SELECTING PRIORITY ON INFORMATION TECHNOLOGY WORK PLANS USING AHP : A CASE STUDY IN CLINICAL LABORATORY POPULER

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ABSTRACT

Information technologies are playing vital and expanding roles in business. The increasing number of newcomers creates a competition where each companies have to survive in clinical laboratory industry. Aware with that competition, Clinical Laboratory Populer are trying to utilize information technology as their competitive strategy to improve interoperability with agencies, to integrate information systems between their departments, and also to improve their overall quality of service. An IT strategic plan have been developed, however, their work plans are limited by the company's budget and time.
Deciding the priority within the limits is important. The decision-making process is complex and both can generate positive results, or make a significant loss to the company. One method that has been used by companies to assist in this decision-making process is Analytic Hierarchy Process (AHP), a multi-criteria method of classification hierarchies, created in 1980's (Saaty, 1980). The objective of this study is to use AHP method in IT work plan priority selection process in Clinical Laboratory Populer.
As the result, by using AHP the weight of all alternatives can be measured. The priority of Process Area sorted from the highest to the lowest consecutively are SD (0,222), OT (0,179), CAM (0,130), OPF (0,126), SCON (0,112), SSD (0,088), RSKM & IRP (0,72). The overall inconsistency ratio is 0,08 (≤ 0,10). Therefore, it can be concluded that Process Area SD becomes the priority.

Keywords: AHP, decision-making process, priority selection.

1. INTRODUCTION

Information technologies are playing vital and expanding roles in business. Information technology can help all kinds of businesses improve the efficiency and effectiveness of their business processes, managerial decision making, and workgroup collaboration, which strengthens their competitive positions in rapidly changing marketplaces (O'Brien, 2011). Efforts in utilizing information technology at clinical laboratory facilities have shown good results such as improving the service processes and creating simplicity in communications with patient. Integrated laboratory equipments within a computer system could prevent duplication of test results, and also could speed up the laboratory services, which could optimize its overall usability.

The increasing number of newcomers creates a competition where each companies have to survive in clinical laboratory industry. Aware with that competition, Clinical Laboratory Populer are trying to utilize information technology as their competitive strategy to improve interoperability with agencies, to integrate information systems between their departments, and also to improve their overall quality of service. An IT strategic plan have been developed, however, their work plans are limited by the company's budget and time.

Therefore, deciding priority within the limits is important. The decision-making process is complex and both can generate positive results, or make a significant loss to the company. One method that has been used by companies to assist in this decision-making process is Analytic Hierarchy Process (AHP), a multi-criteria method of classification hierarchies, created in 1980's (Saaty, 1980). The objective of this study is to use AHP method in IT work plan priority selection process in Clinical Laboratory Populer.

2. RESEARCH FRAMEWORK

2.1. Process Area Mapping

IT work plans are mapped into the relevant CMMI-SVC Process Area (PA). They are distinguished based on categories and specific goals (SG) documented in CMMI-SVC. The results are shown in Table 1, showing the IT work plans and their relevant process areas, categories, and spesific goals. 8 Process Areas have been mapped from the IT work plans; Service System Development (SSD), Capability and Availability Management (CAM), Service Continuity (SCON), Organizational Training (OT), Risk Management (RSKM), Incident Resolution and Prevention (IRP), Service Delivery (SD), Organizational Process Focus (OPF).

Table 1. IT Work Plans Mapped Into CMMI-SVC Process Area

IT Work Plans	CMMI-SVC Process Area	Category	CMMI-SVC Specific Goals
Development of Clinical Laboratory Information System	Service System Development (SSD)	Service Establishment and Delivery	SG 1. Develop and Analyze Stakeholder Requirements SG 2. Develop Service Systems SG 3. Verify and Validate Service System
IT Infrastructure Improvement	Capability and Availability Management (CAM)	Project and Work Management	SG 1. Prepare for Capacity and Availability Management SG 2. Monitor and Analyze Capacity and Availability
Maintain usability of the previous information system until the development process is finished	Service Continuity (SCON)	Project and Work Management	SG 1. Identify Essential Service Dependencies SG 2. Prepare for Service Continuity SG 3. Verify and Validate the Service Continuity Plan
IT training programme for employee and IT staff	Organizational Training (OT)	Process Management	SG 1. Establish an Organizational Training Capability SG 2. Provide Training
Build Disaster Recovery Center to protect data and IT services	Risk Management (RSKM)	Project and Work Management	SG 1. Prepare for Risk Management SG 2. Identify and Analyze Risks SG 3. Mitigate Risks
Improvement for IT support services by helpdesk	Incident Resolution and Prevention (IRP)	Service Establishment and Delivery	SG 1. Prepare for Incident Resolution and Prevention SG 2. Identify, Control, and Address Individual Incidents SG 3. Analyze and Address Causes and Impacts of Selected Incidents
Promotion and education for patients through website	Service Delivery (SD)	Service Establishment and Delivery	SG 1. Establish Service Agreements SG 2. Prepare for Service Delivery SG 3. Deliver Services
Standardize IT	Organizational Process Focus	Process	SG 1. Determine Process

service	(OPF)	Management	Improvement Opportunities SG 2. Plan and Implement Process Actions SG 3. Deploy Organizational Process Assets and Incorporate Experiences

2.2. HIERARCHY STRUCTURE

There are 4 main criteria used to determine priority on the Process Areas, they are Impact on Business Objectives, Ease of Implementation, Human Resource Availability, and Budget Availability. These criteria are identified from interview with the managers and the director of Clinical Laboratory Populer. Figure 1 shows a hierarchy of the criteria, each are broken down into the 8 Process Areas.

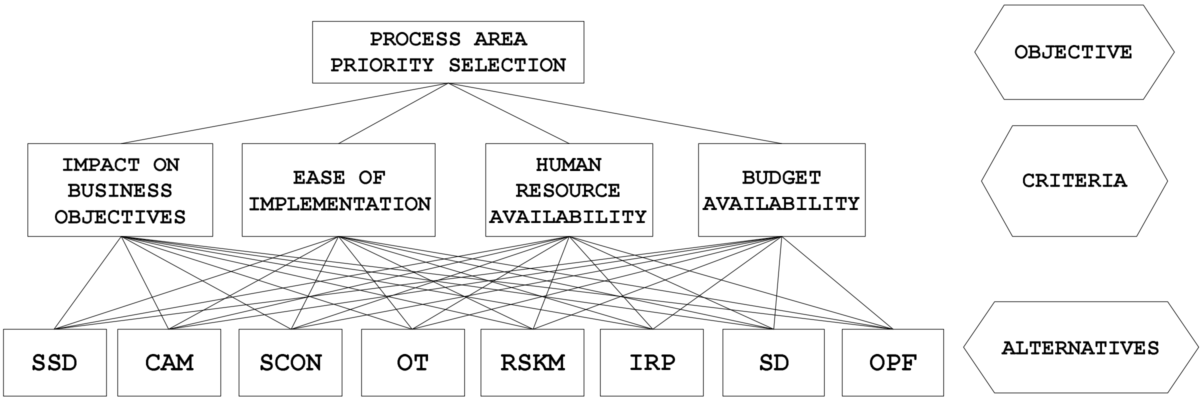

Figure 1. Hierarchy to determine priority Process Area

Definitions of each criteria are explained as follows :

1. Impact on Business Objectives : Priority of Process Area is determined based on its impact on the business objectives of the company. The greater positive impact that could be given by a Process Area, the greater the chance for the Process Area to be prioritized.
2. Ease of Implementation : Priority of Process Area is determined based on its ease of implementation. The less complex a Process Area means it is easier to implement and the priority is higher.
3. Human Resource Availability : The company considers about human resource availability in a chosen Process Area. Clinical Laboratory Populer is not an IT company, so utilization of human resource should be done efficiently. The company will try to fulfill roles needed within a Process Area.
4. Budget Availability : The company considers about budget availability, it means if a Process Area requires big budget during the implementation, then the company should be able to provide it. If the company could not afford the budget, then the priority of the Process Area becomes smaller.

2.3. DATA COLLECTION

There are 2 types of questionnaires used in process area priority selection, a pairwise comparison questionnaire used among criteria and a pairwise comparison questionnaire used among process area in each criteria. The comparative scale used in this step refers to the scale made by Saaty, the scores ranges between 1 to 9.

In the pairwise criteria comparison questionnaire, there are 6 comparative questions which compare all four criteria. Meanwhile in process area comparison questionnaire, there are 28 questions which compare the 8 process area.

2.4. RESPONDENT

There are 19 respondents which consist of: 5 branch managers, 1 finance manager, 1 processing manager, 1 marketing manager, 1 IT manager, 5 IT staffs, and 5 specialist pathology doctors. The respondents are asked to fill the questionnaires, comparing the criteria and the process area in each criteria. The filling process are also guided so errors could be minimized.

2.5. PAIRWISE COMPARISON

The comparison data among criteria and process area obtained from questionnaire are summarized into a pairwise comparison matrix. The average score or combined score from questionnaire are arranged in a table following this condition:

The ratio value of element Ai compared to element Aj is stated as Aij which express the importance relationship between Ai and Aj. When the value of Aij is set, theoretically the value of Aji is 1/Aij, whereas if the value of i is equal to j then the absolute value is 1. Numerical values used in the comparison are obtained from the ratio scale, refer to the ratio scale table created by Saaty. Table 2, 3, 4, 5, and 6 show pairwise comparison matrices among criteria and alternatives.

Table 2. Pairwise Comparison Matrices Among Criteria

Criteria	Impact on Business Objectives	Ease of Implementation	Human Resource Availability	Budget Availability
Impact on Business Objectives	1	5,23	3,72	0,82
Ease of Implementation	0,19	1	3,02	0,35
Human Resource Availability	0,27	0,33	1	0,26
Budget Availability	1,22	2,87	3,80	1

Table 3. Pairwise Comparison Matrix Among Process Area for Criteria Impact on Business Objectives

Criteria	SSD	CAM	SCON	OT	RSKM	IRP	SD	OPF
SSD	1	0,79	1,94	0,81	0,85	4,86	0,67	0,38
CAM	1,26	1	2,20	0,94	1,23	5,22	0,85	0,51
SCON	0,51	0,45	1	0,41	0,56	3,94	0,39	0,30
OT	1,24	1,06	2,44	1	1,51	5,66	1,05	0,55
RSKM	1,17	0,81	1,79	0,66	1	3,77	0,83	0,33
IRP	0,20	0,19	0,25	0,18	0,26	1	0,17	0,18
SD	1,49	1,18	2,57	0,95	1,21	5,86	1	0,55
OPF	2,63	1,97	3,34	1,80	2,99	5,66	1,82	1

Table 4. Pairwise Comparison Matrix Among Process Area for Criteria Ease of Implementation

Criteria	SSD	CAM	SCON	OT	RSKM	IRP	SD	OPF
SSD	1	0,20	0,29	0,19	1,41	0,25	0,18	3,02
CAM	4,90	1	1,42	0,71	4,95	0,88	0,34	5,36
SCON	3,45	0,70	1	0,45	4,40	0,85	0,34	4,86
OT	5,31	1,40	2,20	1	5,56	2,54	0,85	5,86
RSKM	0,71	0,20	0,23	0,18	1	0,25	0,17	1,94
IRP	4,02	1,13	1,18	0,39	4,02	1	0,38	4,65
SD	5,51	2,95	2,91	1,18	5,97	2,61	1	6,41
OPF	0,33	0,19	0,20	0,17	0,51	0,21	0,16	1

Table 5. Pairwise Comparison Matrix Among Process Area for Criteria Human Resource Availability

Criteria	SSD	CAM	SCON	OT	RSKM	IRP	SD	OPF
SSD	1	0,40	0,43	0,33	2,22	0,47	0,28	2,87
CAM	2,48	1	1,29	0,72	4,73	1,33	0,65	5,76
SCON	2,32	0,77	1	0,73	3,69	1,09	0,37	4,05
OT	3,02	1,38	1,37	1	5,22	1,86	0,90	5,86
RSKM	0,45	0,21	0,27	0,19	1	0,27	0,18	2,24
IRP	2,12	0,75	0,92	0,54	3,75	1	0,45	3,98
SD	3,62	1,53	2,70	1,11	5,41	2,22	1	5,86
OPF	0,35	0,17	0,25	0,17	0,45	0,25	0,17	1

Table 6. Pairwise Comparison Matrix Among Process Area for Criteria Budget Availability

Criteria	SSD	CAM	SCON	OT	RSKM	IRP	SD	OPF
SSD	1	0,82	0,39	0,45	1,47	0,76	0,36	3,23
CAM	1,22	1	0,55	0,53	3,02	0,90	0,46	3,77
SCON	2,54	1,80	1	0,82	3,09	2,01	0,35	4,33
OT	2,24	1,87	1,22	1	3,51	2,79	0,65	5,86
RSKM	0,68	0,33	0,32	0,28	1	0,48	0,18	1,99
IRP	1,31	1,11	0,50	0,36	2,07	1	0,27	3,69
SD	2,76	2,18	2,82	1,53	5,58	3,64	1	6,29
OPF	0,31	0,26	0,23	0,17	0,50	0,27	0,16	1

3. THE RESULT AND ANALYSIS

Expert Choice 11 software is used to calculate the weight of all criteria and alternatives. The results are explained in the following:

a. Weight of all criteria

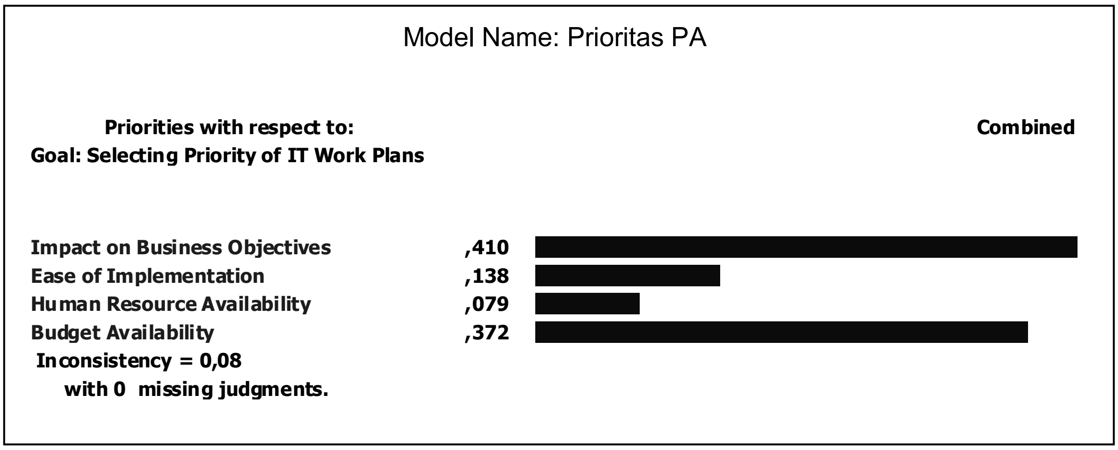

Figure 2. Weight comparison among criteria

The inconsistency ratio obtained from the weight calculation among criteria is 0,08 (≤ 0,10). This means the result is reliable. The criteria Impact on Business Objectives has the biggest value 0,410. This means the company management believe that the criteria is very affecting the priority selection. The second biggest value is Budget Availability (0,372), this means the company management also believe that the criteria can be affecting the priority selection, but not as big as the Impact on Business Objectives. The values of the other two criteria, Ease of Implementation and Human Resource Availability are 0,138 and 0,079. Both have smaller value than the previous two criteria, this means both of these criteria have less impact on determining the priority of process area.

b. Weight of alternatives for criteria Impact on Business Objectives

The inconsistency ratio obtained from the calculation is 0,00992 (≤ 0,10). This means the result is reliable. The biggest weight for the alternatives after processing the pairwise comparison matrix is OPF process area (0,253). This means the process area OPF is considered having the biggest impact on the present business objectives compared to the other process area. The second biggest weight is the process area SD by 0,150 and followed by OT by 0,149.

Both of these process area have quite similar impact on the present business objectives, although smaller than OPF. Figure 3 shows the weight calculation among alternatives for criteria Impact on Business Objectives.

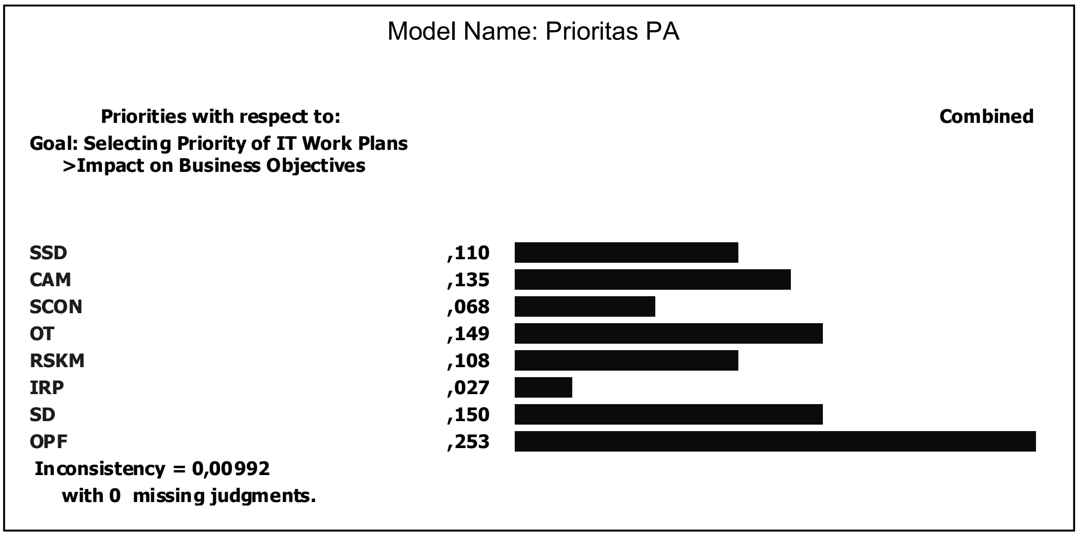

Figure 3. Weight calculation result among alternatives for criteria Impact on Business Objectives

c. Weight of alternatives for criteria Ease of Implementation
The inconsistency ratio obtained from the calculation is 0,03 (≤ 0,10). This means the result is reliable. The biggest weight of the alternatives after processing the pairwise comparison matrix is SD Process Area (0,277). This means the process area is considered as the least complex and its implementation is the easiest than the other process area. The second biggest process area is OT with value 0,223 followed by CAM by 0,147. Figure 4 shows the weight calculation result among alternatives for criteria Ease of Implementation.

d. Weight of alternatives for criteria Human Resource Availability
Expert Choice's calculation shows the value of inconsistency ratio as 0,01 (≤ 0,10), this means it is reliable. The calculation show that SD Process Area has the biggest weight with value 0,244. The company considers the human resource requirement in that process area is the most suitable process area to be fulfilled. Figure 5 shows the weight calculation result among alternatives for criteria Human Resource Availability.

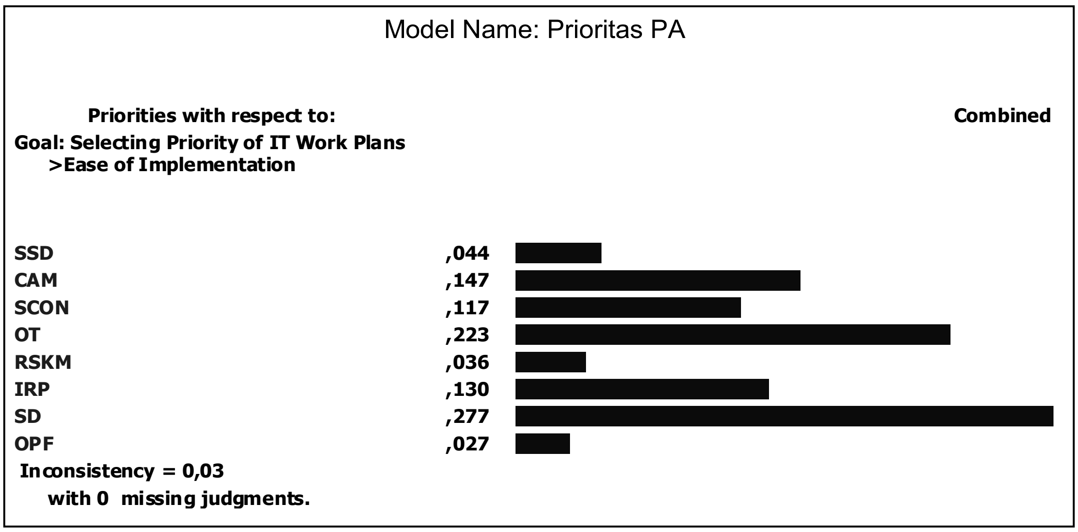

Figure 4. Weight calculation result among alternatives for criteria Ease of Implementation

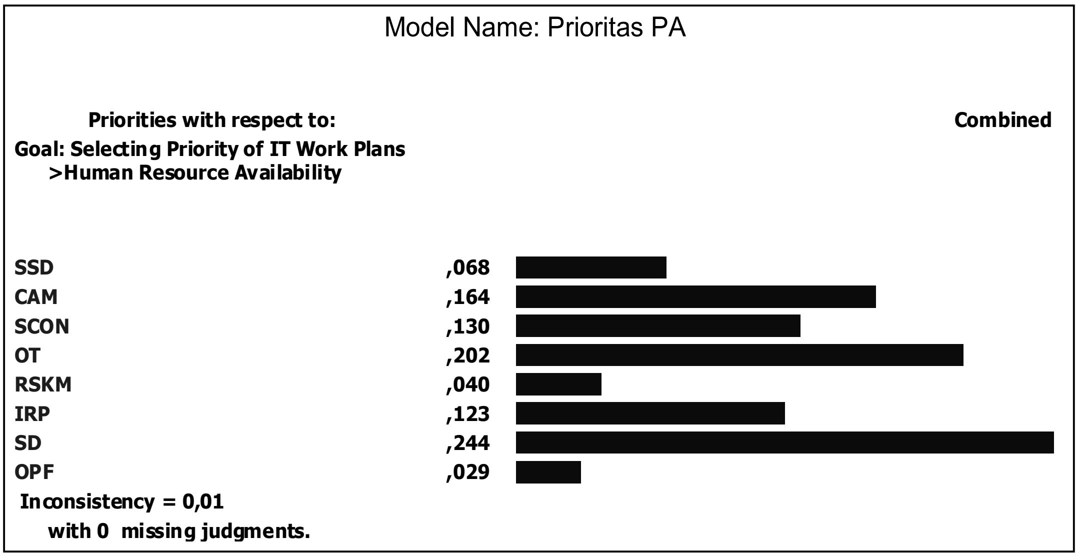

Figure 5. Weight calculation result among alternatives for criteria Human Resource Availability

e. Weight of alternatives for criteria Budget Availability

Expert Choice's calculation shows the value of inconsistency ratio as 0,01 (≤ 0,10), this means it is reliable. The calculation show that SD Process Area has the biggest weight with value 0,283. This means the company considers the budget required on that Process Area is the most able to be fulfilled. The second biggest weight is OT with value 0,193. Figure 6 shows the weight calculation result among alternatives for criteria Budget Availability.

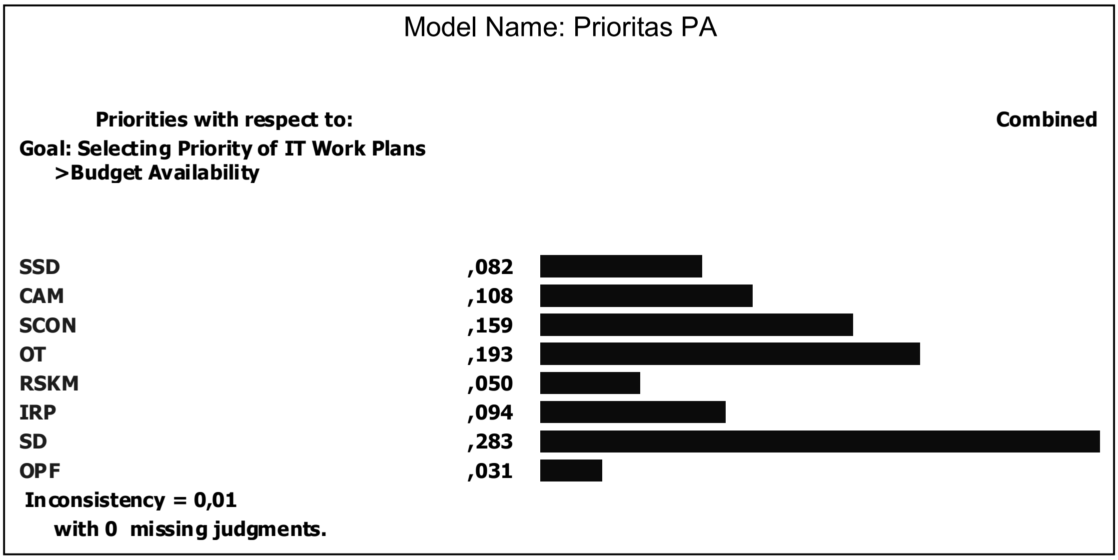

Figure 6. Weight calculation result among alternatives for criteria Budget Availability

f. Determining the priority of Process Area

Determining the priority of Process Area on each criteria has given different results. The highest priority on criteria Impact on Business is OPF, while on the other three criteria is SD. Expert Choice is used once again to measure the highest priority from all criteria by calculating the total weight among alternatives. The total weight are obtained from the sum of all multiplication among alternative weight in each criteria and related criteria weight. The total weight of alternatives will determine the priority of Process Area. Figure 7 and Table 7 show the total weight calculation result for all alternatives.

Figure 7. Total calculation result of the alternatives weight

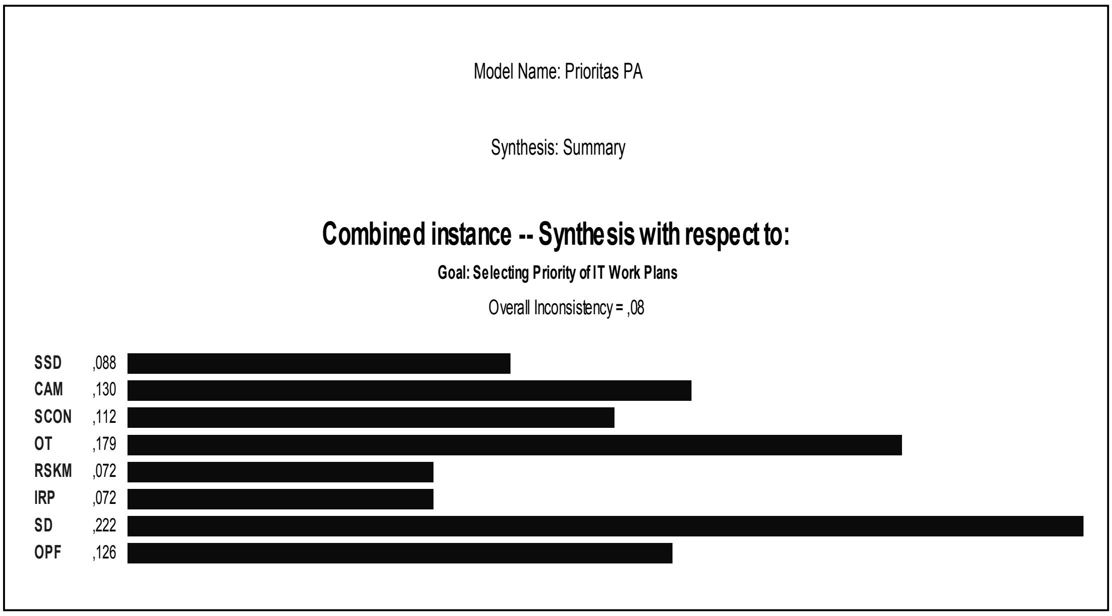

Table 7. Total weight calculation of Process Area alternatives

No	Criteria		*Process Area*								
	Criteria name	**Weight**	**SSD**	**CAM**	**SCON**	**OT**	**RSKM**	**IRP**	**SD**	**OPF**	**Total**
1	Impact on Business	0,410	0,110	0,135	0,068	0,149	0,108	0,027	0,150	0,253	1,000
2	Ease of Implementation	0,138	0,044	0,147	0,117	0,223	0,036	0,130	0,277	0,027	1,001
3	Human Resource Availability	0,079	0,068	0,164	0,130	0,202	0,040	0,123	0,244	0,029	1,000
4	Budget Availability	0,372	0,082	0,108	0,159	0,193	0,050	0,094	0,283	0,031	1,000
	Total Weight	0,999	0,087	0,129	0,113	0,180	0,071	0,074	0,225	0,121	

4. CONCLUSIONS

By using AHP, the weight of all alternatives can be measured. Process Area SD has the biggest weight among the other alternatives as shown in Table 7 and Figure 7. The priority of Process Area sorted from the highest to the lowest consecutively are SD (0,222), OT (0,179), CAM (0,130), OPF (0,126), SCON (0,112), SSD (0,088), RSKM & IRP (0,72). The overall inconsistency ratio is 0,08 (≤ 0,10). Therefore, it can be concluded that Process Area SD becomes the priority.

This study has shown that AHP can be used to help the company choose the priority on IT work plans. Process Area SD represents the IT work plan of promotion and education for patients through website. If that process area becomes the priority, then this means the company considers the work plan as the most important work plan. It has to be the first priority and has to be done first than any other work plans.

For further study, the AHP method could be implemented in a software so the company could choose the priority of work plans quicker and simpler. Also the AHP method could be combined with any other decision making methods so there will be a comparative results between them.

5. REFERENCES

[1] CMMI Product Team. 2010. *CMMI for Services, Version 1.3*. Carnegie Mellon University.
[2] O'Brien, James A. 2011. *Management Information Systems*. Seventh Edition. McGraw-Hill International Edition.
[3] Saaty, T.L. 1994. *Highlights and Critical-Points in the Theory and Application of the Analytic Hierarchy Process.* European Journal of Operational Research.
[4] West, Michael. 2004. *Real Process Improvement Using the CMMI*. Auerbach Publications CRC Press Company.

Design Analysis of Solar Powered Systems Full Flexible 10 WP Capacity

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Abstract

The need for electricity is good for the industry, offices, and public and individuals are greatly increased. However, the increase in demand for electricity is not accompanied by the additional power supply. Based on these problems, chosen solar energy as an alternative energy to generate electric power. A tool that is used here is the solar cell because it can directly convert solar radiation into electrical energy (photovoltaic process). So that solar energy can be used at night, then during the day, the electrical energy generated is stored before a battery which is

controlled by the regulator. Regulator output is directly connected to the inverter from the DC to AC. The test results of solar modules (photovoltaic) indicated that the results of the average power output reached 7.6 Watt, and the currents were 0.4 A. This is because the photovoltaic follows the direction of movement of the sun and always located at the photovoltaic to remain facing the sun. Therefore, it will still be able to capture the radiant sun to the fullest

Keywords: *Solar Cell; Design Analysis; Photovoltaic System; Electric Power.*

1. Introduction

Energy is the ability to do the job. Energy is the power that can be used to perform various processes of activity including mechanical energy, heat, and others. Therefore, almost all disputes in this world, stems from the struggle for energy resources. There is some natural energy as a clean, non-polluting, secure and unlimited alternative energy known as renewable energy (Akhmad, 2011). New and renewable energy sources in the future will increasingly have a very important role in meeting energy needs. This is because the use of fossil fuels for conventional power plants over a long period of time will deplete petroleum, gas and coal resources whose reserves are increasingly depleted (Anggara etc, 2014). In Indonesia located in this tropical region. Actually has a considerable advantage of receiving sustained sunlight throughout the year. Unfortunately the energy seems to be left wasted for natural purposes only (Hasan, 2012). In addition solar energy can be utilized with the help of other equipment, that is by changing the radiation of the sun of another form. There are two kinds of ways to convert solar radiation into other energy, that is through solar cell and collector (Karmiathi, 2012). There is no doubt that solar energy is one of the most environmentally friendly and promising sources of energy in the future, since no pollution is generated during the energy conversion process, and also its energy source is widely available in nature (Rahayuningtyas, etc, 2014). Therefore, the application of Solar Power (PLTS) technology to utilize the available solar energy potentials in those locations is the right solution (Subandi, etc 2015). PLTS or better known as solar cells (Photovoltaic cells) will be more desirable because it can be used for various relevant purposes and in various places such as offices, factories, housing, and others. So it is deemed necessary to be studied further, in order to obtain a comprehensive technical study (Ubaidillah, etc 2012). In this study will analyze the design of solar power plant system design capacity of 10 WP on the laboratory scale. With the aim of research to calculate the characteristics of solar power plants by using Solar Cell 10 WP and calculate the maximum power generated by the solar power generated. So it can be analyzed the performance of the design of solar power generation system for 10 WP capacity.

2. Research Methods

The method used in circuit analysis design is done several stages, including:

(A). Determination of solar panels used, so that in its use there is no damage to the solar panel itself.

(B). Determination of the regulator component to be used, so that in the application there is no error of use that result in less good or can damage the solar panels and electrical equipment installed later.

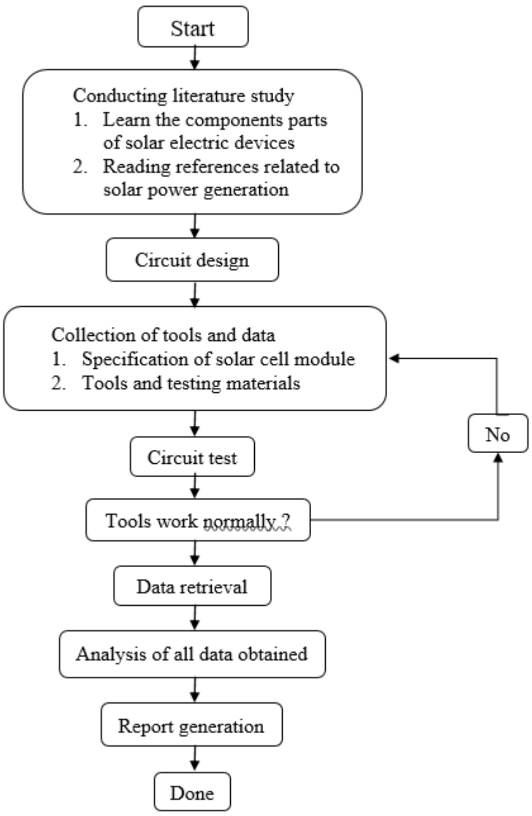
(C). In terms of the use of components, also considered economic terms and conditions in the market, so that in the search component is not experiencing difficulties.

(D). In terms of aesthetics, design tools to be made in such a way that neat, attractive and safe in its use.

(E). Selecting components that pass the qualifications and according to system requirements, such as BCR and inverter (if there is AC load). The methodology used in the design of 10 WP solar power generation analysis can be described in the form of a systematic flowchart such as Figure 1.

3. Results and Discussion

The first step in this research is to study the literature and design of related systems regarding solar cell



power system as shown in Figure 2.

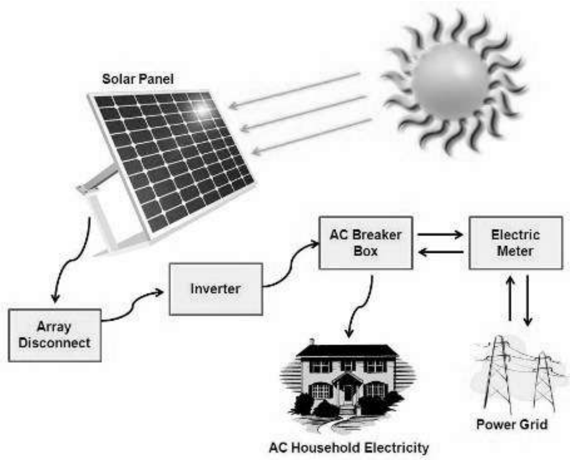


Figure 1. Diagram of the research flow

Figure 2. Installation of 10 WP solar cell

Based on Figure 2, the PLTS block diagram is designed, the working principle of the Solar Power Generation (PLTS) created is as follows: the sun is shining, the radiation produced from the sunlight is then captured by the photovoltaic solar panel. This solar panel is a combination of several solar cells of very small size and thin both in series, parallel or mix (series and parallel), so it becomes a large solar panel and can produce large currents and voltages. The working principle of solar panels is that if sunlight is on solar panels, the electrons in the solar cell will move from N to P, so that at the output terminal of the solar panel will generate electrical energy. The amount of electrical energy generated by solar panels varies depending on the number of solar cells combined in the solar panel. The output of this solar panel is a large direct current (DC) electric current. The outlet voltage depends on the number of solar cells installed in the solar panel and the amount of sunlight that illuminates the solar panel (Bansai, 1990). The output from these solar panels can already be used directly to loads requiring a DC voltage source with a small current consumption. In order for the resulting electric energy to be used in conditions such as at night (the condition when solar panels are not exposed to sunlight), the output of this solar panel must be connected to a storage medium, in this case Is the battery. But this is not directly linked from the solar panel to the battery, but must be connected to the regulator circuit, where in the circuit there is a charging circuit Automatic charger (Automatic charger). The function of this regulator is to regulate the output voltage of the solar panel and adjust the incoming current to the battery automatically. In addition, the Regulator works to connect and disconnect the current from the Solar Panel to Battery automatically and also serves to disconnect the flow from the load battery when there is a short circuit or excessive load. The type of regulator designed here is a type of modification or a combination of series and parallel. Solar panels can actually be directly used without a regulator or battery set, but this is not done because it can overload the performance of the panel (due to excessive load) so there will be no fatal damage to the solar panel. In addition, this regulator also serves to secure from the overload of solar panels so that solar panels are not easily damaged (Widodo et al. 2010). The connection of the battery to the load is connected directly to the parallel load. If the battery is fully charged. To protect the batteries due to overload or short charge in the load, then before the batteries are connected directly must pass through the protection circuit. Where the function is clear enough, namely to protect or protect the battery due to excessive load (over load) or short circuit at the load. If it is desired that the output of electricity from this PLTS in the form of alternating current electricity (AC) then the PLTS can already discharge the direct current (DC) power must be connected to an electronic circuit / electronic module called Inverter DC-AC. Where Inverter DC-AC function to convert electric current direction (DC) become electric current back and forth (AC). Once the electric current is converted to alternating electric current, the output of this inverter which has the form of alternating current can be directly used to supply electrical equipment and electronics that require alternating current. The magnitude of the voltage and output power that can be connected to the load must be in accordance with the ability of the inverter used and the size of the storage system used (the amount of ampere hour (AH) or the amperage of the battery). In this research, we tested the effect of solar angle on the output of solar cell. It aims to find out how big the influence of the angle of the sun comes and also how big the influence of the angle can be ignored. The way of testing is done as Figure 3.

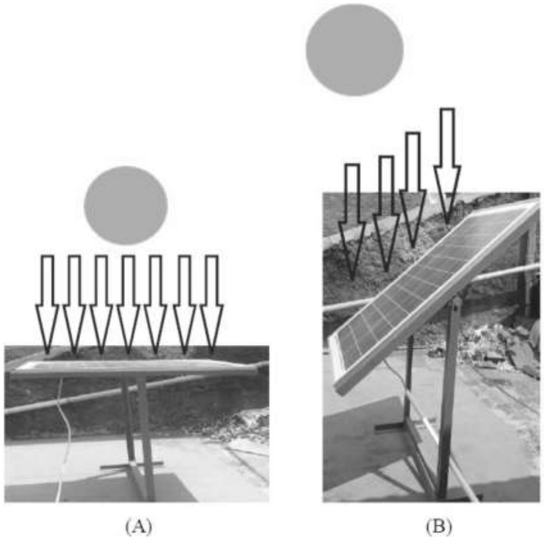


Figure 3 : Testing the influence of the direction of the sun angle to the output of the solar cell (A) the direction of ray perpendicular (B) the direction of the rays to form a certain angle.

The installation of a solar cell panel in a position perpendicular to the direction of sunlight as Fig. 3A is done to find out the maximum output, while to know the effect of sunlight direction on the output panel is done by changing the direction of solar cell panel every 10 to reach Angle 45 to the coming sun angle as Fig. 3B. From these steps can be known the influence of the direction of sunlight on the output of solar cell panels. Data collection of sun position / angle is required. It aims to know how big the shift angle of the sun at a certain time interval. This data retrieval is done from 9:00 to 16:00. Test results can be seen in Table 1. Using the data in Table 1 above can be made graph of the relationship between open circuit voltage with time, as in Figure 4.

Table 1. Results of stress, current and power testing for various angular positions of solar cells

NO	Hour	Straight Position			Angle Shape Position		
		Voltage (Voc)	Current (A)	Output Power (W)	Voltage (Voc)	Current (A)	Output Power (W)
1	8.00	4.08	0.2	3.306	4.14	0.28	4.706
2	9.00	4.18	0.21	3.568	4	0.514	8.306
3	10.00	3.86	0.362	5.65	3.76	0.61	9.162
4	11.00	3.9	0.416	6.522	3.64	0.61	8.826
5	12.00	3.8	0.394	5.988	3.66	0.61	8.874
6	13.00	3.6	0.416	5.936	3.66	0.61	8.874
7	14.00	3.8	0.194	2.948	3.86	0.574	8.896
8	15.00	4.14	0.17	2.856	4	0.41	6.626
9	16.00	4.04	0.166	2.712	2.16	0.27	4.566
Rata - rata		3.934	0.28	4.382	3.654	0.498	7.648

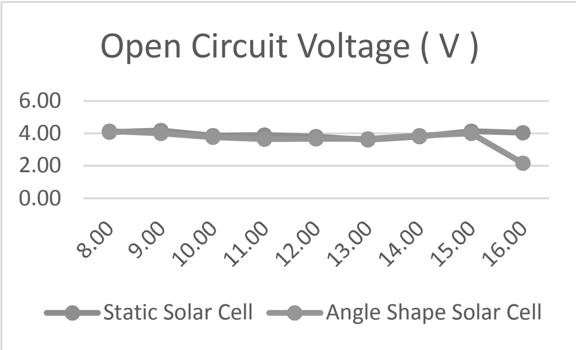


Figure 4. Graph of the relationship between the open circuit voltage to the time on the solar cell.

Based on Figure 4. explains that the average measurement value of open circuit voltage in the solar module angular position position of 3.654 V and obtained the average value of short circuit voltage when the solar module upright position (horizontal) of 3.934 V. Differences in open circuit voltage results (Voc) obtained because the solar module always positioned perpendicular to the sun so that the results obtained will be larger than the solar module with the position to form an angle. Furthermore, to know the comparison of short-circuit current to time can be seen in Figure 5.

Figure 5 illustrates that the current generated by the solar module that forms an angle greater than the current generated by the solar module in the horizontal position has a static property, this occurs because the irradiation captured by the solar module on the position of forming a larger angle so that The current captured in the position to form a larger angle because the greater the irradiation value the greater the irradiation value. From the measurement result data, it is obtained the measurement value of the average short circuit current in the solar module in the position of forming an angle of 0.498 A and obtained the average value of short circuit current when the solar module is perpendicular (horizontal) of 0.28 A. For Knowing further about the magnitude of the ratio of the output power to the time in the solar cell, can be seen in Figure 6.

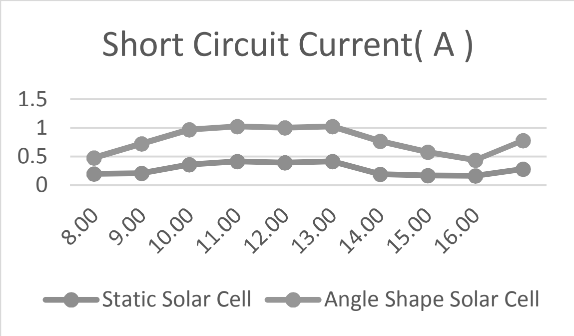


Figure 5. Graph of the comparison between short-circuit current to time on solar cell.

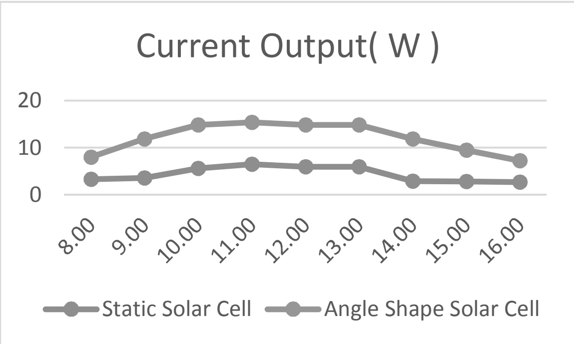


Figure 6. Graph of the comparison between the output power of time on the solar cell.

From the open circuit voltage (Voc) and the short circuit (Isc) obtained at the time of testing the resulting output power by multiplying the fill factor (FF) in the sury module so that the graph of the ratio of output power at the angle position with the solar module at position perpendicular. The average output power generated at the moment of the solar module positioning an angle of 7,648 W and obtained the average output power value when the solar module position is perpendicular (horizontal) of 4,382 W.

4. Conclusion

From the results of design analysis of solar power generation system with 10 WP solar panels can be obtained the following conclusion:

(A). Characteristic of the Design that is, the position of the angle of the solar module when following the direction of the movement of the sun produces an average open circuit voltage (Voc) of 3.654 V and the average current of short circuit (Ioc) 0.498 A and the horizontal position creates an average voltage Average The open circuit (Voc) is 3,934 V while the average current short-circuit (IOC) 0.28 A

(B) The position of the slope angle of the solar module when following the direction of the movement of the sun produces Output Power (Pout) of 7,648 W and the position perpendicular (horizontal) produces Output Power (Pout) 4.382 W.

Bibliography

[1] Akhmad, Kholid, (2011), Solar Power and Its Application for Remote Areas, Journal of Engineering Dynamics, 1 (1): 28-33

[2] Anggara, I.W.G.A, Kumara, I.N.S., Giriantari, I.A.D, (2014), Study on the Performance of Solar Power Generation 1.9 Kw At Udayana University, Bukit Jimbaran, Spectrum, 1 (1): 118- 122.

[3] Hasan, H., (2012), Design of Solar Power Generation In Saugi Island, Journal of Marine Research and Technology, 10 (2): 169-180.

[4] Karmiathi, N.M., (2011), Designed Solar Cell Modules By Utilizing Compatible Photovoltaic Components, Journal Logic, 11.

[5] Rahayuningtyas, A., Kuala, SI, and Apriyanto, F., (2014), Planning Studies of Simple House Scale In Rural Areas For Alternative Power Generation To Support Environmentally Friendly And Renewable Programs, Proceedings of SnaPP 2014 Science, Technology and Health, pp. 223-230

[6] Subandi, Slamet Hani, (2015), Solar Energy Power Plant As A Water Pump Using Solar Cell, Technoscientia Tech Journal, 7 (2): 157-163

[7] Ubaidillah, Suyitno, Juwana, Endra Wibawa, (2012), Development of Termoelektrik Hybrid Devices - Solar Cells For Household Power Generation, Jurnal R & D of Central Java Province, 10 (2): 194-211

[8] Bansai, NK, etc, (1990), Renewable Energy Sources And Conversion Technology, Tata McGraw-Hill

[9] Publishing Co. Limited, New Delhi

[10] Widodo, Djoko Adi, Suryono, Tatyantoro A, (2010), Empowering Solar Energy As An Electric Energy Traffic Control Lamp, Journal of Electrical Engineering, 2 (2): 133-138