PROJECT TIME MANAGEMENT INFORMATION SYSTEM USING CRITICAL PATH METHOD METHOD AT PT. MATRIX PRIMATAMA

Winni Octaviyani Djohar[1], Sufa'atin[2]

[1,2] Informatics Engineerings – Universitas Komputer Indonesia
112-116 Dipati Ukur Street, Bandung, 40132
E-mail : winnieyoctaviani@gmail.com[1], sufaatin@email.unikom.ac.id[2]

ABSTRACT

PT. Matrix Primatama is a national private company which is engaged in construction services. Based on the results of interviews with Mr. Endang A. Jaelani as Project Implementation Coordinator at PT. Matrix Primatama said that in working on a project in the field, not everything went smoothly as planned by the first and second parties. There are often obstacles in the time of project implementation due to the emergence of risks during project work so that it is difficult to determine which work can be postponed and which cannot be postponed.

Based on these problems, needed a solution to overcome the problems that occur at PT. Matrix Primatama, namely by creating a system that helps in managing project time by clarifying which work can be postponed and which work cannot be postponed using the Critical Path Method. The solution in controlling risk is the need for a system that can help the project manager make identification and management of risks that might occur in project work. Furthermore, solutions in controlling the time and cost of the need for a system that can help the project manager evaluate the work on the project every week so that the work every week can be evaluated according to plan and the project work can be controlled even better.

Keywords : Project Management, Critical Path Method, Earned Value Management, Probability Impact Matrix.

1. INTRODUCTION

PT. Matrix Primatama is a national private company which is engaged in construction services with the scope of work covering the fields of architecture, the civil field, the field of interior and procurement of goods. Based on the results of interviews with Mr. Endang A. Jaelani as Project Implementation Coordinator at PT. Matrix Primatama stated that in working on a project in the field, not everything went smoothly as planned by the first and second parties. There are often obstacles in the time of project implementation due to the emergence of risks during project work so that it is difficult to determine which work can be postponed and which work cannot be delayed. From what has been explained above, the factors that cause obstacles are caused by the neglect of risks that arise unexpectedly during the implementation of the project and the absence of project risk control, so the project implementation coordinator has difficulty making decisions early because they have to wait for a decision from the project manager.

Based on these problems, we need a solution to overcome the problems that occur at PT. Matrix Primatama, namely by creating a system that can assist the Project Implementation Coordinator in managing project time by clarifying which work can be postponed and which work cannot be postponed. The solution in risk control is the need for a system that can help the project manager make identification and handling risks that might occur in project work, so that the person in charge of work can see how to deal with the risks that are happening so that handling can be quickly carried out without having to contact the project manager first . Furthermore, solutions in controlling the time and cost of the need for a system that can help the project manager evaluate the project work per week so that the work every week can be evaluated according to plan and the project work can be controlled even better.

1.1. Research Purposes

The objectives to be achieved in building a project management system are as follows :

1. Helps project managers manage project schedules to find out which jobs can be postponed and cannot be postponed.
2. Help the project manager manage project risks so that the obstacles that arise during project work can be identified before project execution and the risks that arise have been properly mitigated so that the company can reduce the likelihood of risks that will arise.
3. Help the project manager evaluate the planned time and cost by the project work to completion.

1.2. Research Method

The research method uses descriptive research methodology with a quantitative approach. [1] The stages of the research methods to be carried out in the construction of Project Time Management Information Systems at PT. Matrix Primatama can be seen in Figure 1.

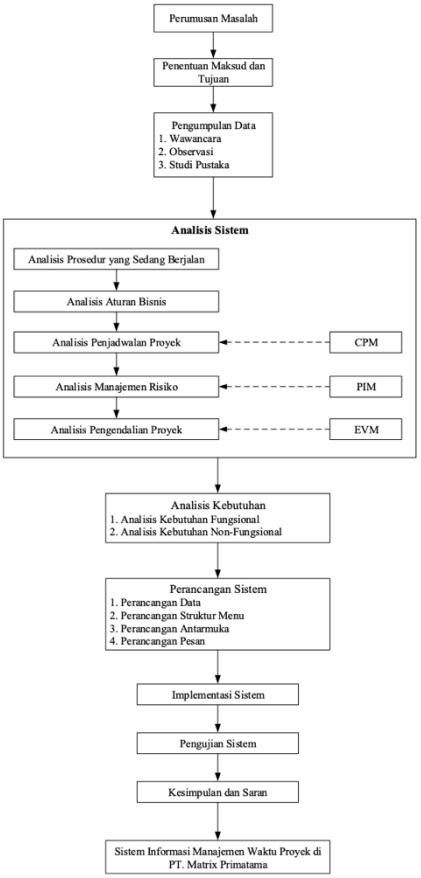


Figure 1. Research method

1.3. Information Systems

The system is a collection of several elements that work together to solve a problem. These elements can be conventional systems (data, people, and procedures) and modern system elements (data, people, procedures, hardware, and software). Information is the result of processing data that has a form that is beneficial for the recipient to make decisions.

Based on the previous understanding, it can be concluded that the information system is a component in the form of data, people and software that work together to solve a problem and produce information that will be used to solve a problem and support business activities in an organization. [2]

1.4. Project Management

Based on the previous understanding, it can be concluded that the information system is a component in the form of data, people and software that work together to solve a problem and produce information that will be used to solve a problem and support business activities in an organization. [3]

Projects are activities to achieve a goal with limited time and budget. In general, the project has three constraints (Triple Constraint), namely budget, schedule, and quality. [3]

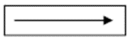
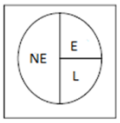
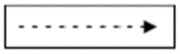
Based on the definition of project management, it can be said that project management is the process of planning, organizing, leading and controlling the resources of an organization to achieve the goals that were previously planned. The process grew because of the urge to find ways to manage things that are in line with the demands of dynamic activities and are different from routine operational activities. [3]

1.5. Critical Path Method (CPM)

Critical Path Method (CPM) or known as the critical path, which is a series of pathways that have components in the form of activities, the longest time, the fastest time and shows the fastest duration of a project. The series provides an overview of the first activity to the last activity in the project and displays the relationship of each work. [4]

The critical path is important for project implementers because it can provide information on which work must be on time and which work can be postponed. This information is very useful for the project owner to be able to determine work priorities. If a critical path is delayed, it will cause a delay in the overall running of the project. The symbol of Activity on Arrow can be seen in Table 1.

Table 1. Table Activity Symbols on Arrow

No	Symbol	Definition
1		Project activity
2		Event at project work
3		Dummy Activity

For calculations, there will be three calculations, namely the count forward, countdown and total float.

1. Forward Pass

This calculation starts from the Initial Event to the Terminal Event to calculate the completion time of the activity (EF), the fastest time the activity is carried out (ES). Forward pass rules as follows:

a. The time for a new activity can start if the predecessor activity has been completed except for the initial activity.
b. The earliest finish time for an activity is the same as the initial start time, plus the time period of the activity that preceded it. The equations for advanced calculations can be seen in 1

$$EF(i-j) = ES(i-j) + D(i-j) \quad (1)$$

c. If an activity has two or more previous activities, then the earliest start time (ES) of the activity is the same as the earliest finish time (EF) that is spread from the previous activity.

2. Backward Pass

This calculation is the opposite of advanced calculation, which is from Finish to Start. Countdown is done to find out when the slowest occurrence of an activity (LF), the time the slowest occurrence of an activity (LS) and when the slowest event occurs (L).

The rules for backward pass are as follows :

a. The last start time of an activity is the same as the last finish time minus the time period for the activity concerned. The formula for backward calculation can be seen in 2.

$$LS(i-j) = LF(i-j) - D(i-j) \quad (2)$$

b. If an activity is divided into two or more activities, then the last time (LF) of the activity is the same as the last starting time (LS) of the smallest next activity.

3. Total Float (TF)

Total Float shows the time allowed for an activity that can be postponed, without affecting the overall project completion schedule. The calculation formula for Total Float can be seen in 3.

$$TF = LF(i-j) - EF(i-j) - D(i-j) \quad (2.3)$$

1.6. Probability Impact Matrix (PIM)

Probability Impact Matrix (PIM) is a method used to measure the risk that occurs by considering two elements, namely Probability and Impact. Probability is the potential of an unwanted event to occur, while the impact is the level of influence of activity in influencing other work if an unwanted event occurs.

Probability Impact Matrix is a way to measure risk by providing a level of risk (Very Low, Low, Medium, High and Very High) to the risk measured by a combination of probability and impact scales. [5] This is done to provide an assessment of the probability of each risk and the impact caused is to scale the index. [6] The following formula for measuring risk can be seen in 4.

$$R = P \times I \quad (4)$$

Explanation :
R: The level of importance of risk.
P: The probability that a risk will occur.
I: Impact (impact) if a risk occurs.

For probability and impact matrices that are used, namely Buston Square Matrix as shown below:

Probabilitas							
	Sangat Tinggi	5	5	10	15	20	25
	Tinggi	4	4	8	12	16	20
	Sedang	3	3	6	9	12	15
	Rendah	2	2	4	6	8	10
	Sangat Rendah	1	1	2	3	4	5
			1	2	3	4	5
			Sangat Kecil	Kecil	Sedang	Besar	Sangat Besar
			Dampak				

Figure 2. *Boston Square Matrix*

Explanation :

15 - 25 = High Risk, immediate treatment is needed.

06 - 12 = Medium Risk, high level attention is needed.

01 - 05 = Low Risk, routine procedures are needed.

1.6.1. Risk Management

Handling of risks is done so that the types and costs of risks whose value has been calculated can be handled immediately and appoint the person responsible for the risk. There are several ways to determine risk management based on the form of risk, namely: [3]

1. Acceptable risks, the risks that can be overcome by the company because the consequences are considered quite small.
2. Reduced risk, that is the risk that can be dealt with by handling an alternative action whose consequences may be empty or smaller.
3. Reduced risk, that is the risk that the impact of the loss can be reduced by minimizing the likelihood of it happening.
4. Risk transferred, which is a form of risk that can be transferred to another party in part or whole.

1.7. Metode Earned Value Management (EVM)

Earned Value Management (EVM) method is a method that can be used to control costs and time when carrying out project work by calculating costs according to the budget in accordance with work completed. [7] This method measures the number of work units that have been completed at a time based on the amount of the budget provided and the realization of the budget for work. By doing this calculation, the relationship between what has been achieved physically and the amount of the budget spent has been appropriate or not. [4] Also, this method also provides information on project progress carried out in a certain period and can predict the progress of the project in the next period in terms of cost and time of project completion. [8]

1.8. Unified Modeling Languang (UML)

Unified Modeling Language (UML) is the design of software in describing software that will be built using the Object Oriented Programming approach.

UML itself has several components, namely Use Case, Activity Diagram, Class Diagram, and Sequence Diagram. [9]

2. RESEARCH CONTENTS

2.1. Research Study Case

Case study of this research material is the project construction activities of the Grand Imperial Residence House and Office with No.SPK 004 / SPK-EX / KTR / VII / 2017. The project will start on July 3, 2017 until January 3, 2018 with an estimated cost of Rp. 1,425,700,000. The cost breakdown can be seen in Table 2.

Table 2. Cost Details Table

No	Work	Cost
I	Preparation	Rp 11.979.000
II	Earth Excavation	Rp 18.945.086
III	Structural	Rp 427.310.183
IV	Wall construction	Rp 379.002.575
V	Roof construction	Rp 82.465.497
VI	Frame and Door Installation	Rp 98.379.000
VII	Ceiling Installation	Rp 46.600.800
VIII	Floor Coverings	Rp 90.810.000
IX	Painting	Rp 74.287.845
X	Electric installation	Rp 47.460.720
XI	Sanitation installation	Rp 72.270.000
XII	Other	Rp 76.192.238
	Total	Rp 1.425.702.944
	Rounded up	Rp 1.425.700.000

2.2. Project Scheduling Analysis

Project scheduling analysis is one of the planning elements that provides information about the project schedule and project progress in terms of resource performance and project duration and progress time for project completion. In this scheduling research using the Critical Path Method (CPM). The following details of the work of the Grand Imperial Residence Home and Office Development project can be seen in Table 3.

Table 3. Job description table

NO	JOB	DURATION (WEEK)
I	Preparation	1
II	Earth Excavation	4
III	Structural	7
IV	Wall construction	9
V	Roof construction	3
VI	Frame and Door Installation	4
VII	Ceiling Installation	5
VIII	Floor Coverings	4
IX	Painting	3
X	Electric installation	2
XI	Sanitation installation	3
XII	Other	3

Berikut adalah hubungan antar pekerjaan pada proyek Pembangunan Rumah dan Kantor Grand Imperial Residence dapat dilihat pada.

Table 4. Table hubungan antar pekerjaan

NO	JOB	ID	PREVIOUS JOBS	NEXT JOB	DURATION (WEEK)
I	Preparation	I	-	II,III	1
II	Earth Excavation	II	I	IV	4
III	Structural	III	I	V	7
IV	Wall construction	IV	II	VII	9
V	Roof construction	V	III	VI	3
VI	Frame and Door Installation	VI	V	VIII	4
VII	Ceiling Installation	VII	IV	IX,X	5
VIII	Floor Coverings	VIII	V,VI	XI,X	4
IX	Painting	IX	VII	XII	3
X	Electric installation	X	VII	XI	2
XI	Sanitation installation	XI	VIII,X	XII	3
XII	Other	XII	IX,XI	SELESAI	3

Based on Table 3 and Table 4 will be calculated to find the critical path and create a network. For the calculation results can be seen in Table 5.

Table 5. Critical path calculation table

ACTIVITY			DURATION	ES	EF	LS	LF	TF
I	J	ID						
0	1	I	1	0	1	0	1	0
1	2	II	4	1	5	1	5	0
1	3	III	7	1	8	1	8	0
2	4	IV	9	5	14	5	14	0
3	5	V	3	8	11	8	11	0
5	6	VI	4	11	15	11	15	0
4	7	VII	5	14	19	14	19	0
8	11	VIII	4	15	19	20	24	5
9	12	IX	3	19	22	24	27	5
7	10	X	2	19	21	19	21	0
10	11	XI	3	21	24	21	24	0
11	12	XII	3	24	27	24	27	0

For critical path networks can be seen in Figure 3.

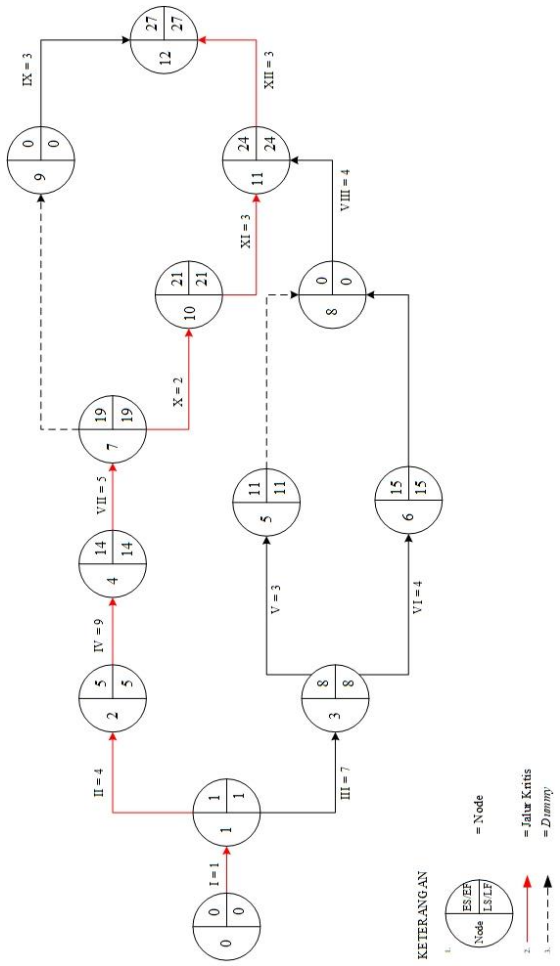


Figure 3. Critical path network

A list of critical jobs can be seen in Table 6.

Table 6. critical job list

NO	JOB	ID	STATUS
I	Preparation	I	Critical Path
II	Earth Excavation	II	Critical Path
III	Structural	III	-
IV	Wall construction	IV	Critical Path
V	Roof construction	V	-
VI	Frame and Door Installation	VI	-
VII	Ceiling Installation	VII	Critical Path
VIII	Floor Coverings	VIII	-
IX	Painting	IX	-
X	Electric installation	X	Critical Path
XI	Sanitation installation	XI	Critical Path
XII	Other	XII	Critical Path

Based on the results of scheduling analysis on Table 6 can be known the total time of work that is on the critical path. Critical path on work with id I - II - IV - VII - X - XI - XII is work that cannot be postponed, if there is a work delay then there will be a delay to the next job.

2.3. Project Risk Analysis

2.3.1. Risk Identification

Identification of risks that will occur is done by grouping based on the type of risk, by providing a risk code for each item. A list of risk identifications can be seen in Table 7.

Table 7. Risk identification

ID	TYPE OF RISK	RISK
R1	Estimation	The schedule is not according to plan
R2		Costs not according to budget plan
R3		Increase in material prices
R4	Personal	Labor unable to attend
R5		Labor resigned
R6	Supporting Tools	Delay when sending work support tools
R7		Damage or loss of work support equipment
R8	Safety	Workers are injured because of tools / materials
R9		Damaged safety equipment (helmet / shoes)
R10		Labor fell during roof installation
R11		Manpower is crushed by materials

2.3.2. Calculation of Risk Interest

The results of the calculation of risk interests can be seen in Table 8.

Table 8. The risk interest

No	ID	P	D	D
1	R1	4	4	16
2	R2	1	2	2
3	R3	1	2	2
4	R4	3	2	6
5	R5	3	3	9
6	R6	1	2	2
7	R7	1	3	3

8	R8	1	2	2
9	R9	1	2	2
10	R10	1	4	4
11	R11	1	4	4
12	R12	2	3	6
13	R13	3	5	15
14	R14	1	4	4
15	R15	2	2	4

2.3.3. Risk Management

Measures to deal with each of these risks can be seen in Table 9.

Table 9. Risk control

ID	RISK CONTROL
R1	Utilizing existing employees by increasing work hours and understanding of the projects being carried out.
R2	Make a reduction in the amount of costs that are less necessary.
R3	Always check and ask the supplier if there is an increase in the price of materials.
R4	Utilize existing human resources by providing additional work and increasing work hours.
R5	Negotiate by utilizing existing human resources by increasing work hours and doing concurrent work.
R6	Coordinate with logistics to follow up with related parties.
R7	Increase caution when carrying out work and increase supervision at the project site.
R8	Give direction to workers to prioritize work safety, one of which uses physical security equipment.
R9	Give direction to workers to prioritize work safety, one of which uses physical security equipment.
R10	Give direction to workers to prioritize work safety, one of which uses physical security equipment.

2.4. Project Control Analysis

2.5.1. Calculation of Work Weight

The calculation of work weight is calculated based on the unit price of the work in accordance with the contract value and does not include VAT of 10%. Details of the weight calculation results for each job can be seen in Table 10.

Table 10. Work weight calculation

No	Job	Cost	Weight (%)
I	Preparation	Rp 11.979.000	0.840
II	Earth Excavation	Rp 18.945.086	1.329
III	Structural	Rp 427.310.183	29.972
IV	Wall construction	Rp 379.002.575	26.584
V	Roof construction	Rp 82.465.497	5.784
VI	Frame and Door Installation	Rp 98.379.000	6.900
VII	Ceiling Installation	Rp 46.600.800	3.269
VIII	Floor Coverings	Rp 90.810.000	6.369
IX	Painting	Rp 74.287.845	5.211
X	Electric installation	Rp 47.460.720	3.329
XI	Sanitation installation	Rp 72.270.000	5.069
XII	Other	Rp 76.192.238	5.344
Total		Rp 1.425.702.944	100.000
Rounding Up		Rp 1.425.700.000	

2.5.2. Recap of Analysis Results

The results of the evaluation analysis can be seen in **Table 11**.

Table 11. Results of analysis recap

Week	Varians Analysis		Performance Analysis		Estimation Analysis	
	Cost CV= EV-AC (Rp.)	Schedule SV=EV-PV (Rp.)	Cost CPI= EV/PV	Schedule SPI=EV/AC	ETC (Rp.)	EAC (Rp.)
1	2.138.554	-	1.217	1.000	1.161.275.782	1.171.113.133
2	1.283.133	-	1.372	1.000	1.036.054.250	1.039.508.016
3	1.283.133	-	1.372	1.000	1.036.054.250	1.039.508.016
4	1.710.844	-	1.027	1.000	1.324.552.676	1.388.623.257

5	1.710.844	-	1.027	1.000	1.324.552.676	1.388.623.257
6	1.568.273	0	1.015	1.000	1.302.439.866	1.404.028.216
7	997.992	-13.829.319	1.011	0.866	1.321.445.240	1.409.774.553
8	1.568.273	-5.859.639	1.016	0.943	1.306.994.160	1.402.722.871
9	1.853.414	5.859.639	1.017	1.057	1.294.301.349	1.401.464.198
10	3.136.546	-	1.031	1.000	1.282.333.411	1.382.353.488
11	1.568.273	-8.126.507	1.026	0.883	1.329.426.227	1.389.331.097
12	1.710.844	-	1.025	1.000	1.322.768.636	1.390.657.442
13	1.283.133	8.126.507	1.017	1.117	1.325.723.879	1.402.166.903
14	1.853.414	13.829.319	1.024	1.207	1.314.210.684	1.392.892.062
15	2.281.125	-	1.072	1.000	1.298.175.521	1.329.809.018
16	2.281.125	-	1.072	1.000	1.298.175.521	1.329.809.018
17	2.281.125	-	1.072	1.000	1.298.175.521	1.329.809.018
18	1.995.984	-	1.066	1.000	1.306.810.512	1.336.836.529
19	1.995.984	-	1.066	1.000	1.306.810.512	1.336.836.529
20	2.281.125	-	1.033	1.000	1.311.108.434	1.380.023.350
21	2.281.125	-	1.033	1.000	1.311.108.434	1.380.023.350
22	2.138.554	-	1.046	1.000	1.316.578.235	1.363.293.768
23	2.423.695	-	1.112	1.000	1.260.594.814	1.282.260.746
24	2.423.695	-	1.112	1.000	1.260.594.814	1.282.260.746
25	2.566.265	-	1.112	1.000	1.258.808.393	1.281.638.650
26	2.566.265	-	1.112	1.000	1.258.808.393	1.281.638.650
27	2.566.265	-	1.112	1.000	1.258.808.393	1.281.638.650

2.5. Functional Requirements Analysis

2.5.1. *Use Case Diagram*

Use cases can be seen in Figure 4.

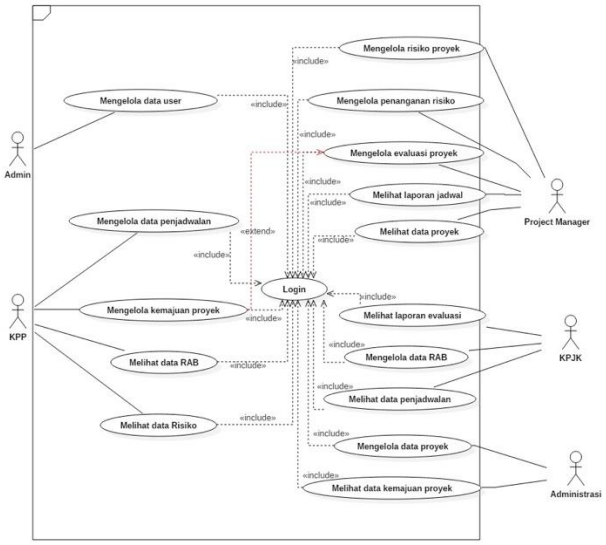


Figure 4. *Use case diagram*

2.6. Interface Design

An example of interface design can be seen in Figure 5.

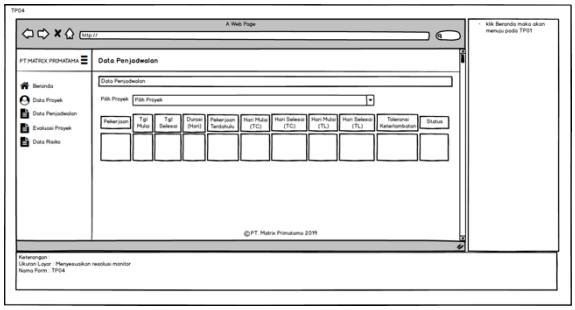


Figure 5. scheduling interface design

2.7. Testing Conclusion

2.7.1. Black Box Testing Conclusions

Software testing uses the black box method. Tests carried out by providing test data that is right and wrong then see the truth of the output results. [10] Based on the results of the black box testing system that has been carried out as a whole it is concluded that the process that occurs in the project time management information system using the critical path method at PT. Matrix Primatama is correct and as expected. Display an error message, a warning is quite maximal and functionally the system built can produce an expected output.

2.7.2. Conclusion of Beta Testing

Based on the results of beta testing, it can be concluded that the project time management information system uses the critical path method at PT. Matrix Primatama is in accordance with the expected goals.

1. The project time management information system built has helped monitor scheduling, manage

evaluation data with recommended costs and time per week and control risk.
2. The project time management information system that was built can help to schedule and make project progress reports.
3. The project time management information system that was built can already help to create a project RAB.
4. The project time management information system that was built can assist the administration to manage project data.
5. The project management information system that was built can help the admin to manage user data.

3. CLOSING

3.1. Conclusion

Based on the results obtained in the final project research that has been done, it can be concluded that:
1. The project time management information system that was built can help the project manager determine the focus of the work by providing information on which jobs can be postponed and cannot be postponed..
2. The project time management information system that has been built can assist the project manager in evaluating project costs and time which will be a reference for controlling time and costs.
3. The project time management information system that has been built can assist the project manager in carrying out risk control by preparing the handling to be carried out from the identification of risks in accordance with the level of risk and the influence of risks that can be a reference for risk control.

3.2. Suggestion

Based on the results that have been done on the project time management information system using the critical path method at PT. Matrix Primatama obtained advice, namely the need for development and maintenance in accordance with the needs for the future.

BIBLIOGRAPHY

[1] P. D. Sugiyono, Metode Penelitian Kombinasi, Yogyakarta: alfabeta, 2015.

[2] I. d. W. A.Yulianto, Analisis dan Desain Sistem Informasi, Bandung: Politeknik Telkom, 2009.

[3] A. Husein, Manajemen Proyek, Yogyakarta: Andi Offset, 2011.

[4] I. Widiasanti dan L. , Manajemen Konstruksi, Bandung: PT. Remaja Rosdakarya, 2013.

[5] P. M. Institute, PMBOK A Guide to the Project Management Body of Knowledge Fifth Edition, USA: Project Management Institute, Inc., 2013.

[6] Sufa'Atin, "Implementasi Probability Impact Matriks (PIM) untuk mengidentifikasi kemungkinan dan dampak risiko proyek," vol. VIII, p. 44, 2017.

[7] T. H. Jesaya Hasadungan, "Sistem Informasi Manajemen Proyek di CV RIAPRIMA PUTRI AMBAR," 2016.

[8] Sufa'atin, "Penerapan Metode Earned Value Management (EVM) dalam Pengendalian Biaya Proyek," pp. 315-320, 2017.

[9] R. Miles dan K. Hamilton, Learning UML 2.0: A Pragmatic Introduction to UML, Sebastopol, CA: O'Reilly Media, 2006.

[10] L.Williams, "Testing Overview and Black-Box Testing Techniques," pp. 34-35, 2006.