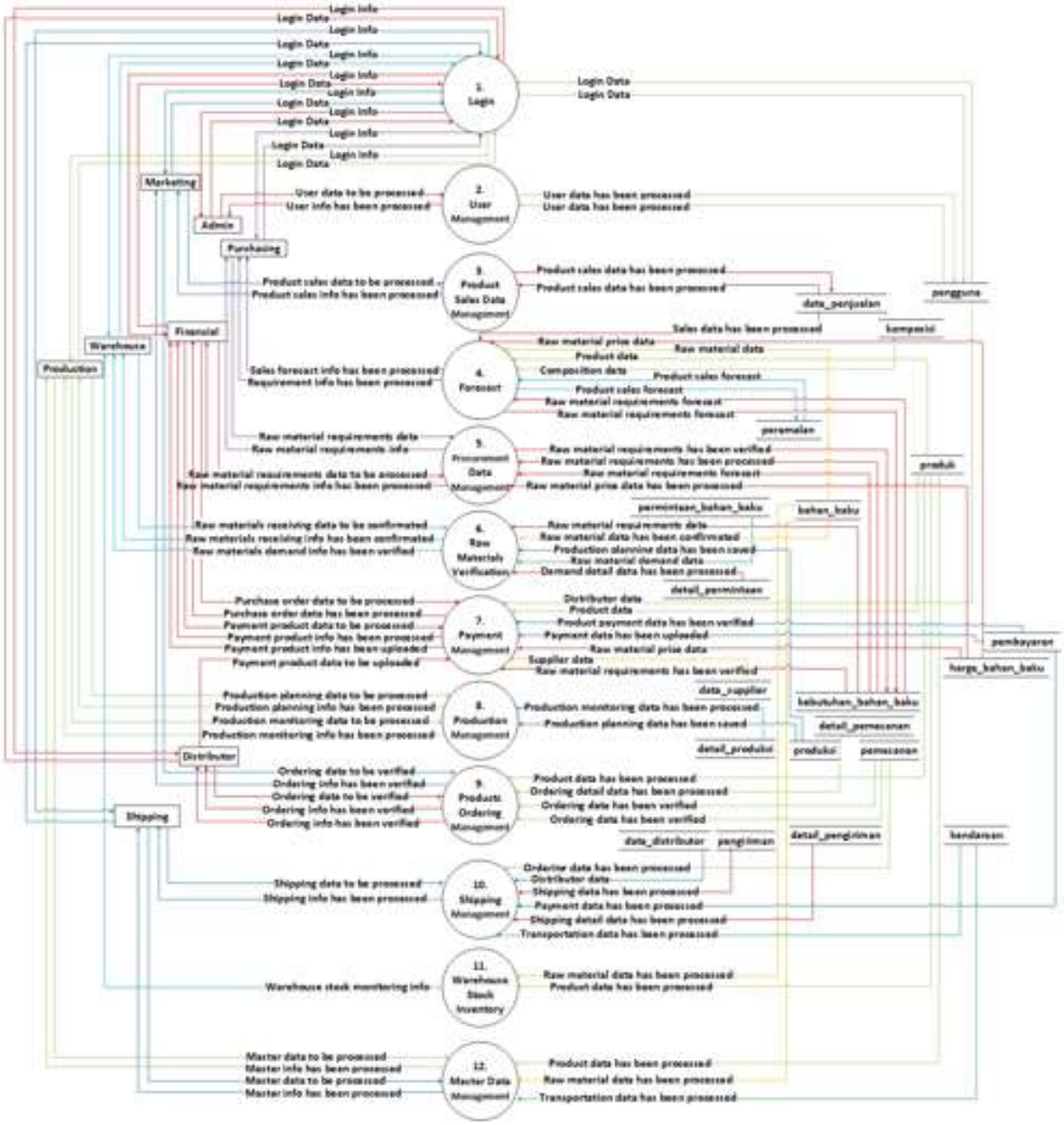

Figure 3. DFD Level 1 Supply Chain Management Information System

D. System Implementation

System implementation is a step to apply the results analysis and designing system. This step aims to do confirmation design. So, a user on the system can give suggestions for developing the system.

Software Implementation

Software implementation describes the specification of software that will be used for information system implementation with using supply chain management approach at the PQR's company. Table 9 is a software implementation of information system supply chain management at PQR's company. A more explanation can be seen in table 9.

Table 9. Software implementation

No	Software	Specification
1	Operation System	Operation System Windows 8.1
2	Web Server	XAMPP Server
3	Web Browser	Google Chrome
4	Database Server	MySql
5	Code Editor	Sublime Text 3

Hardware Implementation

Hardware implementation describes the specification of hardware that will be used for information system implementation with using supply chain management approach at PQR's company. Table 10 is a hardware implementation of information

system supply chain management at PQR's company. A more explanation can be seen in table 10.

Table 10. Hardware implementation

No	Hardware	Specification
1	Processor	Intel Core 2 Duo 2-Ghz
2	Memory	2 Gb
3	Storage	250 Gb
4	VGA	Intel HD Graphic
5	Monitor	14"
6	Mouse	*Optical Mouse*
7	Keyboard	*Standard*

Interface Implementation

Interface implementation is a media for a user interaction with the system that will be built. Interface implementation from information system supply chain management at PQR's company are:

Marketing Department Interface

Marketing interface is used to do recapitulation of sales data as references to forecasting of sale product, forecasting of raw materials needed and for verification order from the distributor. Marketing interface implementation can be seen in figure 4.

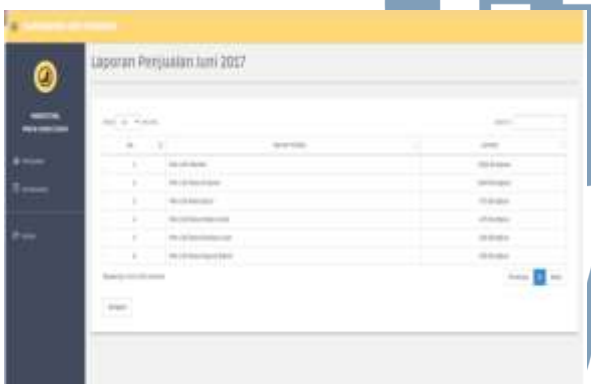

Figure 4. Marketing interface

Purchasing Department Interface

Purchasing interface is used to forecast of sale date, forecasting of raw materials needed, and verification procurement of raw materials from a supplier. Purchasing interface can be seen in figure 5 above.

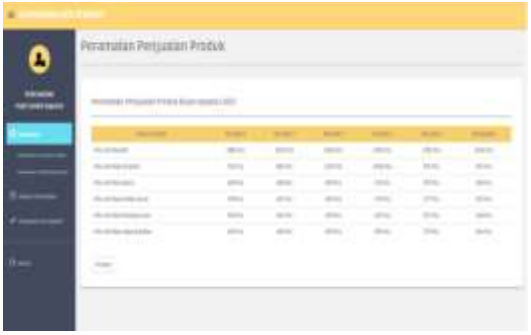

Figure 5. Purchasing interface

Shipping Department Interface

Shipping department interface is used to do shipping schedule, determining transportation capacity, and monitoring of shipping process. Shipping department interface can be seen in figure 6 above.

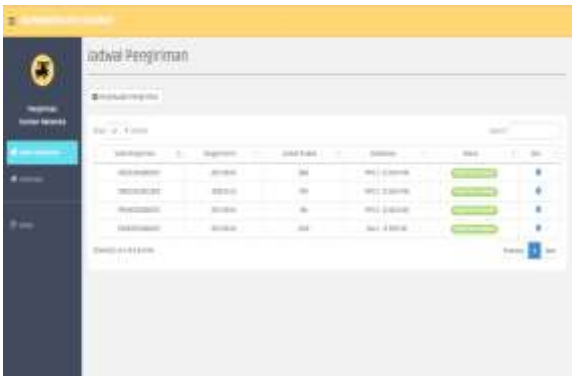

Figure 6. Shipping interface.

E. System Testing

System testing aims to found error or deficiency on an information system that will be tested. It is doing to know what does the development of this information system has completed a performance with the purpose of design or not.

The testing that used to test a system is black box testing method. Black box testing is focused on a functional requirements information system. Planning testing what will be doing is a test a system that will be built on black box and beta.

Functional Testing

Black box testing is focused on functional requirement software will be built. After do testing to several samples, so it can take the conclusion that functional system has been shown the output which is expected.

User Acceptance Test (UAT) Testing

Testing User Acceptance Test (UAT) is to confirm that the system being tested can meet the needs and can work correctly before it is given to the end user. After testing User Acceptance Test (UAT) with some test sample case, it can be concluded that all the process can be run properly and can be used.

Beta Testing

Beta testing is done with the aim to know the extent to which the quality of software that has been built, whether it is in accordance with the goal or not. The test was conducted in January 2018 at PQR Company by using interview technique to 7 resource persons as a user of an information system are head of the department, head of purchasing, head of marketing, head of the production, head of the warehouse, and head of the shipment. Resource persons provide varied answers and after the beta

testing is done, it can be obtained conclusions for several things are as follows:

1. The system has facilitated the purchasing part in determining the amount of raw material procurement to the supplier because the information has been presented automatically in the system.
2. The system has facilitated the delivery part in monitoring during shipment.
3. This system has also helped admin, part production, warehouse, marketing, and finance in carrying out their respective jobs.
4. Information provided by the system is complete enough. However, it is still considered incomplete for some users.
5. The built system has a simple and easy to understand interface.

IV. CONCLUSION

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

A. Conclusion

Based on the results of testing the development of information systems with supply chain management approach, it can be concluded as follows:

1. Development of information systems using supply chain management approaches can facilitate the purchasing department to determine the amount of procurement of raw materials to suppliers because the determination of the amount of raw material procurement has been provided in the system automatically.
2. Development of information systems using supply chain management approaches can provide convenience to the delivery department to monitor during the delivery is in progress.

B. Suggestion

Based on the results of testing the development of information systems with supply chain management approach, it can be obtained suggestions for system development is the addition of password change function in the menu of each user to facilitate users to change the password.

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Journal Aggregator System Concept Using User Centered Design (UCD) Approach

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***Abstract*— Journal as a medium to explain the results of research. It has developed in such a way especially because of the rapid support of information and communication technology today. Various models of online-based journaling management can be easily operated by journals managers as well as writers / researchers who will include research results in the journal. It's just that with the number of journals that exist today, causing difficulties for the manager of journals to be able to promote the journals he managed, in addition to the manager of the journal sometimes difficult to get a researcher who would put his paper into the journal he manages. Meanwhile, with the number of journals that have been online, researchers will find it difficult to get information from the journals. Researchers should open their journal entries, read their profiles and publications, until they are interested to include papers in the journal. This problem is the background of the development of online journals aggregator system, which with this system will facilitate the meeting between journals, journal managers and writers or researchers. In order to develop an online journal aggregator system, a software development method is needed that directly captures the needs of its users. User Centered Design (UCD) is a philosophy in software design that puts users as the center of system development. The UCD approach has been supported by various techniques, methods, tools, procedures, and processes that help design a more user-centered interactive system. With UCD it is expected that the online journals aggregator system can produce a design that will make it easier for its users, both in terms of functionality and from the side of the system interface.**

***Index Terms*— Journal, Agrregator, Online, User Centered Design (UCD)**

I. INTRODUCTION

Journals are an important information medium for science and technology. A journal is a collection of articles or papers that are published periodically, written by the researchers to present the results of research that has been done and reviewed by the best trusted partner. Therefore, the continuity of scientific journals becomes a very important thing for the development of science and technology in order to know the scientific development up to the latest [1].

The development of information and communication technology (ICT) providing assistance to the journal management with the online-based journal management system. On the one hand it helps journalists in disseminating information and manage their journals, on the other hand for research with the online version of journal makes it easy to perform a transaction related articles to be included in the journal. With increasing number of online journals, there are a problem that is often complained by the journal managers, researchers and public. For the journal managers, increasing number of online journal in the field of science, an effective promotion is needed to introduce the journal to the researchers. Meanwhile the researchers find it difficult and takes a long time to find and open one by one journal web pages to view the profile of the journal which are supposed to accept the results of the research he wrote. While the public needs an access to obtain an information related to the results of research in more detail and complete in the same places.

UCD is used as a method in system design, due to its ease in interaction mechanisms with users who are involved in the field by utilizing user opinions, patterns of user behavior [2], in this case is the journal manager, researchers and general public who need access to journals. The activities such as discussion, observation and literature study is used as a medium to find and provide solutions related problems.

The online journals aggregator system takes the concept of a web portal that will be a meeting system between journal managers, journal, researchers and general public. It's will facilitate the journal managers to be able to promote the journals he managed, inviting potential researchers to include their research article, and journal transactions inside it. For the researcher, online journals aggregator system will be a means to choose, like and keep journals that are considered according to the scientific field, so it will facilitate researchers to obtain information related to the journal. As for the general public, the online journals aggregator system will provide search facilities in journals, articles and authors in the same system [8].

II. LITERATURE REVIEW

A. *Scientific Journal*

Scientific journals are considered the primary source of information or the most important in science and technology. Scientific journals contain a collection of articles published periodically, written by research scientists to report on the results of his latest research. Therefore, the existence of scientific journals is essential to advance science and technology. Writing or articles published in scientific journals, has passed the process of peer-reviewed and rigorous selection of experts in their respective fields. This peer-reviewed process is run to ensure the quality and validity of the scientific articles that are published. Publication of research results is an important part of scientific methods. Writing in scientific journals is intended for researchers and other experts in the same field. Articles in a journal should be clear, so an independent researcher can repeat his experiment or calculation to verify the results of his research. Articles in journals will be part of the permanent scientific record [1].

B. *Aggregator System*

Aggregator refers to a website or computer software that collects certain types of information from various online sources. As for the types of aggregator system [3]:

- Data aggregator, an organization which involved in collecting information from a detailed database of individuals and selling information to others.
- News aggregator, a computer software or website that collects news from other news sources.
- Search aggregator, software that runs on the computer user and retrieves, filters, and organizes searches from various search engines
- Video aggregator, a website that collects and organizes online video sources
- Blog aggregator, a website that collects and organizes the source of the blog
- Payment aggregator, a software which handles payment transactions and completes the final settlement.
- Smart grid aggregator, an entity that directly or indirectly controls the energy consumption of the various sources of energy distributed.

C. *User Centered Design (UCD)*

It is a new paradigm in the development of web-based systems. UCD is defined as "efficiency" The practice of designing a product so that users can perform required operation, service, and supportive tasks with a minimum of stress and maximum of efficiency [4].

UCD or User-based design is a term used to describe design philosophy. The concept of UCD is the user as the center of the system development process and purpose/nature, context and environment systems are all based on user experience [5].

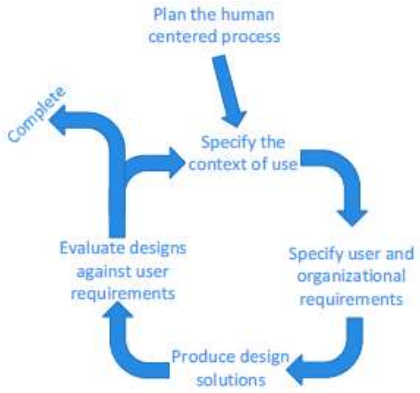

Fig. 1. UCD Working Process

The principle to be considered in UCD is [6]:

- Focus on the user
  Design must be directly related to the actual user or prospective users, for example through interviews, surveys. The objective is to understand the cognition, character, and attitudes of users and characteristics. Its main activities include data retrieval, analysis and integration into user design information about task characteristics, technical environment or organization.
- Integrated design
  The design should include the user interface, help system (how to use), and technical support such as software and hardware required.
- From the beginning continues on user test
  The only successful approach to designing user-centered system is empirically necessary observations about user behavior, evaluation of feedback carefully, insightful solutions to the existing problems, and a strong motivation to change the design.
- Interactive design
  The system being developed must be defined, designed, and performed multiple tests. Based on the results of behavior tests of the function, it will also be drawn of conclusions about the success rate of the product (application).

D. *Web Technology*

The terminology of a website is a collection of web pages, usually summarized in a domain or subdomain within the World Wide Web (WWW) on the internet. A web page is a document written in HTML (Hyper Text Markup Language), which is

almost always accessible via HTTP, a protocol that conveys information from the servers of those websites can form a very large information network. The pages of the website will be accessible through a URL which is called the homepage. This URL sets the pages of the site to be a hierarchy, even though the hyperlinks on the page set up the readers and tell them the whole composition and the current part of the information flow. Some websites require a subscriptions (input data) so that users can access the site. [7]

III. RESEARCH METHODOLOGY

A. *Data Collection Method*

The method of data collection and design of information systems are as follows, shows in figure 2:

- Interview: are conducted to interact directly or indirectly with parties involved in the journal community that is journal managers, authors / researchers and community members who need access to journal.
- Observation: this observation is done by observing directly on the research object and the developed unit. Because researchers are in a position that is also as a user, then this activity is relatively easier to do. In addition, online systems in the field of journal into a medium to make comparisons with systems to be developed.
- Literature review: the literature used, either in the form of library books, research results and other sources.

B. *System Design Method Using UCD*

The method used in the software design is the User Centered Design (UCD) method. This method is a method that sets the user as the center of system development. The process of User Centered Design (UCD) Method which includes 5 processes as follow:

- Plan the human centered process
  At this stage a discussion of the people who will work on the project, to get a commitment that the project development process is centered on the user. The project will have the time and task to engage users in the beginning and end of the process or where they are needed. And also the people who work on the project should be know well about this User Centered Design (UCD) method through literature, training or seminar studies.
- Specify the context of use
  Identify the person who will use the resulting product. This will explain for what and what conditions they will use the product.
- Specify user and organizational requirements
  Identify user needs and organizational requirements.
- Product Design Solutions
  Build design as a solution of the product that is being analyzed.
- Evaluate design against user requirements
  To evaluate the design whether the user and organizational objectives have been achieved.

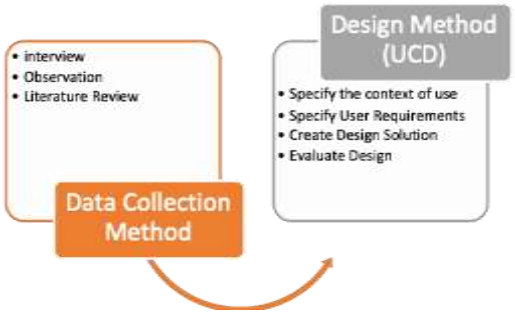

Fig. 2. Research methodology

IV. RESULT AND DISCUSSION

System development method used in this research is by performing step by step on User Centered Design (UCD) method. This method focuses on the user's aspect, so there is often a misperception in pairing it with other software development methods, such as prototype, waterfall and so on. This method can stand-alone or be used in conjunction with another methods.

A. *Plan The Human Centered Process Component*

At this stage the researchers conducted a literature study. The activities conducted by reading and understanding the textbooks, scientific journals, and other media related to data processing systems in general. This is to emphasize that the design of an application system using User Centered Design (UCD) method can meet the wishes and expectations of the users.

B. *Specify The Context Of Use*

Entering this stage, the researcher will identify the users who will use the system and explain for what and what conditions they will use this product through the technique of identify stakeholders. This journal aggregator system is designed to provide information that is primarily concerned with the needs of journal managers, researchers and the general public. The information presented on this web portal system contains data:

- Journal profile data
- Journal manager data
- Researcher profile data
- Journal transaction data
- Abstract and paper data
- Journal category data
- News data

The user target of the online journals aggregator system consists of 3 users, shows in table 1.

Table 1. Target User Of Aggregator Journal Online System

No	User	Function
1	 **Journal Manager**	Users who can input data journal, can find and inform Potential Authors, can favor author's abstract, inviting partner, do journal transactions with author
2	 **Author/Researcher**	Users can search for journals according to the field, can favor the journal, uploading abstract, do journal transactoins with journal manager
3	 **Visitor**	Users who can search the journal, find the author's information, and download the paper

C. Specify User And Organizational Requirements

Entering this stage the researcher identifies the list detailed of user's need. Based on a survey of potential users of the system there is an information that is required related to the activities of system design, such as :

Functional needs:

- The system can process the data of the researcher / author
- The system can process journal manager data
- The system can process the profiles data of researchers / authors
- The system can process journal data
- The system can process journal category data
- The system can perform a search of the journal
- The system can search the researcher / author
- The system can upload abstract papers
- The system can favor the journal
- The system can be distributed journal invitations
- The system can favor an abstract paper
- The system can provide confirmation paper
- The system can spread news related to the journal

Non-functional needs:

- The system was built using MySQL database with PHP programming language, CSS and web framework
- The system works well as long as it's connected to the internet with standard bandwidth
- There is no specific users to use this system.
- This system requires an operating system (Windows, Linux) and a web browser to access the system
- It has an user friendly interface that is easy to understanding user
- The system should be able to protect data from unauthorized access.

D. Product Design Solutions

It is the stage of design solutions, where researchers build the design form as a solution of the system to be developed. The prototype system is started from the global to the detailed form will be elaborated on this aspect.

- Main display which include : Login interface, Manage Journal interface, Manage Journal details, Spread the journal invitation interface, Manage News interface, Manage User interface, Search the Author/ Researcher interface, Journal Search interface, Journal View interface, Upload Abstract interface, Manage Papers interface, Manage Researcher Profile interface, Favorite journal interface, Search interface
- Additional displays that include information about links coming from various external sources of the organization. For example from Dikti, LIPI, Arjuna, OneSearchID, and so on.

E. Evaluate Design Against User Requirements

This stage is the evaluation stage of the design that has been done tailored the users needed. This evaluation was conducted to find out the design progress generated in accordance with the user needed.

V. CONCLUSION

By using UCD method for designing online journals aggregator system, the resulting system gives more satisfaction to users and increases the usefulness of the system itself because since the beginning the user has been involved. The main key to the success of system design using the method is to develop a harmonious proximity between system developers or programmers with users, in order to obtain the actual needs and desires of the user. For systems that require precision and high accuracy, collaboration is required with other software development methods so the perspective is used as a benchmark in system design not only from the user side only.

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Low Cost Data Analytics Implementation on Project Management Process Automation

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***Abstract*— Project management practice used many tools to support the process of recording and tracking data generated along the whole project. Project analytics provide deeper insights to be used on decision making. To conduct project analytics, one should explore the tools and techniques required. The most common tool is Microsoft Excel. Its simplicity and flexibility make project manager or project team members can utilize it to do almost any kind of activities. We combine MS Excel with R Studio to brought data analytics into the project management process. While the data input process still using the old way that the project manager already familiar, the analytic engine could extract data from it and create visualization of needed parameters in a single output report file. This kind of approach deliver a low cost solution of project analytics for the organization. We can implement it with relatively low cost technology on one side, some of them are free, while maintaining the simple way of data generation process. This solution can also be proposed to improve project management process maturity level to the next stage, like CMMI level 4 that promote project analytics.**

***Index Terms*—project management, project analytics, data analytics.**

I. INTRODUCTION

Monitoring is an important project phase in project management processes. It consists of gathering information about current situation of the project and compare it to its baselines (Mahaney & Lederer, 2003). The result then used by the project manager, project sponsors or even top management to create strategic decision upon the project situation in order to maintain the project performance (Mahaney & Lederer, 2010). Feedback that given to the team by analyzing the progress report that is an output of monitoring is also an act of maintaining project performance (Akhavan Tabassi, Roufechaei, Bakar, & Nor'Aini, 2017). Monitoring believed could reduce performance deviation and set the declining performance back on track (Chang, 2017).

II. LITERATURE REVIEW

From the author's experience with the CMMI certification process at the software development company a few years ago, noticed that there are still many processes in project management that are done manually. Starting from data input to report generation.. There is nothing wrong with that. But when we talk about CMMI for development, at process maturity level 4 and above, then the criteria requirements are (1) quantitatively managed, (2) analyzed and (3) continuously improved (Chaudhary & Chopra, 2017, p. 13). We will discuss the first two points.

The meaning of the quantitatively managed is more or less the use of data in every process of planning, execution and monitoring and control of the project (Chaudhary & Chopra, 2017, p. 13). It does not matter whether data is collected manually or automatically, which is important when performing an action there is data that underlies its decision making.

In project management process usually there are activities of information distribution in a project which include making periodic report like: (1) Project status report; (2) Progress report; (3) Trend report; (4) Forecasting report; (5) Variance report (Mulcahy, 2013, p. 393).

Each report has a specific purpose. The status report contains explanation about the position of the current project. Progress report present the percentage of progress in project positions compared to previous period positions. Trend report present a significant trend toward the direction and velocity of project parameters such as time, scope, cost, quality and resources. Forecast report present the approximate direction and achievement of those parameters over the next several periods. While the variance report present deviations that occur from the

planned position at the beginning or last time, which is often called the baseline.

The making of such reports is usually based on data entered either daily or periodically by the entire project team and most likely stored in separate systems according to their respective functions. Quality related data for example, can be extracted from the issue management or bug tracker software application used by the team. The programmer and tester who is responsible for the process of input and update data.

Analytics can be defined as a method to use the results of analysis to better predict customer or stakeholder behaviors (Singh, 2016). Implementation of data analytic can start from this point. Project analytics provide deeper information and a lot of metrics useful for decision making (Stolovitsky, 2011). Current status information, in terms of coverage, cost, time, quality and others, which generated periodically (Mavenlink, 2013), are sources of data that can be used for analysis and generate new insights for the organization and control process of projects, depending on the type of analysis process used, whether descriptive, diagnostic, predictive, or prescriptive (Declues, 2017).

To combine the process of analytics with project management, the first thing we do is to make sure that the underlying processes run with high discipline. The process meant here is the process of data input and update. Make sure it works. In a software development environment that has been CMMI level 3 certified usually ensures the processes are running well by conducting periodic audits. This audit process is usually done by process quality assurance (PQA) or software quality assurance (SQA) (Chaudhary & Chopra, 2017, p. 76). There is a suite of tools for auditing that tracks for every change occur and ensures that all the necessary processes are executed in a disciplined manner.

Project management tools that are equipped with analytics module are rarely found in cheap price. Let's say SAP PPM, that has almost everything you need to run an enterprise scale program and project management, complete with its visual analytics dashboard, can bring high implementation cost or total cost of ownership to organization. Assumed that the implementation itself is successful, if not, it will bring another sunk cost. In this paper we propose a low cost solution that also quite common to the users. Microsoft Excel is a common tool for project managers, it is a basic handy swiss army knife for them to use. Relatively cheap, with only $8.25/month for Office 365 or $399 for one time purchase of Office 2016 [14].

III. METHODS

Because there are ten knowledge areas in project management as seen on table 1 (Project Management Institute, 2013, p. 61), we limit the scope of this experiment on Quality Management area only, with specialization on issue tracking which still related to task management topic.

Table 1 Project Management Knowledge Areas.

No.	Knowledge Area
1	Project Integration Management
2	Project Scope Management
3	Project Time Management
4	Project Cost Management
5	Project Quality Management
6	Project Human Resource Management
7	Project Communication Management
8	Project Risk Management
9	Project Procurement Management
10	Project Stakeholder Management

Issue data are collected and stored in MS Excel file that already has a preformatted table. The Excel file then served as input to our analytical engine build on R platform. R is chosen because of its flexibility and the ability to create customized analytical report using the code (RMarkdown). List of reasons why R is chosen could be described as below: (1) Flexible, easy, and friendly graphical capabilities that can be displayed on the video display of your computer or stored in different file formats; (2) Data storage facility to store large amounts of data effectively in the memory for data analysis; (3) Large number of free packages available for data analysis; (4) Provides all the capabilities of a programming language; (5) Supports getting data from a wide variety of sources, including text files, database management systems, web XML files, and other repositories; (6) Runs on a wide array of platforms, including Windows, Unix, and macOS; (7) R is free (Hodeghatta & Nayak, 2017, p. 21).

The architecture of the solution is presented in figure 1.

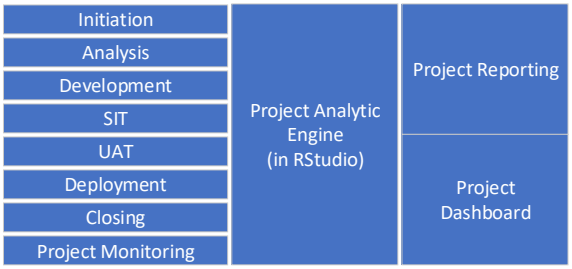

Figure 1 High Level Architecture Diagram.

The Excel file is acting as the data source and will be on its position in the left side of the architecture diagram. It is used by the project to store related data in simple manner. Each stage of the software development project has its own directory that store related Excel file. In example, the SIT Result is stored in SIT folder. The Task List can be stored in Project Monitoring directory. The project analytic engine will then open the file and read all data from selected table. The data will go through a transformation process if necessary and resulted in a *tidy data* ready to be processed.

The project analytic engine itself is a module consists of codes that doing the data analysis. The result of the data analysis process is a table filled with result data. Result data then visualized in charts as a project dashboard component or dumped in a conventional project report. All steps can be done in a single program file including the visualization and report formatting. The last result is an MS Word file contains the analysis descriptions, necessary tables and charts.

The solution model used in this experiment could be summarized with this block diagram:

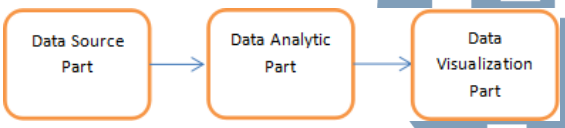

Figure 2 Block diagram of the solution.

There are three parts that comes into play. First part is the Data Source part, dealing with the data input and files that the project management process deal with every day. Second part is the Data Analytic part, dealing with the data extraction (ETL), data analysis processes, and result preparation. Third part is Data Visualization part that deals with the process of shaping the data into visual easy-to-read graphs.

All parts are actually code modules in reality. Data Source part consists of the data file itself and code module that open the file and extract its data into R table. In the real situation the file to be extracted could be in any format, whether it is .csv, MS Excel, or even XML file. As long as the format could be read by the R language program. The Data Source part function can also be extended to include the ETL (Extract, Transform and Load) process. Converting the raw data into tidy data that ready to be processed by the Data Analytic part, or we could say the Analytic Engine.

The Data Analytic part is a code module that contains algorithms or methods, whether it is statistical or not, that deals with the extracted data. From one Data Source part, we can build and connect to multiple Data Analytic part. Each of the module serves specific analytic process.

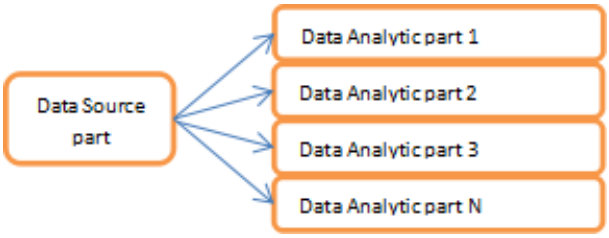

Figure 3 Data Source and Data Analytic part connection.

After the analytic process has been done in Data Analytic part, usually the result data is thrown into visualization module, and it is accommodated by the Data Visualization part. This part consists of codes that draw any model of chart, tables, dashboard components, or anything that can be seen on screen. The relationship between the Data Analytic and Data Visualization part are one-to-many relationship as illustrated on figure 4.

Figure 4 Data Analytic and Data Visualization part.

The connection illustrated above means that for each Data Analytic part that give a result data, we can build many visualization modules to visualize specific requirement (i.e. bar chart, pie chart, line chart, 3D chart, reports etc.) with the same result data. In real case, there can also happen only one Data Visualization part connected to each Data Analytic part. Just make sure to follow the requirements.

All this sequence of process is run in R Studio. We choose this tool and programming language because it is a quite handy tool and relatively easy to understand programming language. R is well known programming language that already used among statisticians. R Studio is used not only to develop the code modules but also to play with the data itself.

To deal with the process of development, we also offer steps to be followed on developing the solution. As illustrated on figure 5, the first step is Data Preparation. In this step, we design the data structure and fill it testing data or if we are in a real project, we can use real data.

The second step is Data Cleaning which consists of cleaning the garbage data that splattered across the data block. Removing data that do not fit to be included in analytic process will make our result more accurate.

The third step is Development of the Data Source part. Codes that functioned for accessing the MS Excel file (data source file) are built in this step. It is

including the transformation from raw data into tidy data. After the development is finished, then testing can be conducted on Data Source Testing step where we conduct the testing for Data Source code module.

The fourth step is Development of the Data Analytic part. Here we build the analytic engine for our solution. Algorithm, business rules and formulas are combined to compose an analytic engine that fit for our solution. This step is followed by Data Analytic Testing step which consists of testing the analytic engine using the testing data.

The fifth step is Development of the Data Visualization part. After the analytic engine finish the analytic process, the result data will be produced.

Data Visualization codes read that result data and create a chart or any other dashboard elements to make the data easily read and understand by business users. This step is also followed by its testing step pair.

Here, we could state that the development phase is done. Every steps of development should be paired with their related testing steps. In advanced software development life cycle used by Java, .NET or Python developer, there are unit tests to run along with the development of the code. In R we still don't have that kind of mechanism, but we can substitute it with other kind of test that show similar purpose.

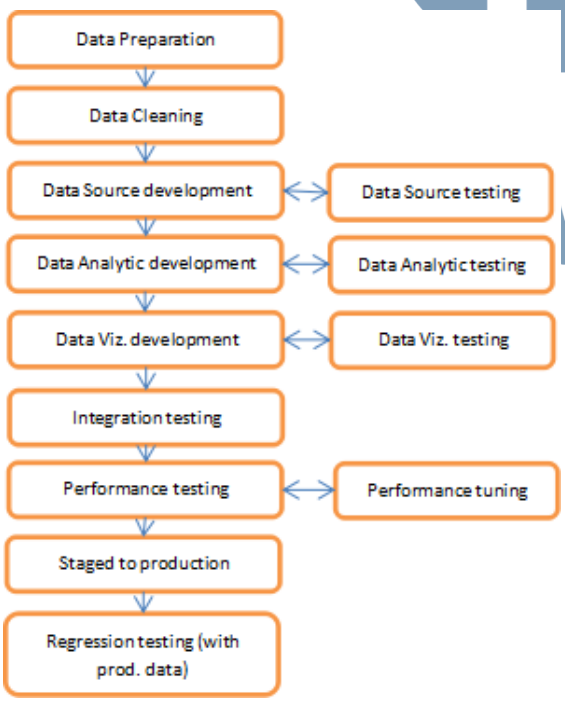

Figure 5 Suggested sequence of the implementation.

When all the code modules are integrated, integration testing is conducted to test the overall data processing and analytic process. In this step we run all integrated part from Data Source to Data Visualization and using testing data for that purpose.

After the integration testing is done, we move to the next step which is Performance Test. On this step we conduct a load and performance testing using a huge volume of testing data to see how our analytic engine and overall modules behave with that kind of situation. Stability is the key to pass this test, but of course a performance threshold should have been set as the expected minimum performance limit. Any instability at number below that minimum limit should be fixed by doing tune up to any of the modules, enhancing the algorithm or upgrading the hardware and network used. This all done in Performance Tuning step.

After the minimum performance limit is achieved, we promote our solution into the production server. Regression test is then conducted after the deployment process finished. Regression test means testing all of the features once again to confirm the readiness of the solution. Real data is used after the regression test finished.

Table 2 The pre-formatted Excel table for task management.

Field	Types	Description
NO	String	Sequence number
TASK ID	String	Task id
SUB PROJECT	String	Sub project / module name
PROJECT PHASE	String	Project phases number (phase 1, 2, ...)
SDLC PHASE	String	Phases of SDLC (analysis, development, etc.)
TASK NAME	String	Task name
DESCRIPTION	String	Task description
PIC	String	PIC responsible for the task
STATUS	String	Status of the task (open, in progress, closed)
PLANNED START	Date	Planned start date
PLANNED END	Date	Planned end date
ACTUAL START	Date	Actual start date
ACTUAL END	Date	Actual end date
LAST LIFE	Integer	Last modified date
LIFETIME	Integer	Difference between actual start and last life
PLANNED DURATION	Integer	Difference between planned start and end
ACTUAL DURATION	Integer	Difference between actual start and end
REMARK	String	Optional remark

We have discussed the input or data source part of the architecture. For the ETL section, analytic engine and data warehousing we can choose technology that is not too complicated and cheap. In this experiment, I chose to use a lightweight and very flexible R studio. One with little experience of R

programming skills will be able to create lightweight ETL modules and customized analytic engine. Another tool that also good to be used is Jasper ETL.

There will be some examples of the results of the analytic engine output encoded in R. Excel file contain related task tracking is used as input or data source. While the output is some graph indicators that can be used as a dashboard component, or just information for management.

The ETL process in R Language is described with modules of code. The first module is building *Task lifetime per module* data as follows:

```
library(xlsx)

project_data <- read.xlsx("pm-analytics/Task List.xlsx", sheetIndex=1, header=TRUE)

#lifetime per module

duration_per_module_max <- tapply(project_data$LIFETIME, project_data$SUBPROJECT, FUN=max)

duration_per_module_min <- tapply(project_data$LIFETIME, project_data$SUBPROJECT, FUN=min)

duration_per_module_avg <- tapply(project_data$LIFETIME, project_data$SUBPROJECT, FUN=mean)

m_duration <- as.matrix(duration_per_module_min)

m_duration <- cbind(m_duration, duration_per_module_avg, duration_per_module_max)

colnames(m_duration) <- c("min", "avg", "max")
m_duration <- t(m_duration)

colours <- c("green", "yellow", "red")
```

The analytics and custom report generation process is as follows:

```
## 1.Task Lifetime per Module
par(mar=c(8.75,4,1.5, 0.1))

barplot(m_duration, main="Task Lifetime per Module", ylab="Duration (days)", ylim=c(0,5+max(m_duration)), las=2, beside=TRUE, cex.names = 0.8, axis.lty = 1, col=colours)

legend("topleft", c("min","avg","max"), cex=0.7, bty="n", fill=colours)
```

The resulting graph is as follows:

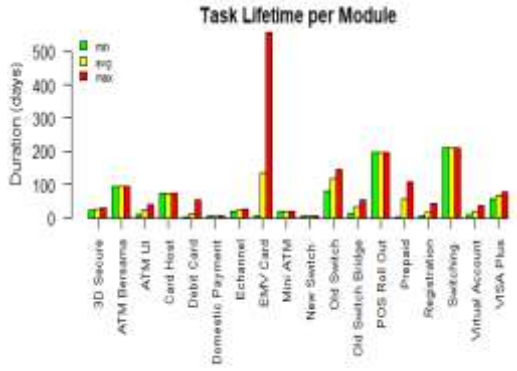

Figure 6 Task lifetime per module.

The second module is building *Task lifetime per phase* data as follows:

```
## 2. Task Lifetime per Phase

duration_per_phase_max <- tapply(project_data$LIFETIME, project_data$SDLC.PHASE, FUN=max)

duration_per_phase_min <- tapply(project_data$LIFETIME, project_data$SDLC.PHASE, FUN=min)

duration_per_phase_avg <- tapply(project_data$LIFETIME, project_data$SDLC.PHASE, FUN=mean)

m_duration <- as.matrix(duration_per_phase_min)
m_duration <- cbind(m_duration, duration_per_phase_avg, duration_per_phase_max)

colnames(m_duration) <- c("min", "avg", "max")

m_duration <- t(m_duration)
par(mar=c(6,4,1.5, 0.1))

barplot(m_duration, main="Task Lifetime per Phase", ylab="Duration (days)", ylim=c(0,5+max(m_duration)), las=2, beside=TRUE, cex.names = 0.8, axis.lty = 1, col=colours)

legend("topleft", c("min","avg","max"), cex=0.7, bty="n", fill=colours)
```

The resulting graph is as follows:

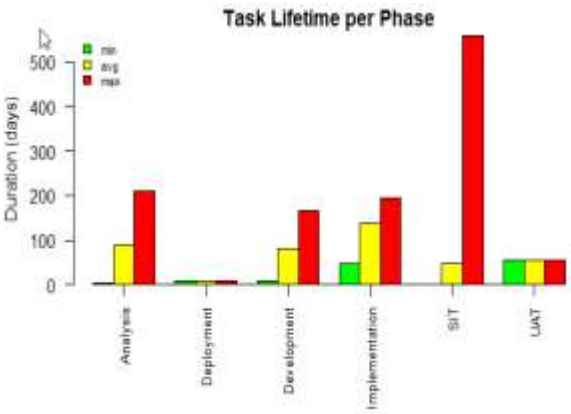

Figure 7 Task lifetime per phase.

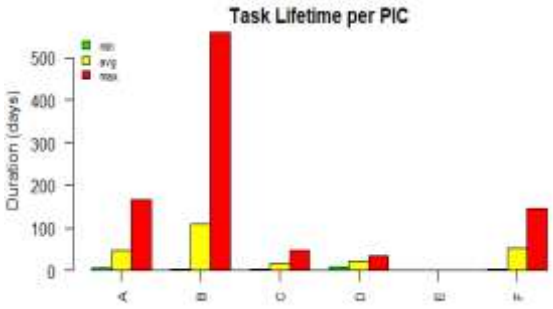

Figure 8 Task lifetime per phase.

In addition to those previous two graphs, we can also create your own other charts according to our own needs. Determine what information we want to dig from existing data, then write the code and run it. Or if we use tools like Jasper ETL, we can set the scheduler to do it periodically.

IV. Discussion of The Result

Experiment conducted with real project data of task tracking resulting in a quite satisfying result. A well formatted report in MS Word format is produced by the Data Visualization part, contains three charts: (1) Task lifetime per module; (2) Task lifetime per phase; (3) Task lifetime per PIC (Person in Charge).

More charts could easily be added into the report as required. The process of report generation also fast, below 0.5 seconds. User should trigger the process of report generation by selecting menu from inside R Studio.

The time taken to run the whole parts are listed below (experiment is repeated ten times) in Table 3:

Table 3 Time required for execution

Experiment	Time (Sec.)
1	0.4258
2	0.4358
3	0.3498
4	0.4188
5	0.4298
6	0.4198
7	0.4169
8	0.3570
9	0.4318
10	0.3510

This time required is directly proportional with the size of data being loaded, transformed and analyzed. The bigger the size of data, the longer the time required to process that data. Performance tuning is needed if huge data volume is involved. But for small or tiny volume, ranging from 10 KB to 1 MB the performance tuning step could be skipped.

The chart produced by the analytic process is useful to determine which module, phase, or even people in charge have a high contribution to a delay time or risk of delay of related project. From figure 6 there are three kind of information could be spotted: (1) The days spent to resolve an issue or finish a task (resolve time). We could see that days spent is very high, around 250 days maximum, and this shows us that vital problems are happening right now in the project and top levels management involvement is needed. (2) The module that has a maximum risk of delay. From the chart, which shows us that EMV (Europay, Mastercard Visa) Card module has the highest contribution to project delay, we could draw a conclusion that this module is quite complex, or has a complex level of coordination needed to develop it. (3) The rank of problem priority level, the top three are EMV Card module, Switching and POS Rollout related tasks. The longer the time for resolving an issue or finishing a task related to a module give us insight that the module probably still has lots of gray area on its specification.

The result of second module, Task Lifetime per Phase can be seen on figure 7. From the chart we can draw some conclusions: (1) The SIT (System and Integration) phase has the maximum resolve time, but its average is quite low compared to Development, Implementation and Analysis phase. The Project Manager should escalate the issue that has maximum resolve time to steering committee. (2) The Analysis, Development, and Implementation phase are definitely at high risk. Problems are happening at those phases. At Analysis phase some requirements or specifications are probably still unclear. At Development phase the problem could be waiting interrelated modules to be finished, dependency to external modules developed by other team, or unclear technical specification. At Implementation phase the problem is usually happen on the deployment preparation.

The third module chart on figure 8 shows us who is the most problematic person in the project. The longest time consecutively taken by D, A and T to finish their tasks. The management or resource manager should check the person whether he or she is overloaded with many tasks or there is a performance problem.

Suggestions for improvement: This experiment is only a small part of the overall project management process. If we want to apply it we can start with the following steps: (1) Standardize all the data input and update processes, along with the output format; (2) Create Extract-Transform-Load (ETL) scenario and analytics engine applications for each need, grouping

per knowledge area (Integration, Scope, Cost, Time, Quality, Communication, HR, Risk, Procurement, Stakeholder).

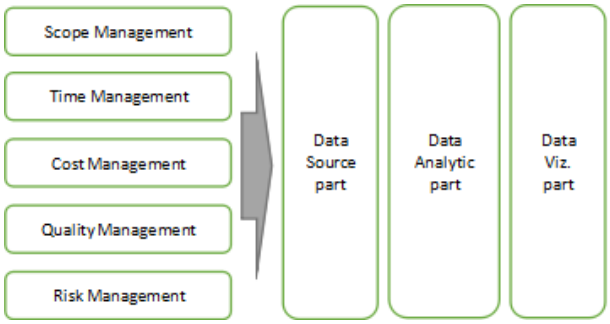

Figure 9 Block diagram of larger suggested architecture.

The suggested architecture shown in figure 9 consists of specific folders on left of the Data Source part. Each of this folder contains project management data file specific to its knowledge area. The Data Source part grab necessary related data file from those folders. The Data Analytic part analyze the data, then give the result to the Data Visualization part. The process of these three core modules could be in build as synchronous or asynchronous processes. The result of this larger solution is a global view of project dashboard that showing all aspects related to project management knowledge areas. Each knowledge area could have more than one measurement metric, so the global dashboard will be very rich with project indicators. This condition also applies to report generated by the solution. We could use the report as a basis for periodical project monitoring and control, project health check, and steering committee meeting; (3) Choose a tool that is good enough and can accommodate process automation.

V. CONCLUSION

Toward the achievement of CMMI level 4 or analytical project management process, we could combine the mainstream tools with any data analytic tool. R language and R Studio are chosen because of their familiarity to use, support statistical methods, and support highly customization upon Data Analytic and Data Visualization parts.

Before we implement the solution, it is suggested that we should design carefully the data structure used in the Data Source part. This is to avoid any problem related to the data structure in the analytic process.

The overall solution should be able to run automatically. This is important when we're dealing with periodic reporting, or dashboard visualization. We could list the application we have developed into the system scheduler to gain the automation trigger.

Implementation of this solution could be done with all knowledge areas of Project Management Process included as long as there are any data management involved in its process or sub-processes. A good and computerized model of project monitoring combined with good mental model will increase the project's probability of success (Abdel-Hamid, 2011).

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Development and Evaluation of Digital ID card as a Portfolio Portal

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***Abstract*— Physical ID card has been use throughout history and are still widely use today. However, such physical characteristic leads to three drawbacks. First, it is not environmentally friendly due to printed materials. Second, Physical ID card requires the need for management and physical storage, prone to damage and lost. Third, information inside a physical ID card limited and cannot be updated. This paper proposes the use of digital ID card in the form of a mobile application as a substitute to physical ID card. A survey is conducted to evaluate the use of these digital ID card. It is then concluded that digital ID card can counter the downside of physical ID card and even provides features to enhance its role such as being a portal for information.**

***Keywords*—Digital ID, Information Portal, Mobile Application, Android.**

I. INTRODUCTION

The use of physical ID card is first introduced by King Henry V of England within the safe conduct act of 1414 [1]. It has then gone through a series of developments along the years including the standardized shape and size in the year 1985. And it is still widely used everywhere to exchange information between persons of interest. And even though physical ID cards makes it easier to exchange information because its small and portable size, it does have a couple of flaw due to its physical nature.

The first flaw of physical ID card is that it requires physical material. Printed materials such as matte or photo paper are the common material for an ID card. Printing large and repeated amount of ID card would not be environmentally friendly. This problem can be solved by the use of a digital ID Card. Although some bio-degradable or recycled paper are also use in the making of an ID card, a digital version of an ID card would lower the need of such material.

Another flaw of physical ID card is that it requires manual management and storage. Physical ID card is highly prone to damage from heat, water, time, pressure, scratch, and can also be lost. To store and to retrieve an ID card could also be laborious. Digital ID card would have no such drawbacks. It will be easily stored and retrieve.

Furthermore, information contained within a physical ID card cannot be updated. If a person changes his/her contact than he/she would be required to create another ID card. Today where contact and address keep rapidly changing, this will not suffice. The information contained within a physical ID card are also limited to the card's size and design. There are limit to the amount of information a physical card could contain. While as we could include more dynamic information inside a digital ID card.

These three flaws could all be accommodated by transferring the physical ID card into a digital one. A digital card would require physical material and can be stored and exchange through multiple media. A digital card could also be retrieved easily through a query. And the information within a digital card could also be updated and or changed with ease. And while it is related, this research will not discuss matters on government-issued ID card (E-KTP in Indonesian) as the goal of the research is to use the ID card on casual / business premises.

II. RELATED WORKS

Several works on using digital ID card as a replacement for physical card has been conducted. Knowee is a digital card provider where user can create their own card and exchange information over it [2]. But, knowee's information are limited to contact. Camcard is another alternative for digital card [3], while camcard offers more feature such as email and linkedin account search, information inside the card cannot be customized according to the user's need.

Inigo card provides team feature so that a team design and team information could be updated simultaneously [4]. Inigo also provide popular social media links Haystack card also provide these type of link [5] but neither of these cards provides customized number of link outside of social media or make them accessible in the card. This lower the value of these cards as a tool to introduce a person. There is also an effort to create an ID card to be used in the university context but it is limited to the purpose of arranging attendance of students [6]. A more complex approach

in this matter has been conducted by ONE Card, Where ONE card can be used as a payment tool or exam card. but this card is also very much limited use to only inside the university [7].

According to GlobalWebIndex [8] on average in 2017 a person has 7.6 social media. The uses of this media is actually quite similar to a digital card which is to store data of an indidual. Information on a person's interest and work are listed on these media. But there are also other media such as deviantart for arts or researchgate for academics which are specifics to a person's interest. This type of information can be more valuable to share among peers than the usual social media information. If an ID card were to stay relevant this information would need to be included with the card. Thus, A digital ID card with customized portal link to this information is proposed.

Adding information to a limited size card would require management of space. If a digital card would like to be customized in terms of information. It should also be customized in terms of looks and positioning. This is also important because style and design is one of the key interest elements in a physical ID card. This paper proposes to provide solution to providing more information and storing them in a digital ID card. Thus preserving the benefit of traditional ID card in a digital one.

III. METHODOLOGY

The common information within an ID card consist of name, address, and contact (by e-mail, phone number, etc) [9]. This information is useful when they are exchanged. While it is enough for today's daily uses, it can be so much more. Customized and personalized information has the potential to be even more beneficial. For example, an academic staff would normally be interested in knowing other academic's research interests, an artist would benefit from sharing a link to his/her portfolio. And while it is possible to post that information on social media, they are usually posted on other more specific media (to name a few: researchgate for academics, deviant arts for artist). The inclusion of such information inside an ID card is therefore proposed. However, there are problems that needs to be addressed beforehand.

First, there are a large of number of mediums to store information and the number keeps on growing. [Inside fact here if found]. So, a predefined list of sites and resource would not be sufficient in an ID card. The range of types of resources is also a problem that needs to be consider since there are so many. It is decided in this research to limit the type of resources to a URL. A URL as the name suggests is a universal resource locator, or a link in modern term. Using url we can link different sites and resources to be attached to our digital card. Hyperlinks are then added to the card so that users can directly access those resources.

The Second problem that arise is how to show that information unto the digital card. One of the reasons why ID card are popular is that it is concise and small in sizes. The ability to include personalized and customized link enables unlimited amount of extra information inside a limited amount of card spaces. While it is beneficial to include more information, too much information is not good. Too much information would distract reader from important link, it will also clump up the design and made it unaesthetically pleasing. Not to mention the placing of this information should also be put into consideration. To solve the number of link, it is proposed to keep the number of link to a maximum of 5. To solve the aesthetic and positioning problem, it is proposed to use a grid-based system to build the custom digital card looks.

The third problem is how to model the physical card into a digital card. Most of the digital mentioned in related works uses an image as digital card representation. The information stored within their software is then visualized unto that image. This system aims to minimize the difference between physical and digital card. While it has its benefits, this system has a downside, the information inside each card is static and does not allowed any interaction in the card itself. This leads to less interactive and less intuitive software. This research proposed using interactable component inside the digital card. By using this component, User can easily navigate desired information within a card.

A. Grid-based Positioning

To solve the problem with positioning, a grid-based component positioning system is developed. The digital card we propose consists of a M x N digital grid. After several initial adjustment we choose M to be 57 and N as 30 so the grID is not too small and too big. If the grID was too big, it will be hard to place a component according to the user's needs. If the grID was too small, it will take more memories to load or store them.

User are allowed to choose which information from their data they're going to show in the digital card. The data would have two information. The Title information is the information shown on the digital card. While the data information is the link connected to the title information. By doing this, users are able to attach any kind of information and data they wanted.

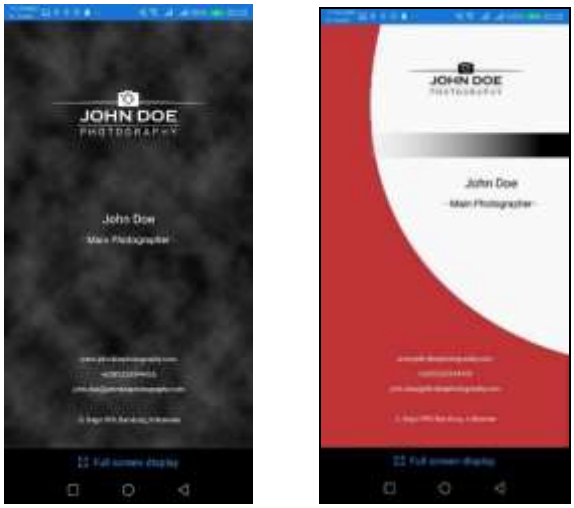

Figure 1 Card Interface

Shows an example of digital card created with the application. All the information on the card is perfectly update-able and dynamically linked to outside resources. The image also shows a different design template to show how the component can be moved across the digital card. This research uses several design templates as oppose to user customizable design, as the purpose of the research is to analyse and evaluate the use of the digital card.

B. Information Portal

Extra information is displayed in another page along with the QR code for the current card. Every information is comprised out of two elements: an identifier, and a link. User can then tap on the link to go to whatever information the user set beforehand. Figure 2 showed the user interface for extra information alongside additional button for additional feature such as scan QR for new card, library to search card and a profile page to edit information.

Figure 2 Extra Information

C. Card Exchange

One of the key factors in the success of physical ID card in its time is its portability. It is simple and fast to exchange information via those cards. Digital ID card should also be as simple and as fast to exchange with. There are a lot of ways to exchange digital information. And though it is possible to use them all in this application, Because of the limitation in time and resources, it is decided to implement a QR code interface for information exchange.

[{‘Key’:’Research Portofolio’,’Value’:’www.research.com’,’Link’,’www.researchgate.com/User=123124?’},{‘Key’:’Design’,’Value’:’www.deviantart.com’,’Link’:’www.deviantart.com/User=123124?’}]

QR Code basically are extensions of traditional bar code. QR code are two-dimensional bar code, able to store up to 7089 characters in a single code [7]. The other benefit of QR Codes are that it can printed in a smaller spaced, it is dirt and damage resistant, it can also be read from any direction [7]. In This research QR code are used to stored link to distribute a card. Which then turn allow the card to be exchange.

Information contained in the QR Code is the basic information of a card. The additional information of

{‘Id’:1,’Name’:’John Doe’,’Title’:’Main Photographer’, ‘Website’:’www.johndoephototgraphy.com’,’PhoneNumber’:’+6281223344555’.’Email’:’john.doe@johndoephotography.com’,’Address’:’Jl Dago 909, Bandung. Indonesia’}

the card is then acquired via web server when necessary. Figure 3 showed the information inside the QR Code in json form. Security feature for

information in this research has not yet been implemented but is advised for future works.

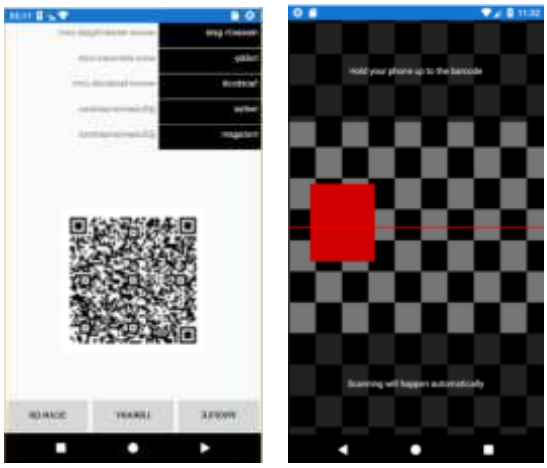

Figure 4 QR Code Interface

Figure 4 shows the Card Exchange interface using QR Code. When a user scans the QR code. Information in the QR Code will be transferred unto the receiver app.

IV. Application Design And Implementation

Aside from the information inside the digital card, several other information is needed to be stored inside the application. The information inside the digital card can be categorized into several item. The first type of information is the basic card information. This is the information usually stored inside the physical card. Person's name, address, phone number, email address is one of that information. The second type of the information is the portfolio information. This is the added information useful for the individual. Any link to any website containing resources or information of the individual could be stored here. This information enables the digital card to be a better representation of a person'.

Information on the application is stored in two separate places, in the mobile application and in the server. The mobile app stored the information inside an SQLite database. While the web server stored in the information in MYSQL database. The database inside the mobile apps only contains one table for user card.

Figure 5 shows a sample json for extra information. The field Key is the label for the information, The value is the label for the link, while the link is the url address for the resource.

Figure 6 shows an ER-Diagram for the application. The field ExtraInfo Contains json object for various information inside a card. This is done to prevent complexities in the Mobile Database.

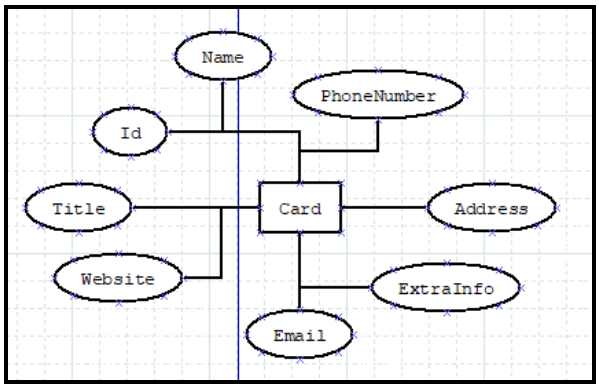

Figure 5 ER Diagram mobile application

Database inside the web server consist of 3 tables, the card info, the card extra information and the card connection. Figure 7 shows the ER-Diagram for the web server.

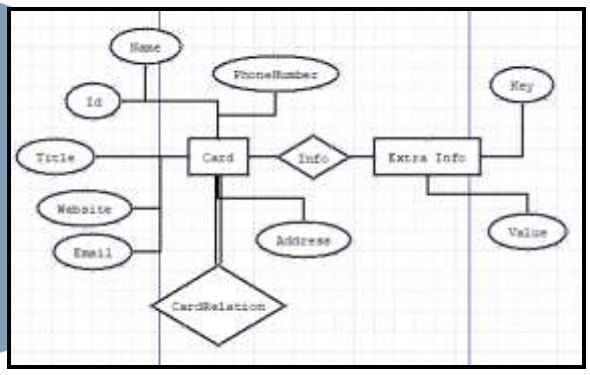

Figure 6 Sample Json for added information

The CardRelation table holds relation between each card. This enables the application to easily add a card and maintain the integrity of the information in the card. If the user changes the card information within the application, it will also change in the other application whenever it is connected to the internet to update its information.

The mobile application is structured in a MVC like structure as shown in figure 8. CardDatabase class is the controller part of the application which operates to manage card data through the help of web services. Web service is designed to control data exchange between server and mobile app.

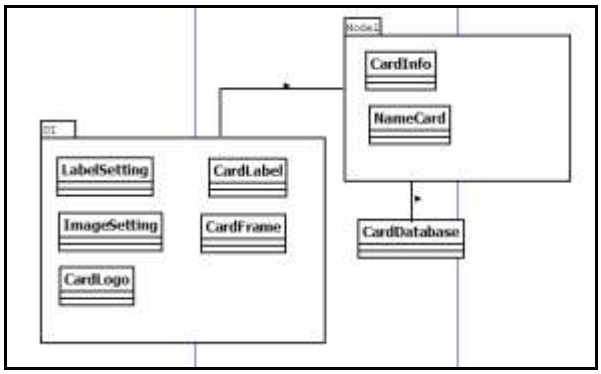

Figure 7 Class diagram for mobile application

V. EVALUATION

To evaluate the use and benefits of Digital ID card and its added feature, a survey is conducted. The survey conducted is modified based on the TAM (Technology Acceptance Model) [11] with and emphasis more on the perceived usefulness (PU). The survey is conducted on 3 types of individuals. Academics, university students to represent an interest group, and random individuals. From 50 response categorized in Figure , 70.6% are university student while 11.8% are academics. The rest of the data are from random individuals. The variety of respondent are shown in figure 9

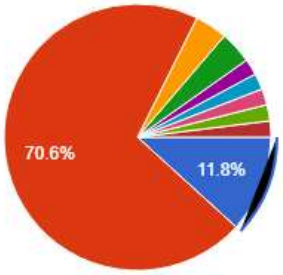

Figure 8 Survey respondent category

Every participant is given a set questions with the value of 1 to 10 as a qualitative answer. The following are the summary for the result of each question. Academics survey result was originally separated from the other group. But since it shows the same trend it was put back together for easy viewing.

Question 1: How useful it is to transfer from physical ID card to a digital ID Card?

Question 2: How useful is the added extra information on the digital ID Card be?

Question 3: How useful QR Code is to transfer card information?

Question 4: How efficient it is to search for card in digital ID Card?

Question 5: How useful is the ability to add/remove or change information in a digital ID Card?

Question 6: How important is customizable design in a digital ID card?

Question 7: How likely it is for u to transition from physical ID card to digital ID card?

Result for question 1: How useful it is to transfer from physical ID card to a digital ID Card?

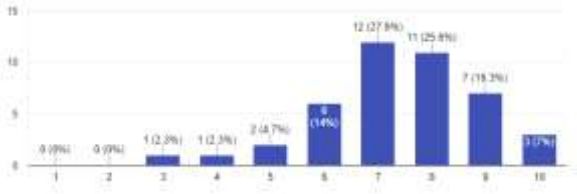

Figure 9 Question 1 result

From Figure 6 it is shown that 90.8% respondent feels that digital ID card is useful as oppose to physical ID card.

Result for question 2: How useful is the added extra information on the digital ID Card be? (in your profession)

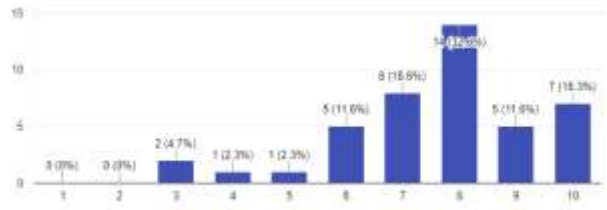

Figure 10 Question 2 result

From Figure 7 it is shown that 90.7% respondent feels that digital ID card is beneficial in their line of work. It is also important to note that Academics respondent results marks all above 7 point.

Result for question 3 : How useful QR Code is to transfer card information?

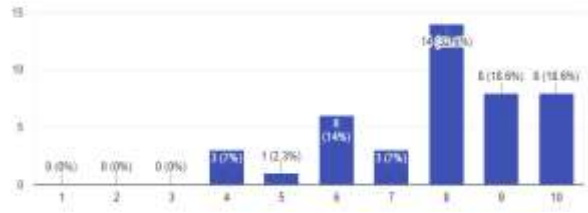

Figure 11 Question 3 results

From Figure 8 it is shown that 90.7% respondent feels that QR Code is useful to transfer card information. Academics results shows varied response but are all greater than 6 point.

Result for question 4: How efficient it is to search for card in digital ID Card?

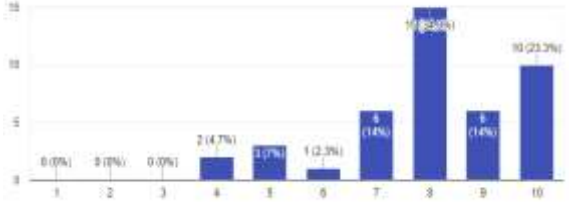

Figure 12 Question 4 results

From Figure 9 it is shown that 88.3 % respondent find it efficient to search for a card in the ID card application.

Result for question 5: How useful is the ability to add/remove or change information in a digital ID Card?

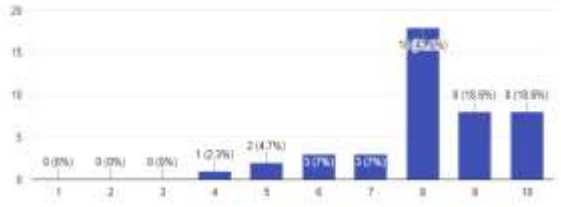

Figure 133 Question 5 results

From Figure 133 it is shown that 93% of respondent finds the ability to change information in the Digital ID card top be useful. Academics scored this question highly as well with all response are above 7 point.

Result for question 6 : How important is customizable design in a digital ID card?

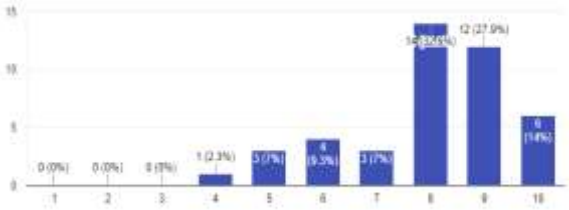

Figure 44 Question 6 results

From Figure 4 it is shown that a majority of respondent (74.5% answered above 7) thinks that it is important to have a customizable design in a digital ID card as shown in the application.

Result for question 7: How likely it is for u to transition from physical ID card to digital ID card?

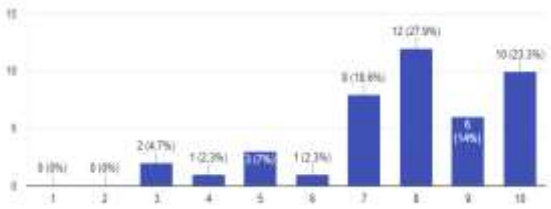

Figure 55 Question 7 results

Figure 5 shows that 86% of respondent claim to be more likely to transition to Digital ID card.

Aside from the question. Respondents are also asked to give a suggestion. Several notable insights coming from the respondent suggestions includes the inclusion of security features as the information inside could potentially be misused, hybrID integration by allowing the digital card to be printed and then scanned to digital, upgrade in user interface such as drag and drop capability, and other technology support such as NFC.

VI. CONCLUSION

From the survey conducted is then concluded that digital ID card is indeed more beneficial. It is also shown that information portal on Digital ID card is indeed beneficial to all respondent. Lastly, It is also shown that the proposed digital card are interesting enough as a replacement for physical card. There are some hesitation shown in the survey to transition into digital ID card (12%), but this is probably from other aspect other than its functionality as shown in other questions.

FUTURE WORKS

Additional feature needs to be added to support overall functionality of the digital cards. One of the most prominent features should be to implement security as the information contained in a digital card are all personal information that could potentially be misused. Other suggestions from the respondent can also be considered.

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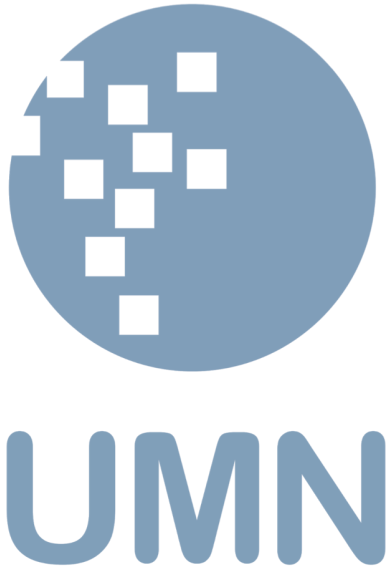

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ITIL 2011: The Maturity of IT Service Operation in Universitas Multimedia Nusantara, Indonesia

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***Abstract*—Information Technology governance (IT Governance) in the world of education is quite widely used including in Indonesia itself, for example at some educational institutes. The ITIL framework, used as a tool for evaluation, audit and also as a reference implementation. To help improve the Universitas Multimedia Nusantara (UMN) IT service in the service operation section, it is necessary to know the maturity level of the service, which is then done through the measurement of maturity level in the service operation section. In addition, the measurement results obtained can be used to produce the right recommendations with the problems found in the service. Measurements are made on the domain service operation which is the focus of UMN's IT department services. Service Operation has 5 indicators: incident management, problem management, access management, event management, and request fulfillment. In this research, the framework used in ITIL Version 2011. The result of this measurement has been found: incident management, problem management, event management, and request fulfillment get the result of measurement at level 1 and access management up to level 2. The result of the measurement and recommendation given is expected to be input material and become development material that can be used by the IT department of Universitas Multimedia Nusantara.**

***Index Terms*— Framework, ITIL, IT, IT Governance, Service Management**

I. INTRODUCTION

Today, Information Technology (IT) has been widely used in various fields, one of which is the world of education. The process of learning and information delivery will be better if using Information Technology (IT), not only uses conventional methods as before. In addition to helping the process of learning and information delivery, Information Technology (IT) can also be utilized to help IT management of educational institutions. [1]

Information Technology Department of Multimedia Nusantara University (UMN IT) has an important role in UMN as it is responsible for UMN IT infrastructure services. The UMN IT department has a service focus on the service operations section. According to Mr. Dwi Kristiawan as UMN's IT department manager, UMN's IT department does not yet have a framework to use as a basis of measuring and improving their services. Therefore, in order to help improve UMN IT services in the service operation section, it is necessary to know the extent of the maturity level of the service, which then does/ did through the measurement of the maturity level in the service operation section. In addition, the measurement results obtained can be used to produce the right recommendations of the problems found in the service.

The purpose of this research is to measure the maturity level of service department operation department of IT Multimedia Nusantara University and to give recommendation according to findings and impacts. This study uses the framework of ITIL 2011 as a research reference.

II. STATE OF THE ART

There is some previous research that used as a reference in this writing, namely:

In the first study, the study audited the maturity level of the Asset and Logistics Management Bureau information system at IBI Darmajaya at the management level using COBIT 4.1 as its framework. The measurement of the audit uses the Gallegos stages and obtains the results, ie the DS1, DS10 and DS12 processes on the Deliver and Service domains provided by the Bureau of Asset and Logistics management to IBI Darmajaya generally at the maturity level of the Defined Process, there is an expected maturity level at the managed level and measurable is at level 4 and the gaps that exist both at the user and management level do not show a large gap [2].

The second study has the object of research that is 51 organizations in several countries, among others: Austria, Germany, Switzerland, Mexico, Canada, America, Singapore, and the Philippines. The study was conducted using the COBIT framework and used

the maturity model in level determination. The study found that the overall level of process maturity in the study was relatively simple, there was a lot of inter-process variability in maturity with several processes and there was still variation between organizations in the process of maturity [3].

In the third study, research was conducted on PURSAIR's IT services to determine how well the services provided to users. The framework used in this research is ITIL V3. Measurements are performed on the domain service operation. This research has found that there are still deficiencies in some parts, ie there are no good human resource management in the company, no documentation process and clear flow of IT service process provided and the tools do not have a clear standard in their use [4].

III. METHODOLOGIES

The research method used in the measurement of the maturity level of governance of information technology domain service operation of the IT department of Multimedia Nusantara University is the framework of ITIL 2011.

The Information Technology Infrastructure Library (ITIL) is a collection of guidelines developed by the United Kingdom's Office of Government Commerce (OGC). These guidelines, which describe integrated processes, provide the best practice approach to managing IT services [5].

In the domain service operation consists of 5 pieces of indicators, including Incident Management, Event Management, Problem Management, Access Management and Request Fulfillment [6].

This research also uses the audit stages of Gallegos [2], namely:

1. Planning

   his stage is the first stage performed. At this stage, there are several things that must be considered. To simplify the execution of the planning then the hypothesis is determined first using 5W + 1H, namely:

   a. What is the method used in the research?
   b. Who is the resource person in question?
   c. Where is the research done?
   d. Why is the research done?
   e. How is the research done?
   f. When can the research implementation begin?

2. Field Inspection

   In a study, it is necessary to conduct a field inspection. In the current study, field checks were conducted to the UMN IT department. The first thing done at this stage is to interview with Mr. Dwi Kristiawan as a UMN IT Manager. After the interview, it was found that what happened to UMN's IT department was about the development or maintenance of UMN IT service, especially in the service operation section because of the development of the era, the adjustment must be done. In addition, improvements to errors and bugs also continue to be necessary. The next step is spreading the questionnaire. Questionnaires were distributed to obtain quantitative data which will be processed at a later stage. The results of the questionnaire indicate that from 5 levels 1 indicator in the domain service operation, there is an indicator that can rise to the next level of Access Management. Therefore, a 2nd level questionnaire was created for the indicator. The result of the questionnaire shows that Access Management stops at level 2.

3. Reporting

   The next stage is done by providing information on the results of interviews and questionnaires that have been processed. Processing information is done in accordance with the provisions of the maturity model that existed on ISO 15504. Questionnaire level 1 has respondents as many as 8 people with a statement of 60 items. It is known that the results of questionnaire level 1 obtained the result that there is 1 fruit indicator service operation that can rise to level 2 of Access Management. Then, the 2nd level questionnaire for Access Management was created by having 15 questions. The questionnaire was distributed among the UMN IT department. Respondents in the 2nd level questionnaire were 9 people. The results of the questionnaire obtained showed that Access Management stopped at level 2. After the results of the questionnaire obtained, then conducted an interview to verify the data has been obtained. The results of these interviews are then processed and analyzed to serve as findings, impacts, and recommendations.

4. Follow Up

   The last stage is the follow-up. This last stage is done by giving reports on research results that have been done. Recommendations and suggestions for IT departments are provided. Recommendations that have been given can be used as a reference by the IT department to make improvements and improvements to the department.

This study also uses the maturity level calculation that existed on ISO 15504 which is listed in the book [7].

There are 4 categories to determine whether an indicator can rise to the next level or not, as for the category include:

Table 1. Categories

Categories	Average Score
N *Not Achieved*	0% - 15%
P *Partially Achieved*	>15% - 50%
L *Largely Achieved*	>50% - 85%
F *Fully Achieved*	>85%-100%

Obtaining scores of each indicator is the average result of all respondents that have filled in the given questionnaire. In accordance with the provisions contained in Axelos [8], an indicator is said to rise to the next level when the average minimum score is> 85%.

IV. Result and Discussion

Here is an analysis and discussion of research based on the audit stages by Gallegos:

1. Planning

   The planning of this research can be aligned as follows:

   a. The first step is to request a license to conduct research to the IT department of Universitas Multimedia Nusantara.

   b. Grant permission and directly request permission to conduct research on measuring the level of IT department IT maturity UMN.

   c. Next, make an appointment with the IT department to conduct a meeting that will be useful for pre-interview.

   d. Pre-interview with Mr. Dwi Kristiawan as UMN's IT department manager. Pre-interviews were recorded to be made as transcripts.

   e. After getting the desired data, the data is then processed into a questionnaire.

   f. Questionnaire creation is done in accordance with the ITIL 2011 level 1 framework.

   g. The implementation of the questionnaire staged to the parties concerned with obtaining 8 respondents who are staff of UMN IT department.

   h. Processing the questionnaire and converting the data onto a determination value of measurement of the next level.

   i. Based on the result of questionnaire level 1 that has been obtained, there is an indicator that can go up to level 2.

   j. Creation of questionnaire level 2 is based on indicators that managed to level up with 15 questions.

   k. Spreading the questionnaire level 2 is done by obtaining respondents as many as 9 people.

   l. The results of questionnaire level 1 and level 2 are then processed and analyzed to make recommendations in accordance with the findings obtained.

   m. The next stage is to provide the recommendations that have been analyzed to the company for corporate IT governance can grow and achieve the desired target in accordance with the framework of ITIL 2011.

2. Field Inspection

   Here are the results of field inspections obtained based on interviews and questionnaires that have been done:

   a. Interview Result. In order to obtain more information about the focus of UMN's IT department services and the problems that occurred or experienced, interviews were conducted. The interview was conducted to UMN's IT Manager, Mr. Dwi Kristiawan. The questions are discussed around the problems with the department and are useful for verifying the results of the distributed questionnaires.

   Based on information provided by resource persons, UMN's IT department has problems with their service operations. The problems of the system are related to the development and maintenance that must be done in order to improve the quality and quality of the system and to fix the bugs in UMN's IT infrastructure.

   The first focus of services carried out by UMN's IT department is the service operation section. However, according to Mr. Dwi Kristiawan for the future did not rule out that IT departments will also focus on service design because according to him both things are mutually integrated.

   The second focus of UMN's IT department is security and safety. According to him, this security problem is very important because if the security of a system has a good level of security then people will believe and want to use

it. In addition, security is sensitive because it deals directly with confidential data that should not be accessed by just anyone. Therefore, the UMN's IT department is always doing development that focuses on this security problem so that security and safety on UMN's IT is not easy to be broken so that will not happen things that are not wanted.

b. Questionnaire Result. The making of the questionnaire was made based on the existing standards in the ITIL 2011 framework according to the ITIL Maturity Model and Self-Assessment Service manual. The questionnaire focuses on domain service operation because according to interviews that have been done with Mr. Dwi Kristiawan the focus on UMN's IT department is currently on the operation service. In the domain service operation there are 5 pieces of indicators used as a benchmark for the UMN's IT department. The indicators include: Incident Management, Problem Management, Access Management, Event Management and Request Fulfillment.

Result of Level 1 Questionnaire. Here is an average gain of a level 1 questionnaire that has been spread:

Table 2. Level 1 Questionnaire Result

Indicator	Average
Incident Management	76.46%
Problem Management	75%
Access Management	85%
Event Fulfillment	79.17%
Request Fulfillment	79.18%

Based on the results of the questionnaire obtained, on level 1 that managed to rise to the next level is access management with an average acquisition of 85%.

Result of Level 2 Questionnaire. The results of level 2 questionnaire of the access management indicators obtained an average of 84.16%.

3. Reporting. The target measurements specified are at level 3 for all indicators in the service operation domain of the UMN's IT department.

Figure 1. Result and Target

Figure 1 shows that the results obtained from the measurement of service level maturity provided by UMN's IT department are as follows:

a. Incident management level 1.
b. Problem management level 1.
c. Event management level 1.
d. Request Fulfilment level 1.
e. Access management level 2.

After the measurement results have been found, recommendations are made in accordance with the indicator. Recommendations made are recommendations for improvement and recommendations to reach level 3. Recommendations made are then provided to UMN's IT department. The recommendations are 158 total.

Table 3. Recommendations

Indicators	*Recommendation*
Incident Management	32
Problem Management	32
Event Management	27
Request Fulfillment	29
Access Management	38
Total	**158**

4. Follow Up. Recommendations made are then provided to the UMN IT department in order to obtain follow-up. Recommendations given to indicators Incident Management, Problem Management, Event Management and Request Fulfilment are recommendations for level 1 improvement and to reach level 2 and 3. Whereas, Access Management recommendation is recommendation level 2

improvement and to reach level 3. There are 158 recommendations provided with the following details:

a. Incident Management. There are 32 recommendations given to the incident management indicators. 16 recommendations have been approved, 9 recommendations are approved and done, 4 recommendations are approved with adjustments, 1 is considered and 2 has no decision.

b. Problem Management. There are 32 recommendations given to the problem management indicator. Of the recommendations, 12 recommendations have been approved, 12 recommendations agreed and done, 7 recommendations agreed with adjustments and 1 being considered.

c. Event Management. There are 27 recommendations given to event management indicators. Results obtained among other areas: 9 recommendations have been approved, 4 recommendations approved with adjustments and 14 recommendations being considered.

d. Request Fulfilment. There are 29 recommendations given to the request fulfilment indicator. A total of 12 recommendations have been approved, 8 recommendations approved and done, 2 recommendations agreed with adjustments, 6 recommendations are considered and 1 recommendation has no decision.

e. Access Management. There are 38 recommendations given to the request fulfilment indicator. A total of 30 recommendations have been approved, 2 recommendations approved and done, 2 recommendations approved with adjustments and 4 recommendations are considered.

V. CONCLUSION

The research was conducted at the service operation domain of UMN's IT department. There are 5 indicators that become the benchmark of measurement in this domain, among other: incident management, problem management, access management, event management, and request fulfillment. The framework used is ITIL 2011.

From the measurement result of the maturity model which has been done to UMN's IT department, the following conclusion can be drawn:

1. Based on the measurement of the maturity model that has been obtained then there are 4 pieces of indicators that remain at level 1, namely: incident management, problem management, event management, and request fulfillment. Meanwhile, access management indicators managed to increase from level 1 to level 2.

2. Recommendations made based on the findings found have received follow-up from the IT department and as many as 129 recommendations have been approved from the total of 158 recommendations. The average recommendation will be made in quarter 2, i.e. in April to June 2018.

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Development of Sales Modules for Agricultural E-Commerce Using Dynamic System Development Method

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***Abstract*—E-Commerce is a process model of selling and buying goods using information and communication technology. This business model offers a broad market for products owned by the seller. However this sales model is not yet common for agricultural products. Most of the process of buying and selling agricultural products is still done conventionally. The lack of agricultural e-commerce sites is the main reason for the research conducted. This research will develop an agricultural e-commerce system. This system has two main modules that are sales module and purchasing module. This article specifically develops sales modules for agricultural e-commerce. In the development of modules applied Dynamic System Development Method. The used of this model is based on characteristic of the project which have limited number of development team and short development time. The development stages consist of pre-project, feasibility study, business study, functional model iteration, and design and build iteration. In this study a prototype has been produced for the sales module on agricultural e-commerce that is being developed.**

***Index Terms*— Agricultural E-commerce, Sales Module, Dynamic System Development Method, DSDM**

I. INTRODUCTION

Agricultural business is a trade process related to the sale and purchase of agricultural commodities / products. Agricultural products can be in the form of agricultural crops, processed products of agricultural crops, tools and materials needed for agricultural processes. Nowadays, most of the trade in agricultural products is still carried out conventionally, that is, farmers sell their agricultural products directly through cooperatives, middlemen, or buyers who come directly to their place. The process of selling products that utilize information technology is still very minimal.

Marketing or selling products using information technology can be done through social media networks, blogs, and existing online sales sites. Any media used for sales and excess. Social media publications and blogs have a vulnerable level. In addition, this media is only used to express and offer products needed for the process of direct communication between sellers and buyers.

Online sales of agricultural products can also be done through several existing commercial e-commerce sites. However, these sites generally sell a wide variety of non-specific items of agricultural products. Whereas agricultural products have specific characteristics such as short product age, unit or size of sales of diverse products and specific product delivery processes.

Therefore, ongoing research conducted the development of an e-commerce application for agricultural products. There are two main business processes in the system: modules for product sales and modules for product purchases. Application development is using Dynamic System Development Method (DSDM). This paper specifically discusses the sales module on E-commerce agriculture being developed. The developed seller module aims to bridge between the seller and the e-commerce system. Through this module sellers can promote and sell agricultural products that they have.

II. LITERATURE REVIEW

A. Dynamic System Development Method (DSDM)

Dynamic System Development Method (DSDM) is a framework that contains knowledge about project management of a system. Initially DSDM was a framework used for software development processes. But the latest version of DSDM has been equipped with software development process, system engineering process, and business development process on the project, so the DSDM framework is now more general and can be used on various engineering projects [1]. DSDM is a framework that can support the completion

of projects on time and cost in accordance with the planning. This framework is prepared based on the successful experience of the development team in carrying out engineering projects. This causes DSDM to become a practical approach to flexible and practical project management [2].

The DSDM method was created in 1995 by a non-profit group in the UK. This method is a development of the Rapid Application Development (RAD) method and is an evolutionary model of its predecessor and successor. The DSDM method appears through the DSDM consortium not the result of scientific literature [3]. Therefore this method is practical as a result of the experience of practitioners skilled in engineering projects. This method continues to evolve from 2001 with the term "Agile" Framework, 2008 with DSDM Atern 4.2. and the latest version of 2014 DSDM is more compatible with several frameworks and other system development methods [4].

System development process in DSDM method consists of 7 main stages: pre-project, feasibility study, business study, functional model iteration, system design and build iteration, implementation, and post-project. These seven stages are known as "the three pizzas and a cheese" as seen in figure 1.

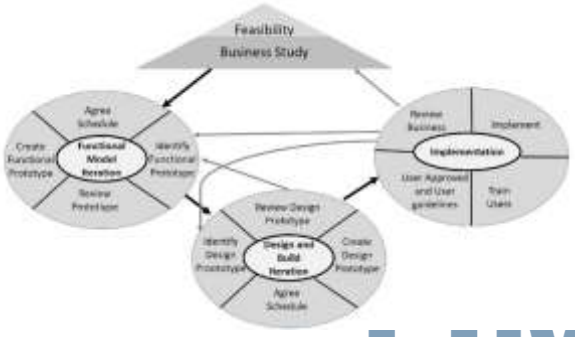

Fig. 1. System Development Process in DSDM

Pre-project stages are done early before the project starts. This stage will ensure that resources and funding to run the project are available. Feasibility and business study stages are carried out sequentially. These two stages form the basis of the next development process. Therefore these two stages must be carried out before carrying out the next stage. The next three stages are functional model iteration, design and build iteration, and implementation can be implemented iteratively and incrementally. DSDM provides the freedom for the project team to take advantage of the flexibility of the method in running the next three stages. The most important thing in the DSDM is to understand the purpose of each stage and the resulting product at each stage [2].

B. E-Commerce

In today's global era promising new business E-commerce models. This business model utilizes the support of information and communication technology (ICT). According to Turban et al [5], Electronic commerce (electronic commerce, abbreviated EC, or E-commerce) trading model that includes the buying, selling, transfer and exchange of products, services or information through computer networks, including the internet.

E-commerce business becomes one of the most important parts of the economy in Indonesia. According to Gentur [6]. Agus Tjandra in Berita Satu [7] as vice chairman & foreign relation of E-commerce Association of Indonesia (idEA) stated that the total value of Indonesia's E-commerce transactions in 2013 reached US $ 8 billion or around Rp 94 trillion and predicted to increase up to US $ 24 billion or around Rp 283 trillion in 2016. The number of people who shop online in the country recorded reached 4.6 million people during 2013 and is estimated to increase to 8.7 million people in 2016.

E-commerce also provides many benefits for both entrepreneurs and customers. Some benefits of e-commerce according to Khan [8] such as increasing the income of the entrepreneur, reducing the company's operational costs, saving time for shopping for consumers, and having a certain level of comfort in shopping.

With the rise of digital world-based economic activities or called E-commerce there are actors or users to make sales and purchase transactions. Most of the users involved in e-commerce business in Indonesia act as buyers, namely 78.5% (office workers (63.4%) and rough labor (15.1%). While only 21.5% do business people who acts as a seller [6]. Some E-commerce companies are currently developing through the digital world such as Lazada, Zalora, Tokopedia, Elevenia, Olx and many more. Quite a number of e-commerce users open new opportunities for business models in Indonesia. Some e-commerce related business opportunities by [9], is :

- Security Service, is a service to provide security to your computer or site, which aims to make your data and systems safer against attacks by irresponsible parties such as hackers and other cybercriminals.
- Data Storage. This type of data storage service primarily for which you need a lot of space to store their data, which is usually stored through cloud technology as well as servers owned by service providers.
- Web Hosting, is a type of business that acts as a hosting service provider from a website that allows people to have their own site.
- Shopping Cart is a transaction collection service that you will or have already done, so that the buyer will know how much the total purchase he/she has to spend.
- Web Design is web site design services that are useful to add an interesting impression for your site so that more visitors from websites that have been made.

- Merchant Processing is a form of business that serves relationship activities between sellers, buyers, and third parties, in this case financial services such as banks. Its role is as a mediator transaction between the seller and the buyer.
- Online Marketing is a product marketing activities conducted through the internet, such as video ads uploaded on the official website of a company and so on.

C. E-Agriculture

Agricultural websites have been widely developed in several countries including Indonesia. Agricultural Information System using web technology is often referred as e-Agriculture. There are several understandings about the definition of e-agriculture including e-agriculture understood as 1) information related to agriculture; 2) technology or tools for information and communication; 3) various types of agricultural information; 4) all stakeholders who will benefit from agriculture; and 5) the benefits that agriculture can gain from the application of ICT applications (E-Agriculture Working Group, 2007). In the application of e-agriculture can be a geographic information system, remote sensing, and various kinds of wireless equipment [10].

According to Cecilia [11], E-Agriculture is a field that appear at the intersection of agricultural informatics, agricultural development and entrepreneurship, refers to agricultural services, technology dissemination, and information delivered or enhanced through the Internet and related technologies. The use of the digital world in conducting business processes has a huge impact on the growth of the agricultural economy market. According to the Organization, Food and Agriculture [12] benefit of e-agriculture are:

- As part of a national ICT strategy, encouraging the development and implementation of national e-agriculture strategies that focus on providing reliable and affordable connectivity and integrating ICT in rural development to support food security and fight against hunger.
- Collaborating and sharing knowledge in agriculture via electronic practice communities, including the e-Agriculture Community, in sequence to exhibit and promote models, methodologies, good practices and adoption of Open Access standards and interoperability, effectiveness and fair use of ICT for sustainable agriculture and rural development.
- Promote the creation and adaptation of content including in local languages and contexts from trusted sources, including, to ensure equitable and timely access to agricultural knowledge by resources- Poor men and women farmers, foresters and fishermen in rural areas.
- Develop the digital literacy of rural and remote institutions and communities in the region to consider local needs and constraints by providing appropriate learning opportunities for all that will enhance the individual and collective decision-making skills.
- Promote the use of ICT to strengthen the country's resilience capacity, Communities and individuals to reduce and adapt to nature and humanity - Create disasters, food chain challenges, socio-economic and other crises, Conflict and trans-boundary threats, diseases and environmental degradation.
- Promote public-private partnerships in collaboration with CSOs / NGOs, cooperatives, farmer organizations, academics, research institutions In the agricultural sector (which also includes forestry and fisheries) for Inclusive, efficient, affordable and sustainable ICT services and initiatives in Indonesia Agriculture and rural development which will promote the widespread use of ICT and encourage sustainable agribusiness business models.

Some e-agriculture applications have been developed including e-Choupal (India), Agricultural Market Information System (Bangladesh), and Infotrade (Uganda) [13].

III. RESEARCH METHODOLOGY

The method used in developing the system is the DSDM method. There are 6 main stages in the research are pre-project, feasibility study, business study, functional iteration model, design and build iteration, and implementation.

A. Pre-Project

At this stage, all resources for system development are available. For the development of agricultural e-commerce, it takes resources of energy for process analysis, designing and coding the program. The need of this resource has been fulfilled with the formation of a team of developers consisting of 2 college students and 4 lecturers from Information Systems and Informatics. Meanwhile for financing, this research activity was fully funded by the Institute of Research and Community Service Duta Wacana Christian University for the system development process and the Information Technology Faculty for publication funding from research. Besides the resource, initialization process and planning have been done when pre-project. Developed system is a part of process of development Integrated Agriculture Information System (IAIS). IAIS is the main project that has been built since 2015 and is scheduled to end in 2022. Agricultural e-commerce developers is a part of the IAIS project and become focus project in 2018. Therefore the development of an agricultural e-commerce system is based on the IAIS blueprint that developed in 2016 - 2017 [14] [15] [16]. With the availability of supporting resources for the development of agricultural e-commerce systems, the

system development process can proceed to the feasibility study stage.

B. Feasibility Study.

Problems that will be resolved at the feasibility study stage are problems related to the unavailability of online sales and purchase of agricultural products. Even though this system can help farmers in expanding the market for selling agricultural products they have. For this reason, this research developed an agricultural e-commerce system. Reviewed from the availability of resources and funds to support research that has been defined in the pre-project then the planned project is feasible to run.

C. Business Study

Business study for system development have been done when developing blueprints for IAIS. The development of e-commerce is an activity that matches the second goal of IAIS business motivation. This goal is a development of architecture and application for IAIS. This goal have an objective, that are 1) Blueprint strategy for system development; 2) Availability of IT Infrastructure; and 3) Development of Agriculture Information Systems and Knowledge Based Systems [16]. Specifically for module development, researchers conducted observation for sales and purchasing process in some farmer groups in Sleman, Special Region of Yogyakarta. Researchers also did literature review to article related with sales and purchasing business processes activities. In particular, researchers observed some business process in some online stores.

D. Functional Model Iteration

Functional Model Iteration is a stage to perform functional definitions of the system to be developed. Activities at this stage are done iteratively. There are several activities undertaken at this stage that are agree plan, create functional prototype, review prototype, and identify functional prototype. Based on the collected data from business study and observation for some well-known e-Commerce sites, sales module can be consists the following functionalities: 1) user management; 2) product management; 3) sales transaction management; and 4) reporting management.

E. Design and Build Iteration

At this stage the module design process for sales on agricultural e-commerce is carried out. The design process is based on module functionality that has been defined in the previous stage. Based on the 4 functionality of the seller module, 8 functions are generated in the seller module. Mapping functionality and function in the module can be seen in table 1.

Table I. Modul Functionality Mapping.

Functional Model	Function Module
User Management	Registration
	Login
Product Management	Product data management
Sales Transaction Management	Check product prices
	Sales transaction management
Reporting Management	Function of user reporting
	Function of admin reporting
	Function of non login user reporting

The design of sales modules includes designing data flow diagram (DFD), designing of database, flowchart, use case diagram, activity diagram, sequence diagram, and user interface. The DFD design is intended to describe the Entities, processes, and data flows that flow in the sales module. DFD seller module level 0 can be seen in figure 2.

Fig. 2. Data Flow Diagram of Sales Module.

Database design of purchasing module is designed using Entity Relationship Diagram. This process uses Logical Data Modelling. There are 8 steps in the modelling: 1) identify main entities; 2) depiction of entity relationship; 3) defining primary and secondary key; 4) defining foreign key; 5) business rules definition; 6) non-key attribute addition; 7) validating normalization rules; 8) data dictionary creation. There are 16 entities in e-commerce database. The followings are relation scheme:

- Master_detail_user (ID_User, nama, jenis_kelamin, tanggal_lahir, alamat, provinsi, kabupaten, kecamatan, kelurahan_desa, no_telpon, email, foto),
- Master_kategori(ID_Kategori, Nama_Kategori, Deskripsi, aktif),
- Master_Kategori_Topik(Id_Kategori_Topik, Nama_Ketegori_Topik)
- Master_user_kat(ID_kategori, ID_user),
- Master_user(ID_User, Password, PIN, Tingkat_Priv),
- Master_Produk_Tani(ID_Produk, ID_Spesies, ID_Kategori, Nama_Produk, Deskripsi_Produk, Satuan),
- Master_Spesies_tanaman(ID_Spesies, Id_Morfologi, Jenis_Tanaman,

Nama_Tanaman, Nama_Latin, Habitat, Masa_Tanam, Akar, Batang, Daun, Buah, Biji, Perkembangbiakan, Foto1, Foto2, Iklim, Jenis_Tanah, Kelembaban),

- Master_Kategori_Produk(ID_Kategori, Jenis_Kategori, Nama_kategori),
- Master_alat_tani(Id_Alat, ID_Kategori, Nama_Alat, Deskripsi Alat, Spesifikasi, Harga_terendah, Harga_Tertinggi, Fungsi),
- Master_bahan_pertanian(ID_Bahan, ID_Kategori, Nama_Bahan, Deskripsi_Bahan, Spesifikasi_Bahan, Harga_Terendah, Harga_tertinggi, Fungsi_Bahan, Jenis_Bahan),
- Master_Hasil_Tani(ID_Hasil, ID_Kategori, ID_Spesies, Nama_hasil, Deskripsi_Hasil, Harga_Terendah, Harga_Tertinggi, Satuan),
- Trans_Topik_Diskusi(ID_Topik, Id_Kategori_Topik, ID_User, Judul_Topik, Tanggal, Waktu, Isi_Diskusi),
- Trans_Komentar_Diskusi(ID_Topik, ID_User, Komentar, Tanggal, Waktu),
- Trans_Pembayaran(ID_Pembayaran, ID_Permintaan, ID_User, No_Rekening, Nama_rekening, Jumlah Rekening, Bukti_Rekening),
- Trans_permintaan(ID_Permintaan, ID_User, ID_Penawaran, Qty, Harga, Tgl_Kebutuhan, Tgl_Permintaan, Status_Bayar, Status Kirim), and
- Trans_penawaran_prod_tani(ID_Penawaran, ID_User, Tanggal Penawaran, Spesifikasi Barang, Id_Barang, Kondisi Barang, Merk, Harga, Tahun_Produksi, Gambar1, Gambar2, Status, Satuan_Barang, Validasi Admin).

Complete figure of Database design can be seen in Figure 3.

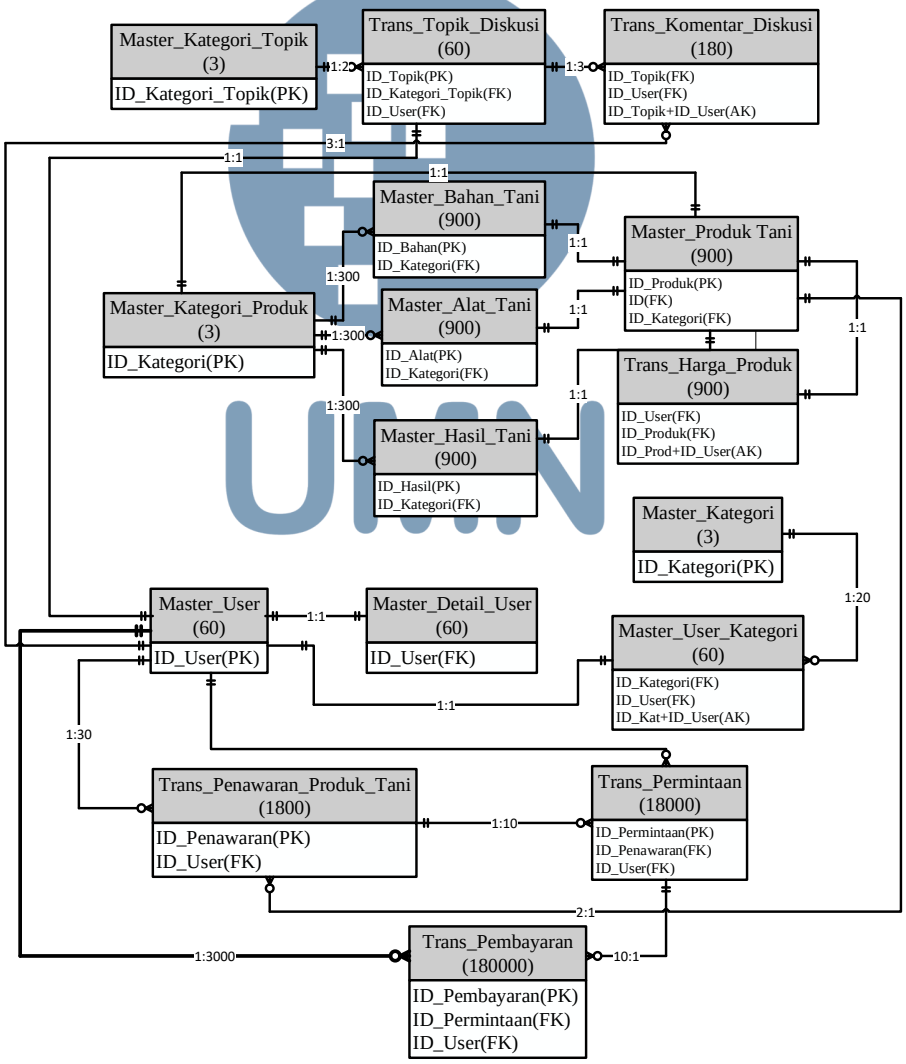

Fig. 3. Entity Relationship Diagram System.

Use case diagram system consists of 2 user categories that are user that act as end user who is a

farmer, seller, and common user. The second user category is an admin of the system. Use case diagram can be seen in figure 4.

Fig. 4. Use Case Diagram of Sales Module.

Activity and sequence diagram developed base on the function of the module. Activity diagram describe a business process that happen in the system. There are 9 activity diagrams in the sales module that are activity diagram for process of login, registration, uploading a product, product management, user management, reporting, product validation, check product price, and check delivery status. Meanwhile sequence diagrams describe or display interactions between objects in the system arranged in a sequence or time series. There are 7 sequence diagrams in the system that are sequence diagrams login, registration, product validation, user validation, product price checks, delivery status checks, and sales transactions. Sequence and activity diagrams for each sales transaction can be seen in figures 5 and 6.

After the design process, proceed with the module coding process. The modules using PHP and HTML 5 as a language programming for website, MySQL for the database, Sublime tools as program code editor, and XAMPP Control Panel software. The design and implementation process will be done in an iterative manner with each function in the module.

F. Implementation

The implementation stage is the stage of delivering products to users. This stage will be done through user approval and user guidelines, user train, implement, and business reviews. Ongoing research has not reached the implementation stage. This research is currently on design and build sales module on agricultural e-commerce.

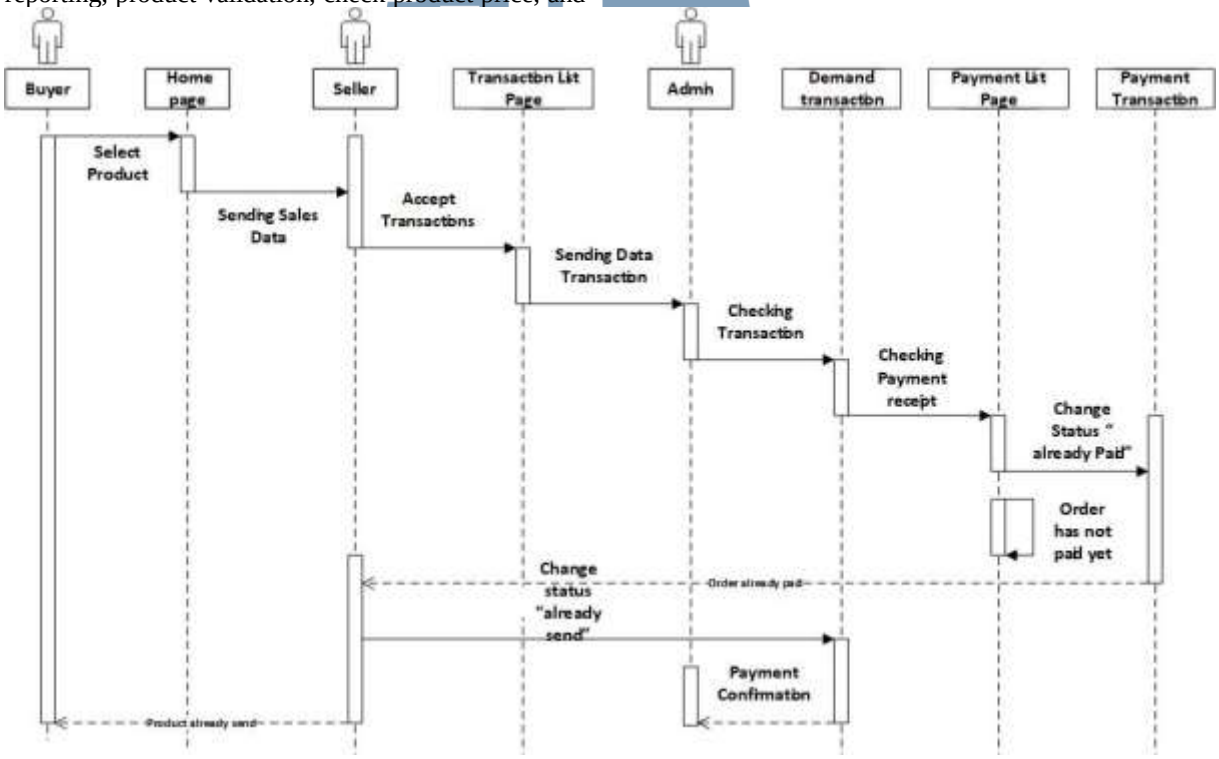

Fig. 5. Sequence Diagram Sales Transaction Process.

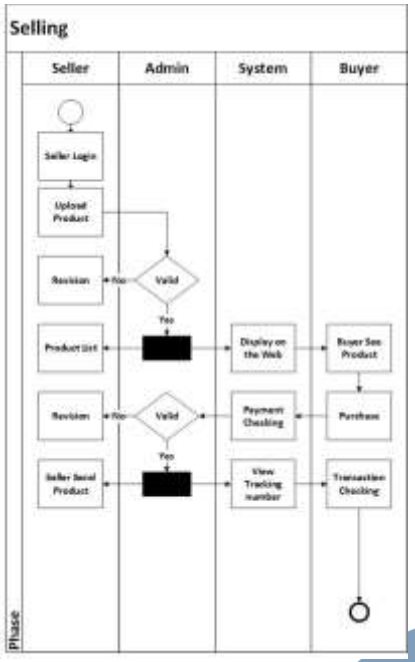

Fig. 6. Activity Diagram of Sales Transaction Process

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IV. IMPLEMENTATION AND ANALYSIS

A. *Implementation of Sales Module*

This system is part of the agricultural sales E-commerce system development so that the main process of this system is the process of buying and selling transactions. The development of sales modules on agriculture is divided into 2 menu views that are seller display which consists of login page, seller main page, product list page, product form add page, product offer form page, product listing page, product price check page, sales page, inbox page, seller report page, profile page. Furthermore, the admin views consists of the admin main page, product category listing page, product list page, product offer list page, seller list page, seller validation page, seller data page, product availability page, transaction data page, payment validation page and report page admin. Site maps of the sales module can be seen in Figure 7. Meanwhile, the product listing page, entering product offer details, sales transactions, product discussions, and sales reports can be seen in figures 8,9,10, 11 and 12.

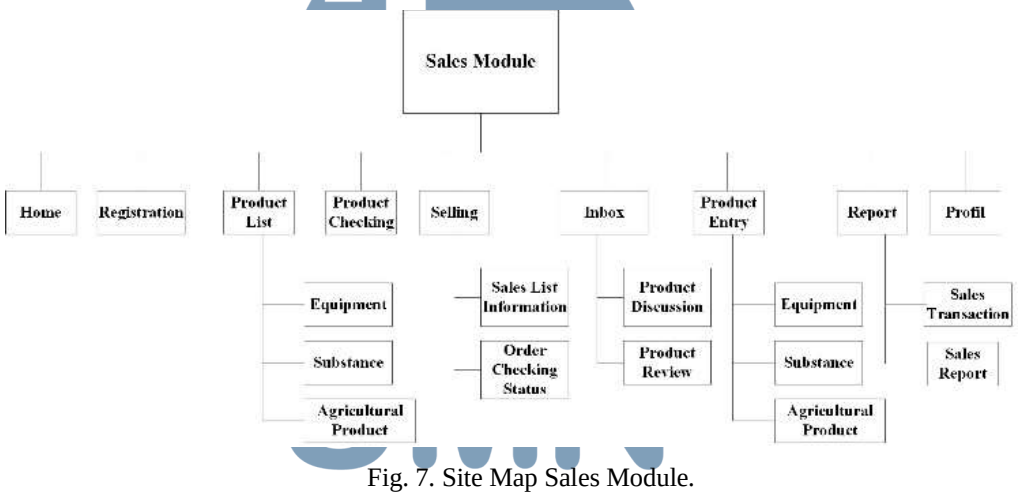

Fig. 7. Site Map Sales Module.

Fig. 8. Product List Page

Fig. 9. Enter Product Offer Details Page

Fig. 10. Sales Transaction List page

Fig. 10. Sales Transaction List page

Fig. 11. Product Discussion Page

Fig. 12. Sales Report page.

B. *Testing System*

Module testing is using the black box method. This black box testing focuses on the functional specifications of the software. Application testers can find out the errors by checking whether the input can be received properly, and the output is in accordance with what is expected. Table II is a table of the number of tests and the results of the sales module trial.

Table II. Modul Functionality Mapping.

No	Type of testing	Number of button/function	Number of tests	Success rate
1.	System User Interface	23 button	143	100
2.	Basic System Functions	3 function	81	100
3.	System Form Handle	6 Form Entry	40	100
4..	System security	2 cases	6	100

Based on the data in table II, it was found that the results of black box testing is 100% success in all test cases. Thus it can be said that the sales module prototype can be used for sales transactions on agricultural e-commerce.

C. *Discussion*

Dynamic System Development Method is an agile method that applies the iterative and incremental principles in development process. The utilization of this model is based on the limited number of project team and short development time. The project consist of 6 members and 6 months (180 days) project time. This module is developed with 9 iterations. Time for each iteration is around 20 days. Activities and function developed in each iteration can be seen in Table III.

Table III. Iteration Activities.

Iteration	Activities/ Function Increment	Time
1	User Registration User Login	20 days
2	Product Data Management (CRUD Product Data)	20 days
3	Testing and Module Improvement	20 days
4	Sales Transaction Management (Sales Data CRUD)	20 days
5	Product Discussion Feature	20 days
6	Testing and Module Improvement	20 days
7	Reporting Module for user and admin	20 days
8	Testing and Module Improvement	20 days
9	Testing and Module Improvement	20 days

D. *The Analysis of Strength and Disadvantage Module*

Based on the trial testing and observations it is known that the system has several advantages that are 1) web-based system so that it can be used extensively; 2) the system has a recommended price feature to make a sale; 3) all reports on the system can be saved in pdf format; and 4) the system is able to send statements via email. But the system also has two main disadvantages that are 1) there is no limit on sending image files and image file forms are still limited to jpg, jpeg, png, and gif; and 2) system not yet full feature and network related product payment.

This module is in development phase and needs to be tested and evaluated. Some evaluations and testings should be conducted, such as usability testing and acceptance testing for application. By using the result for the test, it will be used to improve the system functionalities and modules. After conducting the test and acceptance test, the system will be ready to be implemented.

V. CONCLUSION AND FUTURE WORK

A. *Conclusion*

Some conclusions that can be formulated in this research include: 1) prototype of sales module in agricultural e-commerce system developed using dynamic system development method consisting of pre-project stage, feasibility study, business study, functional model iteration, and design and build iteration; 2) Prototype module has 4 definition of functionality that are user management, product management, sales transaction management, and reporting management; and 3) based on the results of the system testing turn out that all functions and pages in the system can run properly and correctly. Nevertheless, to have sufficient knowledge and understanding system quality and performance, usability and acceptance test will be conducted.

B. *Future Work*

The next work that must be done includes the development of purchase modules, integration of sales and purchase modules, agricultural e-commerce usability testing, and preparation for the implementation stages of the system.

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Genetic Algorithm for Web-Based Food Stand Assignment Scheduling

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***Abstract*— Scheduling is a hard problem due to much considerations in many goals. Combination of goals in this scheduling cause the problem hard to solve even when using mathematical techniques. Optimization is a method which aim to achieve the best result with the least cost as possible. Optimization for large scale problem usually done with more modern technic, such as metaheuristic. Genetic Algorithm belongs to a larger system called Evolutionary Algorithm which is often used for solving the best value in optimization problem. Hence, this food stand assignment scheduling is build using Genetic Algorithm with population size of 50, uniform crossover with crossover rate of 0.25, mutation rate of 0.0125, and roulette wheel selection. An interview was conducted with three coordinators of fund and consumtion that results in three constraints used in building this system. Testing is done for three events and achieve mean fitness that is 87.967%, 89.609%, and 85.001% for FesTIval, TechnoFest, and DISCO, respectively.**

***Index Terms*—Genetic Algorithm, Roulette Wheel Selection, Scheduling, Stand, Uniform Crossover**

I. INTRODUCTION

In the process of scheduling, the use of tools such as Personal Digital Assistant, computer, smartphone, or even a notebook is inevitable [1]. Those tools are highly recommended for creating schedule. Scheduling problem is a troublesome problem due to consideration of many goals [2]. Combination of goals in scheduling cause the problem hard to solve even when using mathematical techniques. There are some constraints while creating a schedule, such as processing time and waiting time. A schedule counts as optimal when it can cover all those constraints.

Optimization is a method which goal is to achieve maximal result with as minimum cost as possible [2]. Optimization can be done with various methods. However, for great scale cases, generally modern technique such as metaheuristic is used. Metaheuristic is capable of solving complex problem by trailing some solutions and create a smaller solution, hence an optimal solution might be found.

Komang Setemen has successfully implemented Genetic Algorithm in lecture scheduling system [3]. Scheduling with small dataset which is 53 to 88 subjects is done within 5.000 generation and results in zero for its fitness value, which means there is no collision between schedules. Scheduling for a larger dataset which is 141 courses, Genetic Algorithm is capable of generating a no collision schedule within 10.000 generations. On the other hand, research by Anita Qoiriah proved that final exam scheduling problem is able to be solved with population size of 50, crossover rate of 0.6, and mutation rate of 0.001 [4]. Another research by Marbun compares Genetic Algorithm and Particle Swarm Optimization in solving lecture scheduling problem [5]. It shows that Genetic Algorithm results in the best fitness value which is 1.0, while Particle Swarm Optimization only results in fitness value of 0.111.

In this paper, we investigate Genetic Algorithm for web-based food stand assignment scheduling in three events: FesTIval, TechnoFest, and DISCO. Ferdinand who was coordinator of funding division of Festival 2016 event said that lots of time needed for creating a schedule for food stand duty. Lecture schedule that is very various among committees make it even harder to create a schedule.

The structure of this paper is as follows. In Section II, Genetic Algorithm is discussed. In Section III, we describe the design of our scheduling system. Implementation and testing of Genetic Algorithm in our system described in Section IV. In Section V, conclusion and future works are discussed.

II. GENETIC ALGORITHM

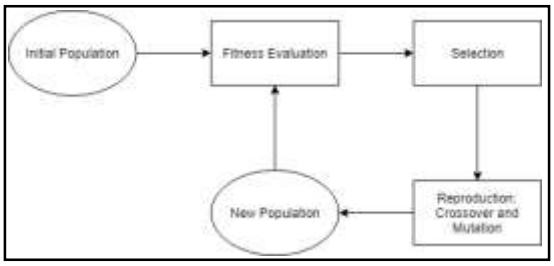

Figure 1. Genetic Algorithm Cycle

Genetic Algorithm belongs to Evolutionary Algorithm which is often used for obtaining a value in an optimization problem [6]. This algorithm is similar to the process of genetic that is in organism or natural selection principle, which is only strong organism can survive in certain environment. Genetic Algorithm cycle first introduced by David Goldberg. Figure 1 shows the Genetic Algorithm cycle [2].

There are several important components in Genetic Algorithm, those are:

1. Chromosome
   One chromosome or individual represents one solution [2]. Generally, encoding is representing some *n* solution using binary number or known as binary encoding.
   Binary encoding is often used due to its simplicity and easy to trace [7]. It has to be noted that if binary encoding is used, the process of binary decoding have to be done in the last phase of Genetic Algorithm. Genetic Algorithm will prepare population as a set of individual. Each individual represents one solution. This population means that there will be plenty solutions due to various individual in this population. Size of recommended population is 50 [8].
2. Fitness
   Fitness function could tell how optimal a solution is [2]. Each individual in the population will be evaluate by fitness function. Formula 1 is a fitness function that is generally used in Genetic Algorithm.

$$F(x) = \frac{1}{1+f(x)} \quad (1)$$

   where *f*(x) will produce a good fitness value. After every solution has been evaluate with the fitness function, some chromosomes will be selected. The chosen chromosomes will be the parent for next generation.
3. Roulette Wheel Selection
   Roulette wheel selection can be imagined as a circle that is split as many as the number of chromosomes [2]. Every area in the circle indicates the chance of every solution which will be picked randomly. Every time the wheel is played, the cursor will point at a specific individual [2]. Hence, individual with higher fitness value has a greater chance to be chosen as a parent.
4. Crossover
   Crossover is an operator in Genetic Algorithm that involves 2 parents to produce a new offspring [2]. Chaturvedi advocates to choose a crossover rate 20 times greater than the mutation rate, which is around 0.25 to 0.95 [8]. There are 3 kind of crossovers, which is one-point, two-point, and uniform crossover. One-point crossover which is inspired from the biology process has a blind spot, which is the offspring combination will be the same as the parent in several cases [7]. Two-point crossover seems to be a good method for multipoint crossover. However, the performance of two-point crossover will drop when population is converging due to the reduction of productivity from crossover. Uniform crossover which can change every bit in chromosome can handle the drawbacks from those two crossover methods. Therefore, uniform crossover is more superior to those two.
5. Mutation
   Mutation might bring out new individual which is not born from crossover [2]. Element that will be mutated is chosen randomly. The higher the mutation rate will result in more fluctuate fitness value [8]. Mutation rate generally ranged from 0.001 to 0.05. The purpose of mutation is to generate a new individual which is different from other individual in current population. Mutation might create a new solution to come out from local optimum [2]. Bit flip mutation is generally used for bit encoding. Bit flip mutation will randomly reverse the bit value [9].

Genetic Algorithm consists of 5 steps:

1. Determine the size of population, crossover rate, and mutation rate. Initiate a random population. Evaluate each chromosome in the population with fitness function.
2. Set iteration t = 1.
3. Do a selection to choose the parent for crossover phase.
4. Crossover phase for the chosen parent.
5. Choose some chromosome in population for mutation phase. Evaluate each chromosome with fitness function. If the solution has not reached optimization, set iteration to t = t + 1. Back to step 3.

III. SYSTEM DESIGN

A. Data Collection

Interview is conducted to collect data which purpose is to know the real problem deeper and to gather information that have relevance with food stand scheduling. Interviewees comes from 3 students that used to create a schedule for events in scope of Technic

and Information Faculty in Universitas Multimedia Nusantara.

Ferdinand, Fisichela Thioanda, and Tommy Miyazaki who was coordinator of funding division of TechnoFest 2016 have a same insight of the most fundamental thing while creating a schedule which is each committee assignment must not collide with their lecture schedule. In one-week period, each committee will be assign 4 to 5 hours for food stand duty and this assignment is continuous. Committees assign as the earliest have to move the food to the stand. Therefore, Ferdinand suggest a male committee for morning assignment.

B. System Model

System model from food stand scheduling is shown in Figure 2. There are 6 components in this system, which is:

1. Committee
   Committee is able to input their lecture schedule and obtain food stand assignment schedule for every event they participate.
2. User Interface
   User interface for displaying the interface of food stand assignment system. Committee and admin are able to interact with system through user interface.
3. Admin
   Admin is capable of creating a new event based on committee demand. Furthermore, admin is also capable of viewing all event's information.
4. Database
   Database is used to store information of every event, committee, and assignment.
5. Coordinator
   Coordinator is students that is used to create a food assignment schedule. Coordinator's role is to provide constraints in making a schedule.
6. Generate Schedule
   Generate schedule is the process of creating schedule with the implementation of Genetic Algorithm. This Genetic Algorithm use population size of 50, crossover rate of 0.25, and mutation rate of 0.0125. Generate schedule purpose is to create a schedule based on specific event data and constraints that is given by the coordinator. Schedule that has been generated is stored in database.

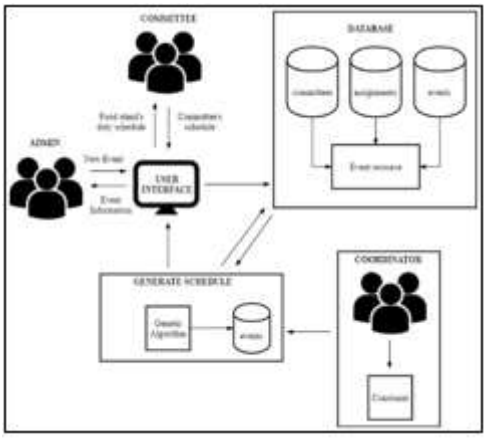

Figure 2. System Model

C. Sitemap

There are 2 sitemaps in this system. Admin sitemap is shown in Figure 3.

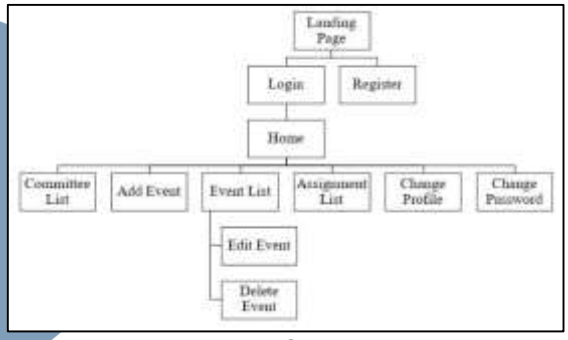

Figure 3. Admin Sitemap

When the first-time user enters the system, user will be direct to Landing Page. User can choose to login or register. User that has login successfully and marked as admin will be able to see every committee, events, and assignments, create new event, change event detail, and change password.

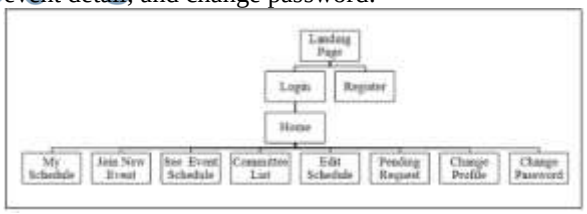

Figure 4. Committee Sitemap

Committee sitemap is shown in Figure 4. User that has successfully login and is marked as committee will be able to see their schedule, join new event, view their event, change their profile, and change their password. Besides that, user might also view every committee in any event they participate in, edit schedule, and view pending request.

D. Flowchart

Process flow of Genetic Algorithm is shown in Figure 5. Genetic Algorithm starts with initialization of every data that is needed, including the starting population. Iteration will start from 1. Fitness will be calculated as reference for Probability Distribution Function (PDF) calculation. Then, there is selection phase for obtaining a better chromosome to be included in crossover phase. After crossover phase, there is mutation phase. Mutation phase is done for some chromosome that is chosen randomly. Then, fitness will be calculated as reference for next PDF calculation. Iteration counter will increase by one by now. If solution is not optimal yet, then there will be a loop from selection phase. An optimal solution will be store to events table in database and success message will be shown.

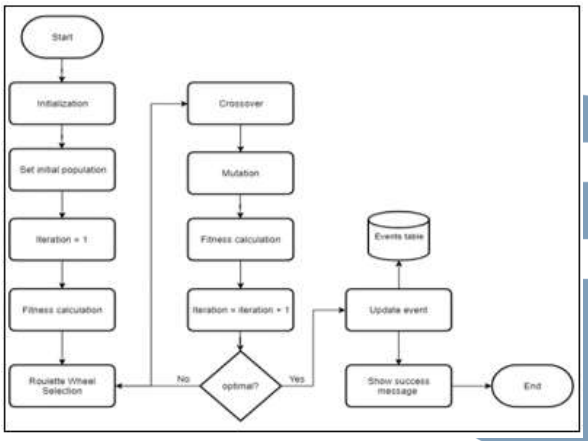

Figure 5. Generate Schedule Flowchart

IV. Implementation and Testing

A. Implementation

Figure 6. Home Committee Interface

The interface of home committee is shown in Figure 6. In this page, committee is capable of viewing every events they participate. Committee that is place in funding division has more privilege, which is to generate a new schedule, accept or reject committee, edit current schedule, and delete event.

See schedule interface is shown in Figure 7. In this page, committee is capable of viewing the food assignment schedule of a specific event. The name of themselves will be emphasized.

Figure 7. See Schedule Interface

My schedule interface is shown in Figure 8. In this page, committee is capable to see and change their own lecture schedule. There are 3 colors that have different meaning. Green indicates there is lecture schedule, orange indicates there is a food stand assignment, and red means there is a collision between both.

Figure 8. My Schedule Interface

B. System Testing

System testing is done by comparing the fitness value which is generated with different penalty point and iteration. Genetic Algorithm in this system uses population size of 50, uniform crossover with crossover rate of 0.25, mutation rate of 0.0125, and roulette wheel selection. Dataset for testing is from a real past event data which is FesTIval 2016, TechnoFest 2016, and DISCO 2017. Then, a schedule is generated for every case and fitness value that has been generated this way is noted to find its mean. Recapitulation of this testing can be seen in Table 1. The highest fitness mean is achieved by setting the iteration to 30.000, 6 penalty point for schedule collision, 4 penalty point for each hour that made a committee to exceed their max duty hour, and 1 penalty point when a female is assigned to the earliest period. The highest fitness means for three events are 87.967%, 89.609%, and 85.001% for FesTIval, TechnoFest, and DISCO, respectively.

Table 1. Recapitulation of Fitness Value

Event	Collision Penalty	Max Hour Exceeded Penalty	Gender Penalty	Iteration	Mean
FesTIval	6	3	1	10.000	85.771
FesTIval	7	3	1	10.000	85.386
FesTIval	6	4	1	10.000	86.944
FesTIval	6	3	2	10.000	85.765
FesTIval	7	4	1	10.000	86.573
FesTIval	7	3	2	10.000	85.977
FesTIval	6	4	2	10.000	86.386

Event	Collision Penalty	Max Hour Exceeded Penalty	Gender Penalty	Iteration	Mean
FesTIval	7	4	2	10.000	86.184
FesTIval	6	3	1	20.000	86.798
FesTIval	7	3	1	20.000	86.796
FesTIval	6	4	1	20.000	87.416
FesTIval	6	3	2	20.000	86.428
FesTIval	7	4	1	20.000	87.312
FesTIval	7	3	2	20.000	86.181
FesTIval	6	4	2	20.000	87.432
FesTIval	7	4	2	20.000	86.103
FesTIval	6	3	1	30.000	87.039
FesTIval	7	3	1	30.000	86.886
FesTIval	6	4	1	30.000	87.967
FesTIval	6	3	2	30.000	86.564
FesTIval	7	4	1	30.000	87.554
FesTIval	7	3	2	30.000	86.147
FesTIval	6	4	2	30.000	87.796
FesTIval	7	4	2	30.000	86.628
DISCO	6	3	1	10.000	82.66
DISCO	7	3	1	10.000	82.328
DISCO	6	4	1	10.000	84.297
DISCO	6	3	2	10.000	83.065
DISCO	7	4	1	10.000	83.48
DISCO	7	3	2	10.000	82.361
DISCO	6	4	2	10.000	84.137
DISCO	7	4	2	10.000	83.175
DISCO	6	3	1	20.000	83.935
DISCO	7	3	1	20.000	82.762
DISCO	6	4	1	20.000	84.414
DISCO	6	3	2	20.000	83.427
DISCO	7	4	1	20.000	84.099
DISCO	7	3	2	20.000	82.718
DISCO	6	4	2	20.000	84.636
DISCO	7	4	2	20.000	83.918
DISCO	6	3	1	30.000	83.366
DISCO	7	3	1	30.000	83.419
DISCO	6	4	1	30.000	85.001
DISCO	6	3	2	30.000	84.177
DISCO	7	4	1	30.000	84.085
DISCO	7	3	2	30.000	83.304
DISCO	6	4	2	30.000	84.705
DISCO	7	4	2	30.000	83.908
TechnoFest	6	3	1	10.000	88.036
TechnoFest	7	3	1	10.000	87.589
TechnoFest	6	4	1	10.000	88.174
TechnoFest	6	3	2	10.000	87.365
TechnoFest	7	4	1	10.000	87.636
TechnoFest	7	3	2	10.000	87.415
TechnoFest	6	4	2	10.000	88.477
TechnoFest	7	4	2	10.000	88.248
TechnoFest	6	3	1	20.000	88.177
TechnoFest	7	3	1	20.000	87.92
TechnoFest	6	4	1	20.000	89.266
TechnoFest	6	3	2	20.000	88.04
TechnoFest	7	4	1	20.000	88.177
TechnoFest	7	3	2	20.000	87.81
TechnoFest	6	4	2	20.000	88.477
TechnoFest	7	4	2	20.000	88.692
TechnoFest	6	3	1	30.000	88.95
TechnoFest	7	3	1	30.000	89.091
TechnoFest	6	4	1	30.000	89.609
TechnoFest	6	3	2	30.000	88.564
TechnoFest	7	4	1	30.000	88.367
TechnoFest	7	3	2	30.000	87.979
TechnoFest	6	4	2	30.000	89.204
TechnoFest	7	4	2	30.000	88.772

V. Conclusion and Future Works

Genetic Algorithm has successfully been implemented in this food stand assignment scheduling system. This system generates a schedule for one-week period. The result of interview concludes 3 constraints that is used as references in generating a schedule. Those 3 constraints are food stand assignment schedule should not collide with committee lecture schedule, food stand duty hour should not exceed 5 hours for one-week period, and the earliest period of each day should prioritize a male committee.

The experimental results indicate that the highest mean fitness value can be obtained with penalty point configuration such as, 6 penalty point for schedule collision, 4 penalty point for each hour that made a committee to exceed their max duty hour, and 1 penalty point when a female is assigned to the earliest period. The highest fitness mean for three event is 87.967%, 89.609%, and 85.001% for FesTIval, TechnoFest, and DISCO, respectively.

Based on the research that has been done, here are some ideas for future research.

1. System can be integrated with single sign-on from UMN system, hence system can gather the lecture schedule for each committee automatically.
2. This system can be developing to be mobile application to ease committee in viewing their schedule.

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Assessing The COBIT Maturity Model in Manufacturing Company

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***Abstract*— PT Hema Indonesia is manufacturing company established in 2001 and has continued to grow. Nowadays the company has supported business processes in various companies, such as the use of information systems. The purpose of this research is to get an overview of the performance of information systems in order to determine the extent of maturity level which is currently running, with a few aspects to consider such as effectiveness and, efficiency. Implementing IT Governance, is a challenge to organizations. To ensure IT alignment with business goals use COBIT standard. The analytical tool used is the standard procedure COBIT issued by ISACA. In this paper the method to be used is COBIT 4.1. Coverage of Audit IT Domain are Plan Organize (PO), such as PO4, PO5, PO7 and PO8. The conclusion that can be drawn from the research that has been done is IT Governance at the company has been done, although still run optimally within each IT process contained in the sub domain average on level repeatable but intuitive and defined proses. Result audit of IT Governance based on COBIT in domain PO, average was at 2.4 until 2.9.**

***Index Terms*—Maturity level, PT Hema Indonesia, COBIT 4.1, Delivery Support.**

I. INTRODUCTION

The maturity model that provided by COBIT Management Guidelines has become an important tool to assess the current situation of a firm as well as identification of reasonable important measures readiness of firms to apply good IT governance [1], [2]. Scholars addresses the use of COBIT enables to manage the timeless issue of balancing risk and control in a cost-effective manner [3], [4]. The effective use of IT governance is believed enables to improve the profits, firm competitiveness, market agility, and enlarge market shares. For this reason, all organizations should develop sustainable IT and business strategy [5], [6], [7].

Increasing manufacturing flexibility is a key strategy to improve market responsiveness and dealing with future uncertainty [8]. The article takes a manufacturing firm, PT. Hema Indonesia (PTHI). The firm has applied ISO 27002 Information System Security and combined with COBIT framework. COBIT is abbreviation for Control Objectives for Information and Related Technology, is a standard in IT governance to assist a company in controlling business needs within the enterprise, where business needs include IT activities and emphasize activities to be achieved and controlled effectively [6], [8]. Problems with PTHI are difficulties in production i.e.: ensuring the availability of materials for production, capacity and schedule, estimating the availability of merchandise in accordance with customer demand to perform a quick audit of inventory based on batch number. In IT Department i.e.: Lack of investment and the quality of human resources is still relatively low. Company is using IT for the advancement of their companies. With the application of IT in a company, of course the application of IT is not free from mistakes. Problems that occur on the IT course can be audited by audit information system [9].

Benefits that can be taken from the implementation of technology security system audit is to know the level of readiness and quality of information system security of PTHI [10]. The review of the discussion will only be focused on the Plan and Organize (PO) domain COBIT framework that deals with security, problems and system maintenance i.e.: PO4 is Define the IT Processes, Organization and Relationships, PO5 is Manage IT Investment, PO7 is Manage IT Human Resources and PO8 is Manage Quality [11]. Money and people have long been considered to be assets, but nowadays, many organizations rely on their data to make more informed and effective decisions which help the organizations to achieve their goals. Hence, data needs to be managed seriously [12], [13]. Most of problem management or organizations included IT

process maximises system availability, improves service levels agreements, minimizes costs, and improves customer satisfaction [14]. It is expected that with this audit PTHI gets an idea of how the performance of the application system is already running, given recommendations and input for this company to be better [15]. And to make sure quality in IS/IT requires not only monitoring and management, but also adherence to strict standards by COBIT [16].

II. THEORIES

A. *Overview Manufacture Company*

Previous study by J.F. Andry and B. Sanjaya in manufacturing company [17], results are companies have not evaluated quality satisfaction, documentation has not been carried out in several fields of information technology, procedures and policies have not been taken seriously [18].

The development of the manufacturing and service industries is growing tighter today has led to open competition on a national scale as well international. Every company will always try to do as much as possible improving the quality and quantity of production to continue to gain confidence of its customers [19]. To observe that a company's manufacturing function could do more than simply produce and ship the products. Manufacturing strategy generally refers to exploiting certain properties of the manufacturing function as a competitive weapon. In the literature, manufacturing strategy is seen as that part of the operations management area that focuses on the strategic consequences of investments at the operational level [20]. Corporate governance is an issue that never goes out to continue to be studied businessmen, academics, policy makers, and others. An understanding of corporate governance practices continue to evolve over time. Corporate governance is one interesting phenomenon to be studied in connection with the vigorous publicity about fraud as well as a business slump that occurred as a result of errors made by the executive management [9].

B. *COBIT*

COBIT has had the following major releases: in 1996, the first edition of COBIT was released. In year 1998, the second edition added "Management Guidelines". In early 2000, the third edition was published. In 2003, an on-line version became available. In December 2005, the fourth edition was initially released and in May 2007, the 4.1 revision was released. COBIT framework concentrated on helping to achieve the institutions or managements requirements to present the information, it help to manage and take control the resources of IT/IS by a structured set of processes to supply information technology services that deliver the required information for the institutions [7]. Framework of COBIT 4, presents the 4 (four) domains along with the 34 (thirty four) high-level processes with each process subdividing into many varying activities and the relationship between the processes is brought about through documents and relations [7].

C. *Maturity Level*

Maturity model approach is that it is relatively easy for organizations to place itself on the level and appreciate what is involved if improved achievement is needed. The level includes 0 because it is quite possible that no process exists at all. The 0-5 level is based on a simple maturity level showing how a process evolves from a non-existent performance to an optimized performance [6].

Table 1. COBIT 4.1 Maturity Level Assessment [7], [11]

Level Index	Description
0 – 0,50 Non existents	Company knew nothing about the issue to be solved. Each process or problem is not clearly defined.
0,51 – 1,50 Initial	Company already has proof in identifying existing problems but needs to be directed. There i no standard process and the approach taken is ad-hoc.
1,51 – 2,50 Repeatable but Intuitive	Company has a developed process. There is a procedure to run a defined process; there is no formal training and standard communication procedures.
2,51 – 3,50 Defined	Company already has a standardized and documented procedure. The procedure has been well communicated through formal training.
3,51 – 4,50 Managed	Company monitors and measures the procedures and policies that have been effectively implemented. In the event of errors and irregularities, a series of procedures for corrective actions to be undertaken are already exist.
4,51 – 5,00 Optimized	The conducted process has had improvement efforts at the level of continuous best practices that produces the best process and best results. The use of integrated information technology is already available there by automation can be done within the company.

Currently the company wants to know the extent of maturity level of IT in the company, whether it can achieve the expectations of the Management is at the level of managed level (average 3.51 - 4.50) or not, for that required a comprehensive audit of the functions that there are some aspects of attention such as: effectiveness, efficiency (efficiency), functional unit of information technology in an organization, data integrity, safeguarding assets, reliability, confidentiality, availability, and security [21]. Table 1 provide COBIT Maturity Level Assessment

III. RESEARCH METHODS

The article research uses literature study by conducting early survey by analyzing vision and mission, goals and objectives as well as the company's strategic plan as well as the strategies, policies related to the management of IT investments and field observations.

Explanations of the Figure 1, provide Step by Step of Research Methods, are number of 1 overall about process of company, authors studied the business process of a company engaged in the manufacture of preservatives for export imports in containers, so that items carried in a container are not damaged if they are kept in the container for too long. Products offered include HD1000, HD 750 power gel and others. How to learn about information systems in the company, such as Security System, monitoring internal user, monitoring of implementation, control of access to IT/IS facilities, access rights, detection of damage, regular backups of data, Repair procedures in case of damage, routine of maintenance and protection of physical technology. Number of 2 Conduct studies related to research, such as COBIT, information systems. There are several questions that must be answered in between are how to solve the problem when there is an IT problem in PTHI? What is the level of physical security applied by PTHI? How to manage user and database at PTHI? And how to maintain hardware on PTHI? Number of 3 determination of the domain based on the needs that have been described in the process at the company.

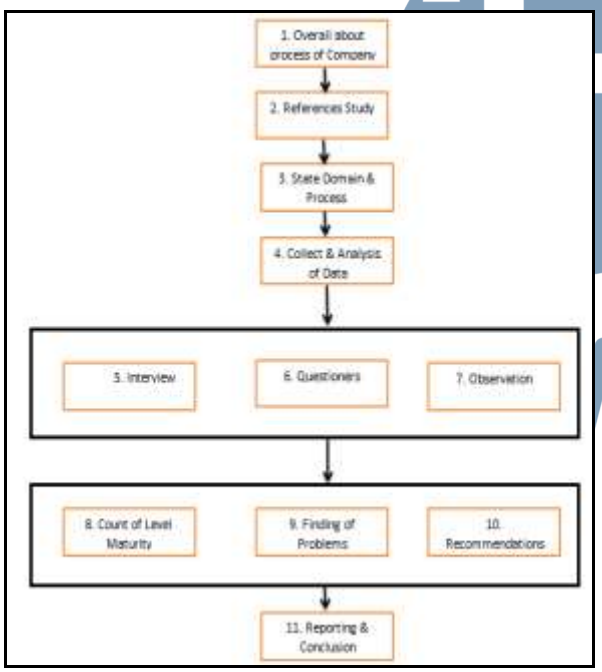

Figure 1. Step by Step of Research Methods [16]

The scope of this study is limited to attendance information system audit on PTHI. This stage, establish the information technology process in accordance with COBIT standards that have been processed in accordance with the case study. The IT coverage of domains that are audited in the attendance information system is shown in Table 2. The focus on this research is on PO4, PO5, PO7 and PO8 domains only. Collect and analysis of data from IT department of PTHI. Number of 5, 6 and 7 are interview, questioners and observation can be done parallel. After that count of level maturity for number of 8, then number 9 are finding of problems and number 10 are recommendation to PTHI, finally number 11 are make reporting and conclusion.

Table 2. Scope of Audit IT Domain

Sub Domain	Descriptions
PO4	Define the IT Processes, Organization and Relationships
PO5	Manage the IT Investment
PO7	Manage IT Human Resources
PO8	Manage Quality

The analytical tool used in this study is the standard procedure COBIT issued by ISACA (Information systems Audit and Control Association) [6], [7], where the data can be obtained by: questionnaire, by distributing questionnaires to every department in PTHI. The respondents consist of 5 respondents from the top management and 35 respondents as representatives of every department in the PTHI, so the overall total respondents obtained are 40.

Audit Selection of domains are Plan Organize (PO), such as PO4, PO5, PO7 and PO8 because: a) Input of control is all data entered into or input into the system must be authorized by management. Methods for authorization or approval have many forms, among others user access control, workstation identification, approved transactions and batches, and source documents. b) Input of validation is the input validation process is used to ensure that the type and value of the information is appropriate and rational. Type of input validation including type checking, range checking and input value, completeness, consistency, length or variable length, digit check, word checking, unwanted characters, and data control batches. c) Handling of error is the program should also be programmed and configured to take action specific if the previously mentioned input validation fails. Many possible responses, depending on the inputted data and input method i.e.: batch rejection, transaction rejection, and request re-input. d) Process of control is all newly generated data must be checked for results rationality calculations, to make sure that the calculations are already working with proper and bad information e) Output of control is applications receive input data, perform calculations, and generate data output. The result of the final calculation and its transformation must be checked for viewing rationality and validity. Some types of output controls are available, depending on the type of activity and data.

Reporting and conclusions, after count of level maturity, finding of problems and recommendations were distributed, the collected data were processed to be calculated based on the maturity level calculation. The result of the audit contains the findings of the present (current maturity level) and hope in the future (expected maturity level). The next steps were to calculate the gap analysis in order to analyze the interpretation of the current and expected maturity

level and to provide recommendation lists of the corrective actions to overcome gap to achieve the improvements in IT governance

IV. Result and Analysis

Further analyze more to the environment that occur within the IT department PTHI, from employees, equipment, physical security, regulations, etc., focused to domain on PO4, PO5, PO7 and PO8.

A. *PO4 Define the IT Processes, Organization and Relationships*

Process Description are An IT organization is defined by considering requirements for staff, skills, functions, accountability, authority, roles and responsibilities, and supervision. PO4 Define the IT Processes, Organization and Relationships.

Table 3. PO4 Define the IT Processes, Organization and Relationships

Sub Domain	Descriptions	Maturity
PO4.1	IT Process Framework	2
PO4.2	IT Strategy Committee	3
PO4.3	IT Steering Committee	2
PO4.4	Organisational Placement of the IT Function	2
PO4.5	IT Organisational Structure	3
PO4.6	Establishment of Roles and Responsibilities	3
PO4.7	Responsibility for IT Quality Assurance	3
PO4.8	Responsibility for Risk, Security and Compliance	3
PO4.9	Data and System Ownership	3
PO4.10	Supervision	3
PO4.11	Segregation of Duties	2
PO4.12	IT Staffing	4
PO4.13	Key IT Personnel	3
PO4.14	Contracted Staff Policies and Procedures	4
PO4.15	Relationships	3
	Average of sub domain PO4	2.9

This organization is embedded into an IT process framework that ensures transparency and control as well as the involvement of senior executives and business management. A strategy committee ensures board oversight of IT, and one or more steering committees in which business and IT participate determine the prioritization of IT resources in line with business needs. Processes, administrative policies and procedures are in place for all functions, with specific attention to control, quality assurance, risk management, information security, data and systems ownership, and segregation of duties. To ensure timely support of business requirements, IT is to be involved in relevant decision processes.

The IT department within the company should determine the staff's skills, functionality, accountability, authorization, regulation, and responsibilities and supervision based on their needs. The IT department should be part of the IT process framework that ensures openness and control which also involves senior executives and business management. Administrative processes, policies and procedures are required for all functions with particular attention to controls, quality assurance, risk management, information security, data and ownership systems, and the division of tasks. To ensure timeliness of business support, IT needs to be involved in decision-making related processes

Finding of Problems are at PTHI the rules and responsibilities of IT departments within the company as well as third parties have been defined. The IT department within the company has been developed in accordance with the existing IT strategy. This can be seen from the fatal IT part in the company. And all employees are given facilities tailored to their needs and effectiveness. The relationship between IT departments within a company with users and third parties is formally defined. From the above explanation, the Company concluded that for the PO4 process, the average is at 2.9, Defined. In more detail are sub domains PO4 Define the IT processes, organization and relationships, See Table 3.

Recommendations are adding human resources to help and improve the performance of the company Creating policies or procedures governing the issue of backup staff or secondary persons for important IT processes and always updating those policies or procedures Creating an ever-updated list to manage who is responsible and secondary person, It is necessary to create policy documents and procedures that govern the work processes of contract employees or suppliers in performing their respective duties and socialize to other fields for consultation or seek approval from the company about network problems. Calculate average sub-domain PO4 Define the IT Processes, Organization and Relationships included are PO4.1 + PO4.2 + PO4.3 + PO4.4 + PO4.5 + PO4.6 + PO4.7 + PO4.8 + PO4.9 + PO4.10 + PO4.11 + PO4.12 + PO4.13 + PO.4.14 + PO4.15 divided total sub domain = (2 + 3 + 2 + 2 + 3 + 3 + 3 + 3 + 3 + 3 + 2 + 4 + 3 + 4) / 15 = 43 / 15 = 2.9, same calculation is done for domain PO5, PO7 and PO8.

B. *PO5 Manage IT Investment*

Process Description are a framework is established and maintained to manage IT-enabled investment programmed and that encompasses cost, benefits, prioritization within budget, a formal budgeting process and management against the budget. Stakeholders are consulted to identify and control the total costs and benefits within the context of the IT strategic and tactical plans, and initiate corrective action where needed. The process fosters partnership between IT and business stakeholders; enables the effective and efficient use of IT resources; and provides transparency and accountability into the total cost of ownership (TCO), the realization of business benefits and the ROI of IT-enabled investments.

Table 4. PO5 Manage the IT Investment

Sub Domain	Descriptions	Maturity
PO5.1	Financial Management	2

Sub Domain	Descriptions	Maturity
	Framework	
PO5.2	Prioritisation Within IT Budget	3
PO5.3	IT Budgeting	2
PO5.4	Cost Management	2
PO5.5	Benefit Management	3
	Average of sub domain PO5	2.4

Policy and maintenance of the framework to manage the selection of IT investments covering cost, profit, budget priority, official budgeting process and budget reset. Work with stakeholders to identify and control total costs and benefits in the context of IT strategy, tactical planning and initiatives to take action needed to improve a condition. The process fosters the relationship between IT and business stakeholders, enabling increased effectiveness and efficiency of the use of IT resources by providing openness and accountability within the existing total cost of ownership, realization of business profits and return on investment from applied IT investments.

Finding of problems are Selection of investments made in PTHI is quite good. Because everything that is invested for the IT department is used can be as much as possible almost nothing useless, ranging from computers, laptops, LCD TV, hub, network cable, wireless router, internet connection, and so forth. Everything that will be invested is always communicated to all IT departments so that the investments made always follow the existing IT strategy. From the above explanation, the Company concluded that for the process of PO5, the average is at 2.4, Repeatable but Intuitive. Average of sub domain PO5 maturity level at 2.4. In more detail are sub domains PO5 Manage IT Investment, see Table 4.

Recommendations are implement a decision-making process to priorities the allocation of IT resources for operations, projects and maintenance to maximize IT contribution to optimizing the return on the enterprise's portfolio of IT-enabled investment programmed and other IT services and assets. The practices should allow for ongoing review, refinement and approval of the overall budget and the budgets for individual programmed. Implement a process to monitor the benefits from providing and maintaining appropriate IT capabilities. IT contribution to the business, either as a component of IT-enabled investment programmed or as part of regular operational support, should be identified and documented in a business case, agreed to, monitored and reported.

C. PO7 Manage IT Human Resources

Process Description is a competent workforce is acquired and maintained for the creation and delivery of IT services to the business. This is achieved by following defined and agreed-upon practices supporting recruiting, training, evaluating performance, promoting and terminating. This process is critical, as people are important assets, and governance and the internal control environment are heavily dependent on the motivation and competence of personnel.

Table 5. PO7 Manage IT Human Resources

Sub Domain	Descriptions	Maturity
PO7.1	Personnel Recruitment and Retention	2
PO7.2	Personnel Competencies	3
PO7.3	Staffing of Roles	2
PO7.4	Personnel Training	2
PO7.5	Dependence Upon Individuals	3
PO7.6	Personnel Clearance Procedures	3
PO7.7	Employee Job Performance Evaluation	3
PO7.8	Job Change and Termination	3
	Average of sub domain PO7	2.6

Maintenance and provision of competent workshops to create and deliver IT services to businesses. This can be achieved by following predetermined and approved support practices, such as recruitment, training, performance evaluation, promotion and job breakers. These processes are critical if humans are considered to be the most important asset, the management and internal control environment will depend on the motivation and competence of the personnel. From the above explanation, the Company concluded that for the PO7 process, the average is at 2.6, Defined. In more detail are sub domains PO7 Manage Operations, see Table 5.

In the IT governance of human resources, company does so tactically and strategically approaches in hiring and managing IT personnel. The company has its own way of choosing and seeing people who will be recruited to become IT personnel. Once IT personnel are recruited, they will be in through training informally or informally with the help of senior IT personnel within the PTHI. And everything done in this case should refer to IT strategy. Management does not have policies and procedures concerning the process of handling IT human resources [30].

Finding of Problems are Management recognizes the need for IT human resources management. There is a tactical approach to hiring and managing IT personnel, driven by project-specific needs, rather than by an understood balance of internal and external availability of skilled staff. A rotational programmed, designed to expand technical and business management skills, is established.

Recommendations are the level of supervision should be in line with the sensitivity of the position and extent of responsibilities assigned. Provide IT employees with appropriate orientation when hired and ongoing training to maintain their knowledge, skills, abilities, internal controls and security awareness at the level required achieving organizational goals. Take expedient actions regarding job changes, especially job terminations. Knowledge transfer should be arranged, responsibilities reassigned

and access rights removed such that risks are minimized and continuity of the function is guaranteed. Should receive coaching on performance and conduct whenever appropriate. Maintain IT personnel recruitment processes in line with the overall organization's personnel policies and procedures.

D. PO8 Manage Quality

Process Description is a QMS is developed and maintained that includes proven development and acquisition processes and standards. This is enabled by planning, implementing and maintaining the QMS by providing clear quality requirements, procedures and policies. Quality requirements are stated and communicated in quantifiable and achievable indicators. Continuous improvement is achieved by ongoing monitoring, analysis and acting upon deviations, and communicating results to stakeholders. Quality management is essential to ensure that IT is delivering value to the business, continuous improvement and transparency for stakeholders.

QMS (Quality Management Services) should be developed and maintained, including standards and development processes and guaranteed acquisitions. This can help planning, implementing and maintaining QMS by providing clear policies, procedures and quality requirements. Quality needs should be reported and communicated quantitatively and with an achievable indicator. Continuous improvements can be achieved by monitoring on a regular basis. Focusing on the definition of a QMS, ongoing performance monitoring against predefined objectives and implementation of a programmed for continuous improvement of IT services.

Table 6. PO8 Manage Quality

Sub Domain	Descriptions	Maturity
PO8.1	Quality Management System	2
PO8.2	IT Standards and Quality Practices	3
PO8.3	Development and Acquisition Standards	2
PO8.4	Customer Focus	2
PO8.5	Continuous Improvement	3
PO8.6	Quality Measurement, Monitoring and Review	3
	Average of sub domain PO8	2.5

The company continuously analyzes and performs an action against deviations that occur and communicates the results obtained to stakeholders. Quality management is fundamental to ensuring that IT delivers value to the business, conducts continuous improvement and transparency actions to stakeholders. In terms of quality, PTHI always prioritizes customers. So quality specifies based on customer demand. For quality standards applied based on senior experience in IT departments. The company has had regular planning of activity improvement since the company has not felt too important about it yet, but now the company is doing as planned. From the above explanation, the Company concluded that for the PO8 process, the average is at 2.5, Defined Process. In more detail are sub domains PO8 Manage Quality, see Table 6.

Finding of Problems are a programmed is being established to define and monitor QMS activities within IT. QMS activities that do occur are focused on IT project- and process-oriented initiatives, not on organization wide processes. QMS process is communicated throughout the enterprise by management and involves IT and end-user management. An education and training programmed is emerging to teach all levels of the organization about quality. Basic quality expectations are defined and are shared amongst projects and within the IT organization. Common tools and practices for quality management are emerging. Quality satisfaction surveys are planned and occasionally conducted.

Recommendations are The QMS should define the organizational structure for quality management, covering the roles, tasks and responsibilities, because it hasn't run with maximum QMS in PTHI. All key areas should develop their quality plans in line with criteria and policies and record quality data. Monitor and measure the effectiveness and acceptance of the QMS, and improve it when needed, Use industry good practices for reference when improving and tailoring the organization's quality practices, because the quality of products that are highly desired by the customer. Focus quality management on customers by determining their requirements and aligning them to the IT standards and practices. Define roles and responsibilities concerning conflict resolution between the user/customer and the IT organizations.

V. CONCLUSIONS

With an audit on PTHI the production difficulties can be overcome because the IT processes and other organizations in the company have synergized well, based on PO4 and relations with IT Human relationships with other department its clear base on PO7. Company has implemented information technology security system proven by managing the IT Investment that has been done, even though it has not been maximally base on PO5, for the problem of the batch production number it has been resolved properly because quality management has been improved in each department specially IT department base on PO8. Level maturity at Repeatable but Intuitive level and Defined Process. The results of questionnaire processing found the average value of 2 for the range of values 0 to 5. This is evident from the absence of fixed procedures on how to solve problems and the absence of documentation problems and solutions to problems encountered. This will make it difficult to detect, has it been done the right action in solving the problem? Then the absence of procedures can also increase the likelihood of IT staff doing the wrong action in solving the problem. Sub Domain PO4, PO5, PO7 and PO8 the results are quite

satisfactory. PTHI is aware of the importance of optimal IT operations, and conducts disaster prevention measures. But in practice in the field there are still many who only rely on intuitive. In some cases there are already done well, but the documentation in real terms. In addition there are also things that still require a fixed procedure in doing activities, in order to be more controlled.

Suggest for company are whether management demonstrates active support for security measures within the organization. This can be done via clear direction, demonstrated commitment, explicit assignment and acknowledgement. Whether regulations for acceptable use of information and assets associated with an information processing facility were identified, documented and implemented. Whether employee security roles and responsibilities, contractors and third party users were defined and documented in accordance with the organization's information security policy. Were the roles and responsibilities defined and clearly communicated to job candidates during the pre-employment process. Whether data protection and privacy is ensured as per relevant legislation, regulations and if applicable as per the contractual clauses.

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Design and Development of Job Recommendation System Based On Two Dominants On Psychotest Results Using KNN Algorithm

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***Abstract*—Employees are an important factor in the progress of a company. Employees with good performance will certainly provide positive results for the company. One that can determine employee performance is the right placement in the job. To find out the right place in a job, one way can be done psychologically. Psychotest can help to know the nature of an employee and suitable work based on their nature. The construction of a job recommendation application system was created to help prospective employees know their true identity and suitable work so that they can apply according to their expertise. This system is built with the programming language PHP, Javascript, HTML for web-based platforms and the KNN algorithm as the method. The KNN algorithm is used to measure the closest distance between training data and test data to produce job recommendations. Training data is taken from the expert, and book references. System trials are given to users by filling in psychological tests and questionnaires regarding the satis-faction of system use. After getting feedback from users, the value of system satisfaction reached 85%. This states that the system can provide job recommendations that are in accordance with the psychological test results of the user.**

***Index Terms*— Dominant, job recommendation, psychotes, psychological tests, KNN**

I. INTRODUCTION

A company is a form of business in the form of an organization or business entity established, work-ing and domiciled in the territory of the Indonesian state for profit [1]. For business owners and workers, they certainly agree that the ideal worker is the one who is the right man on the right place. The unique-ness of each person becomes an important capital for the industrial world to keep surviving because with variations, it can fill the gap with each other.

Companies rarely have the right people in the right position lately. It will have a psychological im-pact on employees because they will lose their moti-vation to work. Psychological examination needs to be done by psychological tests to help map out the potential and ability of a person to be able to fill in the right points [2]. Therefore a psychological test system is needed to produce work recommendations in accordance with the results of the psychology test.

In this study, the algorithm that will be used is k-nearest neighbor. This algorithm is a method that uses a supervised algorithm where the results of query instances are classified based on the majority of the categories in the KNN. This rule simply retains the entire training set during learning and assigns to each query a class represented by the majority label of its k-nearest neighbors in the training set [3]. The k-nearest neighbor algorithm has a fairly simple way of work-ing, namely by calculating the shortest distance from the test data to sample data to determine the KNN [4]. The KNN algorithm has been used in several previous studies. In the study entitled "Comparison of Accura-cy of K-NN and Naïve Bayes for Student Final Predic-tion System Algorithms" [5] yielded better results for KNN, namely 95% and only 68% with Naïve Bayes.

In another study entitled "Determination of the Department of Senior High School Using the K-Nearest Neighbor Classi-fier Method at SMAN 16 Semarang"[6] obtained the results of 79.68% in the study, so the application was made Job recommendations with two personality dominants from psychological results using KNN rhythm in order to get good results with a high percentage of success so that it can help users to find suitable work based on psychological results.

II. LITERATURE STUDIES

A. Recommendation System

The recommendation system is an application to provide choices to users according to the criteria of the user. This program is commonly used to predict an item, such as movies, books, music, etc, that attract users. This system can run by collecting data from users directly or indirectly. Direct data collection can be done as follows [7].

1. Asks the user to give rate an item.

2. Asks the user to give rank favorite items at least choose one item.
3. Give the user several choices of items and ask him to choose the best.
4. Ask the user to register the most preferred item and the item they don't like.

Indirect data collection can be done as follows [7].

1. Observe items that users see on an e-commerce website.
2. Collect transaction data at an online store.

The results of data collection, will be processed with a certain algorithm that is in accordance with the problem and produces recommendations in accordance with the parameters of the user [7].

B. *Psychotest*

Psychology comes from two words, phsicology which means someone's psychology and tests which means a way to find out one's abilities [8]. So the psychological test is a test conducted to find out one's abilities by exploring the psychological aspects of that person [8]. Psychology tests in companies are usually carried out by third parties to ensure the neu-trality of the results of the assessment [2]. The purpose of the Psychological Test is usually for employee ac-ceptance, employee mapping, and for evaluating em-ployee performance which later can be considered as a promotion for employees [2]. Psychological examination consists of three, namely psychological test, observation, and interview [2]. There are 4 personality types in human beings namely sanguinis, melancholy, koleris, plegmatis [2]. However, there is no human who has 100% of the four personalities [9]. Usually, someone will have a combination of two or three personality types and one or two dominant ones will appear [9]. According to D. W. Ekstrand, there are 12 combinations that become two dominant in human personality, such as [9],

1. Sanguine – Phlegmatic
2. Sanguine – Melancholy
3. Sanguine – Choleric
4. Melancholy – Choleric
5. Melancholy – Phlegmatic
6. Melancholy – Sanguine
7. Choleric – Melancholy
8. Choleric – Sanguine
9. Choleric – Phlegmatic
10. Phlegmatic – Choleric
11. Phlegmatic – Melancholy
12. Phlegmatic – Sanguine.

C. *KNN Algorithm*

The KNN algorithm is a method for classifying objects based on learning data which is closest to the object. Learning data is projected into a large dimension space, where each dimension presents features of the data. The KNN algorithm includes methods that use supervised algorithms [10].

The difference between supervised learning and unsupervised learning is that supervised aims to find new patterns in data by connecting existing data patterns with new data [10].

Whereas in unsupervised learning, data does not yet have any pattern, and the aim is to find patterns in a data [10]. The KNN algorithm uses neighboring classifications as predictive values from examples of new test data [10]. Near or near neighbors are usually calculated based on the euclidean distance represent-ed in the equation where matrix D (a, b) is the scalar distance of both formula vectors [11].

$$D(a,b) = \sqrt{\sum_{k=1}^{d} (a_k - b_k)^2}$$

Where:

D (a, b) = distance between test data and training data

d = number of training data

a = test data

b = training data

III. APPLICATION DESIGN

A. *Data Flow Diagram*

Data flow diagrams are used to design data flow in the job recommendation system with two dominant using the KNN method. There are two entities namely user and expert.

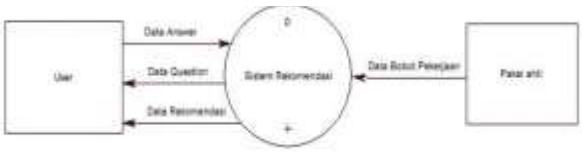

Fig 1. Level 0 DFD

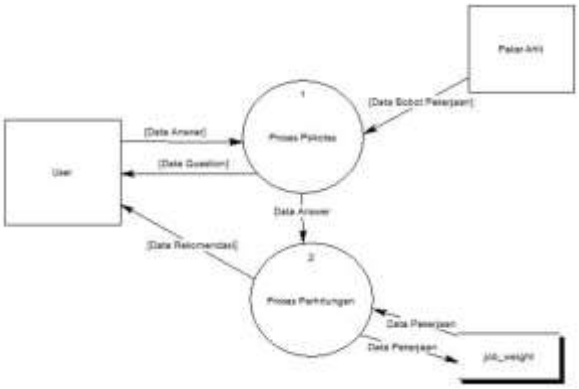

Fig 2. Level 1 DFD

The figure 1 shows DFD level 0. There are two entities, namely user and expert expert. Expert experts provide information about the work weights used as a comparison for training data and test data. The system will display questions to the user to answer, then sistem will do the calculation process using the KNN method and produce recommendations to the user regarding the appropriate work based on the answers to the psychological question.

The figure 2 above illustrates DFD level 1. There are two entities and two processes in DFD level 1. Psychological process are when the system gives a question to the user and the user provides answers to questions to the system. The calculation process is when the system matches the psychological test answer data with the work weight to produce recommendations.

B. Flowchart

Flowchart is used to describe the flow of the overall system work process. The workflow of the system is built as follows.

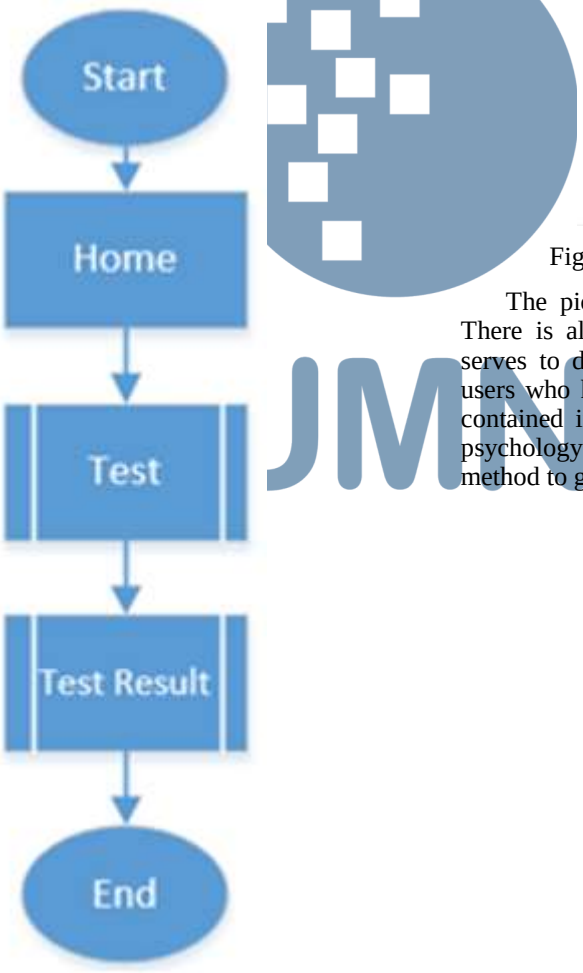

Fig 3. Flowchart System

The picture 3 illustrates the flow process of the user getting work recommendations starting from when accessing the website. When user star use sistem, user will go directly to the start page that contains the psychological test and about. Furthermore, the user can choose a psychological test to find out the recommendations of work based on the system.

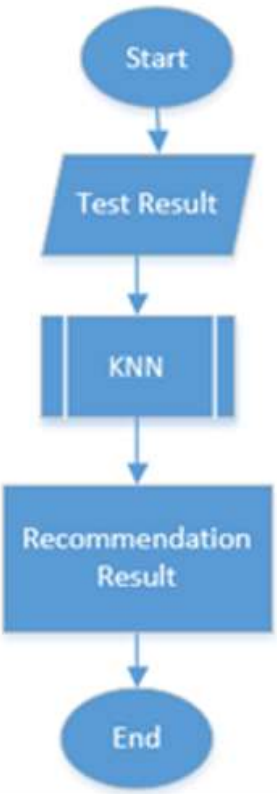

Fig 4. Recommendation Result Flowchart

The picture 4 describes subprocess in figure 3. There is algorithm that is used KNN. This process serves to display the results of recommendations to users who have filled out all psychological questions contained in the system. After getting the results of psychology tests, the system will calculate the KNN method to get work recommendations.

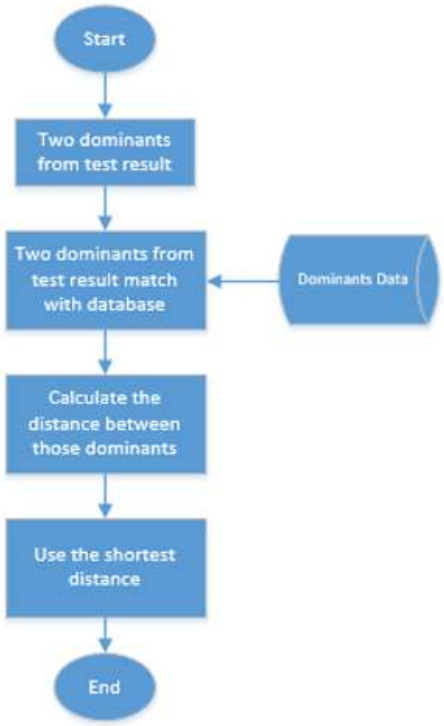

Fig 5. Calculation KNN Flowchart

The figure 5 is the process of KNN calculation flow to produce job recommendations. Data received from the user will be calculated using the euclidean distance formula to compare the closest distance be-tween test data and training data in the database. The data compared is the first and the second dominant dominant from the results of the psychological test with the first dominant and the second dominant on the weight of the work contained in the database. Af-ter comparing the two data, the shortest distance is calculated to produce a job recommendation to the user..

IV. Implementation and Testing

A. *Implementation*

This implementation is to show the design of the application that has been created and how it works. The following are pieces of the application image that have been built.

Fig 6. Home Page

The picture 6 is the start page of the system. There are 2 features on this page, namely psychotest and about. Users can take a psychological test to get a job recommendation by clicking the psychotest button. The feature contains information about the system.

Fig 7. Question Page

The picture above illustrates the psychotest page. There are 40 questions that must be answered by the user to get work recommendations. Each question can only be answered with one answer. After selecting an answer, the user can click the next button to answer the next question. The results obtained from the psychological test questions will be calculated using the KNN method to produce work recommendations that are in accordance with the character.

Fig 8. Recommendation Page

The picture above illustrates the results of recommendations after the user answers all psychological questions. Recommendation results show main character and secondary character from each user, and provide job recommendations that are in accordance with user characteristics. If you want to take a psychological test again, you can click the test button again, it will return to the start page..

B. *Testing*

There are 2 tests on this system, namely manual calculation testing to show whether the manual KNN algorithm calculation is the same as the results of the system and the system display testing obtained from user feedback. The manual calculation shows compat-

ibility with the system calculation, so the KNN algorithm used runs well on this system. Display testing gets the percentage of satisfaction using the system from the questionnaire given to the user by 85%. This shows that the recommended work recommendations match the user's personality. The following is a table of recapitulation of the results of questionnaires from the user.

Table 1. Recapilutation Questioner.

No	Question	Score					Persentation
		1	2	3	4	5	
1	Suitability of color and background design	0	1	6	17	7	79%
2	Color compatibility of writing with background	0	0	9	11	11	81%
3	Button color suitability	0	0	5	15	11	84%
4	The accuracy of the button functions according to the menu	0	0	5	17	8	79%
5	Ease in operating the website	0	0	7	12	12	83%
6	Comfort in using the website	0	1	8	11	11	80%
7	Satisfaction gets the results of the recommendations from the system	0	0	7	9	15	85%

V. CONCLUSION

The job recommendation system that serves to provide job choices to users based on two dominant personalities from the results of the psychological test has been successfully designed and built. The KNN algorithm used in this study has been successfully applied in calculating the shortest distance to produce job recommendations for users. This system can also provide recommendations that are in accordance with the two principles of the psychological test results that are filled in by the user. This is evidenced by user satisfaction in using this system which reaches 85% on the results of the questionnaire.

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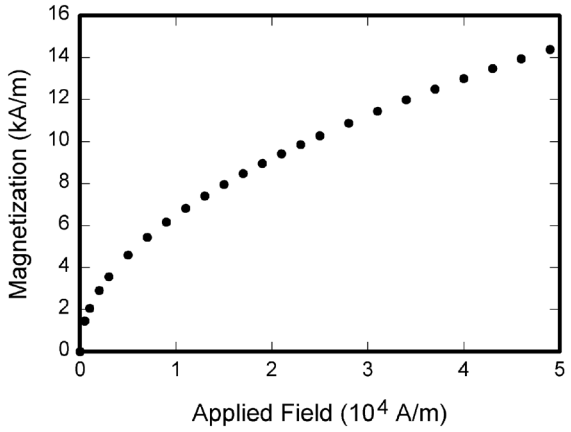

Fig. 1. Example of a figure caption

V. CONCLUSION

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Appendixes, if needed, appear before the acknowledgment.

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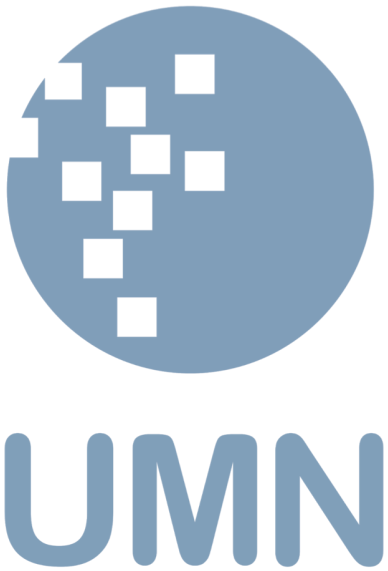
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