HYBRID METHOD OF THE HOUSE OF RISK AND MONTE CARLO FOR PLANNING MODELS ON THE NEW CONSTRUCTION OF PROJECT X

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ABSTRACT

The series of activities which include preparation and selection of various alternatives, as well as its implementation, are carried out in a way and logically so that the consequences that may occur can be predicted and anticipated. In an activity, especially projects, risks is an inseparable part. HOR method is used identify and measure impact risks on project X. Monte Carlo simulation is used as a simulator in estimating the completion of a project. The simulation results on project X are known that there are 30 potential events that occur due to 29 risk agents in the project. Trajectory critical of the project the occurs in activity A-B-C-D-E-F-G-H-M-V-W-AG-AH-AI-AJ-AK. Based on results simulation montecarlo with crystal ball software known that with under risk so that the solution project becomes pessimistic with time completion 1.074 days or 351 late from time already planned.

Keyword : Risk Management, Project Management, Forecasting, House of Risk, Monte Carlo

1. INTRODUCTION

According to Coleman Woodbury in (Setiadi, 2014) defines planning as a process to prepare in a fairly systematic way, recommendations related to policies and actions as well as attention to be given to the impact or "spillover effect". Planning is a series of activities that include preparation, selection of alternatives in which the implementation is carried out logically and systematically so that various consequences that may occur can be predicted and anticipated. Every planner must be able to anticipate the consequences that will result from a plan that will be made between different factors, proper scheduling is one of the important elements for the success of a management project (Habibi et al., 2018). The most difficult aspect is scheduling because it estimates the duration of the activity which is highly correlated with the estimated cost, available resources, construction methods to be used in project work, how much is involved and what level of production (Farr, J., & Dow, Benjamin L. , 2010). In an activity, especially projects, risk is an inseparable part. Evaluation and assesment to something risk need to use implementation mitigation. Risks that occur in a project can have a direct impact on the project completion time, so that mitigation can be carried out as a form of anticipation. Delay in completion will not only have an impact on costs, but many factors will be affected, both tangible and intangible, so that a risky development planning framework is needed.

2. LITERATURE REVIEW

2.1 Risk Management

The possibility of an event that has an impact on the company's objectives is often interpreted and understood as a risk. Meanwhile, the culture, processes and structures that are geared towards realizing goals and managing side effects are project management. Risk management aims to prepare for all possible risks that may occur during the project (AS/NZS 4360:2004).

2.1.1 Management Project

The application of knowledge, the use of equipment, skills and techniques from project activities to meet the requirements that exist in a project is also called project management (PMBOK, 2017). Where in management includes :

a. Identify various requirements in project implementation.

b. Meeting the needs and resolving various concerns and expectations of stakeholder interests as planned and implemented into the project.

c. Balancing the various constraints that cover the project but are not limited to the project. These constraints are:

1) Scope (work scope)
2) quality (quality)
3) Schedule (Schedule)
4) Budget (budget)
5) Resources (Source Power), and
6) Risk (Risk)

2.1.2 House Of Risk (HOR)

House Of Risk is a framework of combining FMEA and HOQ methods (Pujawan & Geraldine, 2009). Two stages have been shown in the House Of Risk framework, namely HOR1 and HOR2. HOR1 is used to determine the risk rating of each agent based on the potential risk aggregate (ARP). After knowing the priority of risk through ARP, then to prioritize the actions that must be taken by the company/organization in dealing with the selected risk agent, it can be done in HOR 2.

2.1.3 Monte Carlo Simulation

The Monte Carlo method is class algorithm calculations that rely on taking sample by random for count the result . Advantages from Monte Carlo simulation that is more flexible than PERT (Farr, J., &Dow, Benjamin L., 2010). Existence Monte Carlo dependence on numbers / numbers random , method this often run with help device soft . (Hubbard, 2014).

2.2 Flowchart Of Research

In order to facilitate understanding to achieve the goals expected in the proposed framework, a design is made which is represented in the research flow diagram.

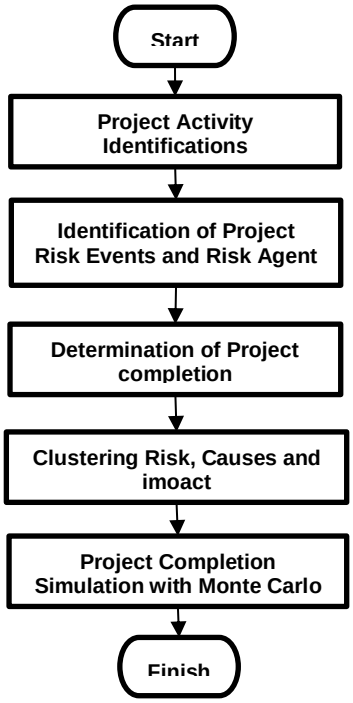

Figure 1. Project Risk Assessment Flow Chart.

2.3 Step Of Simulation

2.3.1 Project Activity Identification

Planning is the determination of the requirements for project resources in the order of use in various activities that must be carried out to achieve the goals achieved. However, a plan is incomplete if it is not accompanied by a time factor, but time must be flexible to financial, social and other factors in planning. The results of the dependency logic in table 4.1 are then processed into POM QOM V.4 software using the CPM method or single estimate time, resulting in the current project time duration, and knowing the project's critical trajectory in the form of a Gant Chart. An activity is said to be critical if its initial delay will cause a delay in the completion time of the entire project. The critical path (path) of a

project is the path in a network such that activities on this path have a slack of 0 (zero).

2.3.2. Identification of Project Risk Events and Causes

At the risk assessment stage, the House of Risk (HOR) method is needed to determine the factors that have the potential to cause project delays on the project's critical path with SCOR rules. The stages in compiling HOR 1:

a. Identify risk events that may occur on the critical path that has been identified from the project duration.

b. calculate the severity of each risk event. In this process, a scale is used to identify categories of risk impacts.

c. Identify risk agents and measure the occurrence value of each risk agent.

The emergence of opportunities / probability and consequences/impacts that arise can be used as a basis for risk assessment. An index scale is needed to provide a guideline for assessing the probability of each risk and its impact. The use of index scale guidelines refers *to the index as shown in table 1.*

Table 1. Index scale risk assessment.

Scale	Probability	impact	
		Cost	Time
Very High	>70%	>€250K	>4 months
High	51-70%	€101K-€250K	2-4 months
Medium	21-50%	€51K-€100K	1-2 months
Low	5-20%	€10K-€100K	1-4 weeks
Very Low	<5%	< € 10K	<1 weeks

2.3.3 Determination of Project completion

In compiling the determination of project completion, it is necessary to know the duration of each activity to be carried out. The goal is to determine the critical path of the project being worked on. Planning the duration of this project can be done by collecting data about the duration of each activity. Critical Path Method (CPM) is used in determining project completion.

2.3.4 Clustering Risk, Causes and Impact In Critical Path

At this stage, risk clustering is carried out on the critical path that can cause delays in a project. Risk clustering consists of risk events, risk causes and risk impact on the completion time of activities on the project.

2.3.5 Project Completion Simulation with Monte Carlo

One method by which uncertainty analysis can be carried out in different models is the Monte Carlo method. The Monte Carlo method is a class of calculation algorithms that rely on random sampling to calculate the results. This simulation begins by generating a random number obtained from the impact of risk on each activity on the critical path.

3. RESULTS AND DISCUSSION

3. 1 Project Activity Identifications

Based on the activity description data and the estimated duration of activity from the planning and control department as well as the network diagram, a logic of dependence between activities in the construction of ship X is drawn up which is shown in table 2.

Table 2. The Dependency logic Project X .

Activity	Predececors					Duration
A						2
B	A					110
C	B					92
D	C					80
E	D	C				62
F	E	K	P			2
G	F					150
I	A					130
J	I					88
K	J					82
L	K	J				80
M	L	G	H			48
N	A					100

3 .2 Identification of Project Risk Event (*Ei*) and Risk Agent (*Aj*)

At the stage of identifying risk events and causes of risk, the SCOR model is used, where the SCOR model is an approach model to identify risk from a supply chain management perspective. SCOR . Based on results Interview depth that has been validated with the experts/risk owners in project could identified risk events and potential risk agents Becomes reason lateness project . Risk events and risk agents shown in table 3 and 4.

Table 3. Identification Risk Event (Ei) Project X.

SCOR Model	Code	SCOR Model	Code	SCOR Model	Code	SCOR Model	Code	SCOR Model	Code
Plan	E1	***Source***	E11	***Make***	E18	***Deliver***	E24	***Return***	E29
	E2		E12		E19		E25		E30
	E3		E13		E20		E26		
	E4		E14		E21		E27		
	E5		E15		E22		E28		
	E6		E16		E23				
	E7		E17						
	E8								
	E9								
	E10								

Table 4. Identification of Project X 's Risk Agents (Ai).

Risk Agent (*Ai*)		
A1	A11	A21
A2	A12	A22
A3	A13	A23
A4	A14	A24
A5	A15	A25
A6	A16	A26
A7	A17	A27
A8	A18	A28
A9	A19	A29
A10	A20	

3.3 Determination of Project completion

From the results of the dependency logic in table 2 , it is then processed into POM QOM V.4 software with the CPM or single estimate time method, resulting in the current project time duration, as well as the project's critical trajectory in the form of Gant Charts and Precedence diagrams. An activity can be categorized as a critical activity if its initial delay causes a delay in the completion time of the entire project.

Project Management (PERT/CPM) Results

Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish	Slack
Project	723					
A	2	0	2	0	2	0
B	110	2	112	2	112	0
C	92	112	204	112	204	0
D	80	204	284	204	284	0
E	62	284	346	284	346	0
F	2	346	348	346	348	0
G	150	348	498	348	498	0
H	8	498	506	498	506	0
I	130	2	132	46	176	44
J	88	132	220	176	264	44
K	82	220	302	264	346	44
L	80	302	382	396	476	94
M	48	506	554	506	554	0
N	100	2	102	88	188	86
O	88	102	190	188	276	86
P	70	204	274	276	346	72
Q	80	348	428	500	580	152
R	30	506	536	580	610	74
S	120	132	252	218	338	86
T	88	274	362	388	476	114
U	78	382	460	476	554	94
V	60	554	614	554	614	0
W	48	614	662	614	662	0
X	90	252	342	338	428	86
Y	68	342	410	428	496	86
Z	56	410	466	496	552	86
AA	50	466	516	552	602	86
AB	52	536	588	610	662	74
AC	56	342	398	434	490	92
AD	50	398	448	490	540	92
AE	62	448	510	540	602	92
AF	60	516	576	602	662	86
AG	40	662	702	662	702	0
AH	10	702	712	702	712	0
AI	6	712	718	712	718	0
AJ	4	718	722	718	722	0
AK	1	722	723	722	723	0

Figure 2. Current Duration project X Calculation Results with CPM.

Based on the results of the dependency logic in table 4.1, it is then processed into POM QOM V.4

software with the CPM or single estimate time method, resulting in the current project time duration, as well as the project's critical trajectory in the form of Gant Charts and Precedence diagrams. An activity is said to be critical if its initial delay will cause a delay in the completion time of the entire project. Data processing using POM QM V.4 software shows that the project's critical path is in the A-B-C-D-E-F-G-H-M-V-W-AG-AH-AI-AJ-AK activity, it can be seen from the absence of lag or the slack value = 0 (zero). Furthermore, processing the duration of the initial conditions using POM QM V.4 obtained a Gantt Chart that describes information about the scope of the initial task that must be completed as a condition for completing the next task, as shown in Figure 3.

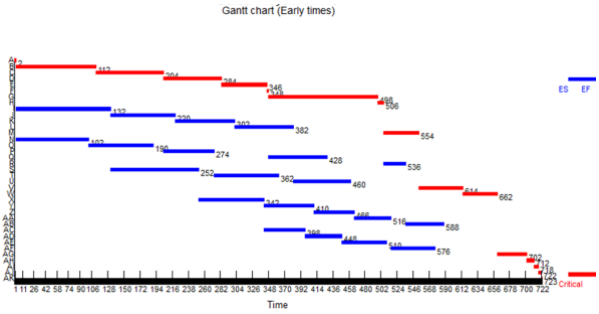

Figure 3. Gantchart project X.

3.4 Clustering Risk, Causes And Impact Critical Path.

The identified potential risks can be mapped on the project's critical path. Measurement of Severity Level states how much disturbance/impact caused by a risk event that can disrupt the project completion process. The value of the level of impact is seen from the size of the impact on the system/customer, the potential for property damage and the potential for danger to arise

Table 5 shows the impact on time caused by the risk agent. So it can be suggested mitigation or prevention so that the impact can be kept to a minimum. Impact on time will be used as forecasting data in the Monte Carlo simulation. The Impact data is a reference in generating random numbers.

Table 5. Risk and impact clusters.

Critical Path	Risk Agent	Scale	Impact (days)
A	A1, A3, A4	Very Low	< 7
B	A1, A3, A4	Medium	30-60
C	A8	Very Low	<7
D	A3,A8	Very Low	<7
E	A21, A23	Medium	30-60
F	A1,A4,A8	High	60-120
G	A1,A43,A21	Very Low	<7
H	A21,A23,A25	Very Low	<7
M	A25,A26,A27	High	60-120
V	A8,A26,A27	High	60-120
W	A1,A4,A8	Medium	30-60
AG	A8,A21,A23	Very Low	<7
AH	A1,A3,A8	Medium	30-60
AI	A3,A8,A27	Very Low	<7
AJ	A1,A4,A8	Very Low	< 1 week
AK	A3,A4,A8	Very Low	< 1 week

3.5 Simulation Project Completion with Monte Carlo

Existence impact on the project makes the solution project is at in uncertain because of the presence of risk. Make an estimation to influence impact to the crucial project, for knowing estimation in solution time as well as the steps and strategies that will take for preventing risk happening. In Monte Carlo simulation, each input is varied in the range that has been determined hundreds of times for produce a shared output range with the frequency its appearance. Frequency this then translated to in probability of occurrence of each output. With use Monte Carlo simulation, can produce distribution mathematical in the form of curve bell indicating range possible results. Data used use PERT Beta distribution and processed using Crystal Ball software with simulation 10,000 times. Based on Figure 4.

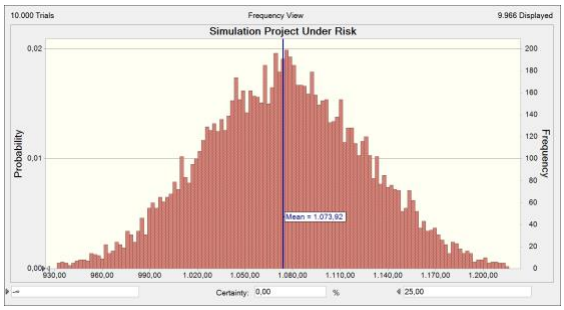

Figure 4. Simulation Project X Under Risk

In this figure is known that with existence potency risk on project X, known average time solution project is around 1,073.9 days or 1,074 days. The average time for making estimates is pessimistic from the return plans that can be made for 723 days or 351 days late from the plan returns.

4. CONCLUSION

Based on results simulation on project X is known that :

a. There are 30 potential events occurs caused by 29 agents risk inside solution project .

b. trajectory critical of the project the occurs in activity A-B-C-D-E-F-G-H-M-V-W-AG-AH-AI-AJ-AK.

c. Based on results simulation montecarlo with crystal ball software known that with under risk so that solution project Becomes pessimistic with time completion 1,074 days or 351 late from time already planned.

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REFERENCES

AS/NZS 4360: 2004. (2004). Risk Management.

Farr, J., & Dow, Benjamin L., J. (2010). Project management's role in life cycle costing. Rolla: American Society for Engineering Management (ASEM). Retrieved from https://www.proquest.com/books/project-managements-role-life-cycle costing/docview/1704370205/se-2. https://doi.org/10.1201/b10963-16

Habibi, F., Taghipour Birgani, O., Koppelaar, H., & Radenović, S. (2018). Using fuzzy logic to improve the project time and cost estimation based on Project Evaluation and Review Technique (PERT). Journal of Project Management, 3, 183–196. https://doi.org/10.5267/j.jpm.2018.4.002

Hubbard, DW (2014). How to measure anything: Finding the value of intangibles in business. John Wiley & Sons.

Project Management Institute . (2017). A guide to the project management body of knowledge (PMBOK guide) / Project Management Institute (6th ed.). Project Management Institute.

Pujawan , IN, & Geraldin , LH (2009). House of risk: A model for proactive supply chain risk management. Business Process Management Journal, 15(6), 953–967. https://doi.org/10.1108/14637150911003801

Setiadi, H. (2014). Fundamentals of Planning Theory. Module 1 Fundamentals of Planning Theory, 1–47.

Sufa'atin, IPIM (2017). To Identify Possible Project Risks and Impacts. ULTIMA InfoSys, 8(1), 45-47.