PROJECT RISK MANAGEMENT INFORMATION SYSTEM USING THE HOUSE OF RISK METHOD IN CV PHILIA KAMI

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ABSTRACT

CV Philia Kami is a company engaged in the field of services, especially construction. For every project that has been implemented, CV Philia KAmi has not used project risk control to support the implementation of project activities. Due to the absence of project risk control, if there is a deviation in activity, the site manager will find it difficult to identify project risks and the order of mitigation priorities that must be carried out. Therefore a project risk management information system is needed, which can assist site managers in identifying the likelihood of risks occurring in a project that will run and assist in determining the priority of mitigation used to prevent risks when implementing project activities. In this study the method used for project risk management is the house of risk (HOR) method with stages of risk identification, risk analysis, risk evaluation, and risk response (mitigation). Based on the implementation and testing using the Black-Box and the User Acceptance Test (UAT) method, it can be concluded that the project risk management information system built can help site managers identify risks, and determine the priority of mitigation used to prevent risks when implementation of project activities.

Keywords : Risk, CV Philia Kami, Management, HOR, Mitigation.

1. PRELIMINARY

CV Philia Kami is a company engaged in the field of services, especially construction. The projects handled varied including the construction of houses, shops, warehouses, steel gutters construction and others. Based on interviews with the director of CV Philia Kami, we said that in the previous year CV Philia Kami handled 2 to 3 projects that had to be done in the same time period. For each project that has previously been carried out, CV Philia Kami has not used project risk control to support the implementation of project activities. Due to the absence of project risk control, if there is a deviation in activity, the site manager will find it difficult to identify project risks and determine the order of mitigation priorities that must be carried out. This study aims to assist Site Managers in identifying the likelihood of risks occurring in a project that will run and help determine the priority of mitigation that is used to prevent risks when implementing project activities. The method used in this project's risk management is the House of Risk (HOR). This model is a method developed by Pujawan and Geraldin [1]. Broadly speaking, the stages in this method are divided into two phases or models, namely HOR1 which contains risk identification, risk analysis, and risk evaluation, and HOR2 which contains risk handling.

Various studies related to risk mitigation have been carried out including Sufa'atin [2], applying the Probability Impact Matrix (PIM) to identify the likelihood and impact of project risks. Dewi Kurniasari [3], applying the House of Risk (HOR) method to mitigate the risk of the Gempol-Pasuruan toll road development project. Mutiara Yetrina [4], applied the HOR method in the development of construction project risk management algorithms. Hartono, A. Christiani, and Lasiman [5] that the House of Risk (HOR) method has the advantage of identifying risks that are priority risks and providing strategic priorities for quality improvement. Bayu Rizki Kristanto [6], the HOR method is used for the risk mitigation process in the leather raw material supply chain. Maria Ulfah [7] who uses the HOR method for risk management of refined sugar supply chains. While research conducted by Nurlela [8] the HOR method is also used for risk management in high rise building construction projects.

2. CONTENT OF STUDY

2.1 Literature Review

Literature Review aims to provide explanations from various sources and theoretical studies relating to the development of Project Risk Management Information Systems in CV Philia Kami.

2.1.1 Information Systems

Information systems are a regular combination of people, hardware, software, communication networks and data resources that collect, change, and disseminate information within an organization [9].

2.1.2 Project Management

Project Management is the application of science, expertise and skills, the best technical means and limited resources, to achieve the goals and objectives that have been determined in order to obtain optimal results in terms of cost performance, quality and time, and work safety [10].

2.1.3 Project Risk Management

The word risk comes from Arabic which means a gift that is not expected to arrive, the risk is negative connotation as the possibility of loss due to accidents, disadvantage and damage [10]. In a study conducted by Mutiara Yetrina [4] explained that risk management is a field of science that discusses the way an organization determines the size in mapping various risks and problems that exist through a comprehensive and systematic management approach.

2.1.4 House of Risk (HOR) Method

The House of Risk method is a method for proactively managing risk that focuses on preventive measures, where the risk agents identified as causes of risk events can be managed with effective proactive steps to reduce the likelihood of the occurrence of risk agents, so that risk events can be reduced or prevented [11] The proactive step is carried out in accordance with the order of the magnitude of the impact that may be caused. House of Risk is also commonly referred to by the acronym HOR.

As explained in the research conducted by Maria Ulfah [7] the HOR method has two interrelated models namely the HOR1 and HOR2 models, HOR1 is used to determine which risk sources are prioritized for preventive action, while HOR2 is to prioritize effective actions.

2.1.5 Model HOR1

In the HOR1 model, the stages starting from risk identification, risk analysis, to risk evaluation with output in the form of risk agent priority ranking. There are several variables used in calculating the HOR1 model. The variables are as follows:

1. Ei (risk event) shows the risks that occur.
2. Si (Severity) shows the severity of each risk.
3. Aj (risk agents) shows risk agents.
4. Oj (occurrence) indicates the possibility of occurrence.
5. Rij (relationship) shows the correlation between each risk agent with each risk.
6. ARPj (Aggregate Risk Potential) which is the result of the possibility of the emergence of risk agents j and the aggregate consequences of the occurrence of risks caused by risk agents.

Following is the HOR1 model can be seen in Figure 1 [3]:

		Risk Agents (*Aj*)							
Business Processes	**Risk Event (*Ei*)**	A1	A2	A3	A4	A5	A6	A7	**Severity of Risk Event *i* (*Si*)**
Plan	E1	R11	R12	R13	…	…	…	…	S1
	E2	R21	R22	…	…	…	..	..	S2
Source	E3	R31	…	…	…	…	…	…	S3
	E4	R41	…	…	…	…	…	…	S4
Make	E5	…	…	…	…	…	…	…	S5
	E6	…	…	…	…	…	…	…	S6
Deliver	E7	…	…	…	…	…	…	…	S7
	E8	…	…	…	…	…	…	…	S8
Return	E9	…	…	…	…	…	…	Rij	S9
Occurrence of Agent *j*		O1	O2	O3	O4	O5	O6	O7	
Aggregate Risk Potential *j*		ARP1	ARP2	ARP3	ARP4	ARP5	ARP6	ARP7	
Priority Rank of Agent *j*									

Figure 1. Model HOR1

The stages that occur in the HOR1 model are as follows:

1. Risk Identification Stage

This stage includes identification of risks that might occur in supply chain activities [7]. This stage is the first stage in the HOR1 model. The identification process must involve risks that are either controlled or not controlled by the company. In this stage a list of risks will be generated obtained from the identification of sources of risk [3], starting from what is the risk (what), where the risk appears / is found (where), how the risk arises in that place (how) and why those risks arise (why), which risks can have an impact on the achievement of the company's goals and objectives.

Following are the steps in the risk identification stage, namely:

a. Identifying the risks that may occur in each business process, Ei (risk events).
b. Give an assessment on a scale of 1 to 10 regarding the severity of Si (severity) due to the risk that occurs [12].
c. Identify risk agents Aj and rate a scale of 1 to 10 regarding the likelihood of Oj (occurrence) [12].
d. Develop a matrix of relationships (correlations) between each risk agent with each risk. Rij (relationship) {0, 1, 3, 9} with a value of 0 indicates no correlation (no correlation) and values 1, 3, and 9 show a correlation of low (moderate), moderate (moderate), and high (high) [3].

2. Risk Analysis Stage

Risk analysis is a process to analyze qualitatively and quantitatively the impact of risks (severity) and the probability of risk (occurrence) against the project targets that have been set [3]. The purpose of risk analysis, which is to separate between hazardous risk and insignificant risk and create a risk map profile according to rank. This result will be the basis for the analysis and handling of risk in the next stage. Severity and correlation between risk events and their risk agents, and the likelihood of these occurrences combined to determine the level / ranking of risks. This risk analysis process is carried out by analyzing the causes of the risks that have been identified and then calculating the value of the

ARPj (Aggregate Risk Potential). ARP value is obtained from the sum of the results of the multiplication of severity with the level of occurrence. The formula can be written as follows:

$$ARPj = Oj \sum Si\ Rij \qquad (1)$$

The results of the risk analysis stage are risk priorities and ranking classifications which are then used as a reference for preparing risk management plans.

3. Risk Evaluation Stage

The purpose of risk evaluation is to produce a priority sequence of risks for further handling [3]. What is done in this stage is to compare the risk profile with the risk evaluation criteria previously determined, and estimate whether a risk is acceptable or not, in accordance with the previous criteria, or consider with an analysis of benefits and costs.

2.1.6 Model HOR2

In the HOR2 model the stage that occurs is the risk mitigation stage or also called the risk response is the last stage of risk management. This phase aims to identify the risk mitigation and evaluate the mitigation, before later the mitigation is chosen. There are several variables used in calculating the HOR2 model. The variables are as follows:

1. Aj shows the selected chosen risk agent for handling.
2. ARPj (Aggregate Risk Potential) of the risk agent.
3. PAk (Preventive Actions) shows the handling strategy to be carried out.
4. Ejk shows the correlation between handling strategies and risk agents.
5. TEk shows the total effectiveness of each treatment action.
6. Dk shows the level of difficulty in implementing handling actions.
7. ETDk shows the total effectiveness divided by the degree of difficulty.
8. Rk shows the ranking of each handling action based on the order of the highest ETD value.

Following is the HOR2 model can be seen in figure 2 [3]:

	Preventive Action (PAk)					
To be treated risk agent (Aj)	PA1	PA2	PA3	PA4	PA5	**Aggregate Risk Potentials (ARPj)**
A1	E11	E12	E13	...	...	ARP1
A2	E21	E22	...	...	...	ARP2
A3	E31	...	...	...	...	ARP3
A4	...	...	...	...	...	ARP4
A5	...	...	...	...	Ejk	ARP5
Total efectiveness of action k	TE1	TE2	TE3	TE4	TE5	
Degree of difficulty performing action k	D1	D2	D3	D4	D5	
Effectiveness to difficulty ratio	ETD1	ETD2	ETD3	ETD4	ETD5	
Rank of priority	R1	R2	R3	R4	R5	

Figure 2. Model HOR2

The stages that occur in the HOR2 model are as follows:

1. Risk Response Phase

The strategy design process is carried out using a HOR2 model matrix to develop mitigation actions in dealing with potential risks [3]. The steps at this stage are as follows:

a. Select a number of risk agents with values to be followed up on HOR2. The selected risk agents Aj are placed in the left column and in the right column for ARPj values.
b. Identifying possible actions to prevent risk from arising. These mitigation actions are placed in the top row of HOR2 (Preventive Actions PAk).
c. Determine the correlation between each preventive action and each risk agent (Ejk). Ejk {0, 1, 3, 9} with a value of 0 indicates no correlation (no correlation) and values of 1, 3, and 9 indicate a low, medium, and high correlation. Ejk also showed the effectiveness of mitigation actions taken in reducing the possibility of the emergence of risk agents.
d. Calculate the Total Effectiveness (TEk) of each action using the formula:

$$TEk = \Sigma ARPj\ Ejk \qquad (2)$$

e. Provide an assessment of the level of difficulty in carrying out each mitigation action Difficulty (Dk).
f. Calculate the Total Effectiveness Ratio (TEk) to the Difficulty (Dk) using the formula:

$$ETDk = TEk / Dk \qquad (3)$$

g. Determine the Priority Rating of each action (Rk), the first rank shows the action with the highest ETD.

2.2 Results and Discussion

At this stage several stages will be explained in the completion of the study. The following are the stages.

2.2.1 HOR1

At this stage, identification of any risk events that might occur in all areas of project activities is carried out. The process of identifying risk events is collected from direct and active interviews with site managers at CV Philia Kami. Determination of the results of the identification of risk events finally obtained as many as 31 risk events.

After identification of risk events, the next step is to assess the impact or severity of the existing risk events. Rating of risk events is assessed on a scale of 1 to 10 such as the example of Risk Events "Changes in work volume" have a Severity (Si) value of "8" which means the risk events have sufficient impact on the course of project activities.

Then the risk event is coded with the prefix "E" followed by the sequence number of the risk event. The results obtained as shown in Table 1.

Table 1. Risk Event

Code	Risk Event	Si
E1	Change in work volume	8
E2	Incomplete working drawings	3
E3	Incorrect job description	3
E4	The lack of experts in their field	6
E5	Lack of facility readiness	5
E6	Increase in construction costs for material purchases	3
E7	Lack of budget	8
E8	Lack of HR	5
E9	Repetitive work / repair work	4
E10	Error execution	3
E11	Payment for material purchases or equipment rentals is late	6
E12	The quality of work does not meet specifications	3
E13	Clients make design changes	7
E14	Damage that causes work results must be dismantled / repaired	3
E15	Delayed work schedule	3
E16	Excess costs	8
E17	Error requesting purchase	4
E18	Weak work coordination	5
E19	Engine failure	6
E20	Delay in project work	7
E21	Material unavailability during project implementation	7
E22	Occupational accident	8
E23	Damaged material cannot be used anymore	5
E24	Equipment installation error	5
E25	Electric waste	3
E26	Administrative delays	3
E27	Material differences received	6
E28	Late mobility of lifting and transporting equipment	5
E29	Installation equipment delays	5
E30	Access to project sites is difficult	3
E31	Delay in exchanging material	7

The next step is to identify the cause of the risk (risk agent). One cause of risk can lead to one or more risk events, or vice versa, one risk event can be caused by one or more causes of risk. 18 identified risk agents have been assessed and the possibility of emergence (Oj) as an example of the Causes of Risk "Incorrect calculation of work documents by the planning department" has an Occurency (Oj) value of "4" which means the cause of the risk is rare. Then the cause of risk is coded with the prefix "A" followed by the sequence number of the cause of risk. The results obtained as shown in Table 2.

Table 2. Risk Agent

Code	Risk Agent	Oj
A1	Incorrect calculation of workmanship documents by the planning department	4
A2	An additional type of job has occurred	5
A3	Changes to workmanship details	5
A4	Advance payment or late payment by the client	3
A5	Planning the amount of human resources that will be used is not right	3
A6	Inadequate and slow decision making mechanism	5
A7	Material price information obtained is not accurate	5
A8	Limited number of workers	3
A9	Communication failure	4
A10	Long distance	4
A11	Incompetent labor	3
A12	Sudden requests from clients	6
A13	Lack of maintenance on project machines	7
A14	Natural disasters	1
A15	The lack of supervision in the field	5
A16	Design drawing error	5
A17	Fire	2
A18	Transport equipment / transporter / crane is damaged	5

After identification of risk events and causes of risk, the correlation between risk agents and risk events with a value of 0 indicates no correlation and values 1, 3, and 9 indicate low, moderate, and high correlations. Then next calculate the Aggregate Potential Risk (ARP) value to prioritize the risks that will be followed up. For example, the cause of risk (Risk Agent) "A3" with Occurrence (Oj) "5" which has a correlation to two risk events (Risk Event) namely "E1" with a correlation value of "3" and "E5" with a correlation value of "9 ", Then the ARP calculation is done with the value of Severity (Si) respectively. ARP_{A3} calculations can be seen as follows.

$$\begin{aligned} ARP_{A3} &= O_j \sum S_i R_{ij} \\ &= O_{A3} * [(S_{E1} * R_{E1A3}) + (S_{E5} * R_{E5A3})] \\ &= 5 * [(8 * 3) + (5 * 9)] \\ &= 345 \end{aligned}$$

ARP value is used to determine the priority causes of risk that must be followed up first. The greater the ARP value indicates that the cause of the risk is a priority that must be followed up, the first ranking priority is seen from the largest ARP value.

The results of the calculation of the HOR1 model can be seen in Figure 3.

Business Processes	Risk Event (Ei)	Risk Agents(Aj) A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	A18	Severity of Risk Event i (Si)
Plan	E1	9	3	3													3			8
	E2	3															9			3
	E3	9								3										3
	E4											3								6
	E5	3	3	9																5
Source	E6							9												3
	E7	3	3		9															8
	E8					9						3								5
Make	E9									9		3				3				4
	E10									3		3					3			3
	E11				9															6
	E12											3				3				3
	E13												3							7
	E14														1	9		1	3	3
	E15						3		9						3			3	3	3
	E16	9	9					3												8
	E17	3								3							3			4
	E18															9				5
	E19											3		9	1					6
	E20				3							3				3				7
	E21	3								3										7
	E22											9		3	3					8
	E23											3			1					5
	E24											9								5
	E25															3				3
	E26				3															3
	E27	3								3										6
Deliver	E28										9									5
	E29										9									5
	E30										3				3					3
Return	E31										3				3					7
Occurrence of Agent j		4	5	5	3	3	5	5	3	4	4	3	6	7	1	5	5	2	5	
Aggregate Risk Potential j		1080	675	345	468	135	45	255	81	400	480	756	126	546	77	615	360	24	90	
Priority Rank of Agent j		1	3	10	7	12	17	11	15	8	6	2	13	5	16	4	9	18	14	

Figure 3. Calculation of HOR1

2.2.2 HOR2

At this stage, mitigation of 18 risk sources (Table 2) was identified.

After identifying the mitigation of the causes of risk, the next step is to assess the level of difficulty of the application of the mitigation or Difficulty (Dk). Evaluation of the difficulty of implementing mitigation is assessed on a scale of 1 to 5. For example, Mitigation "Review and analysis of design intensively" has a Difficulty value of "3" which means that mitigation is quite difficult to do. Then risk mitigation is coded with the prefix "PA" followed by the serial number of the cause of the risk. The results obtained as shown in Table 3.

Table 3. Risk Mitigation

Code	Risk Mitigation Actions	Dk
PA1	Intense design review and analysis	3
PA2	Placing personnel who have the qualifications and experience in similar projects	4
PA3	Improve communication with third parties	3
PA4	The design in the tender document is final data and has been through a process of analysis and design review	4
PA5	Identifying the scope of the project in the initial tender period	4
PA6	The contractor must make a cost estimate based on current condition prices and estimated price increases during project implementation	5
PA7	Update your payment projection regularly at least once a month by CV Philia Kami	4
PA8	Recruiting competent new workers	4
PA9	Select subcontractors who have good workers or resources	3
PA10	Make a schedule of the priority scale of work	3
PA11	Placement of site managers who have good coordination and communication skills	3
PA12	Update material prices regularly	3
PA13	Perform project engine maintenance routinely	3
PA14	Change jobs that can be done first	3

In HOR1, the risk agent ranking is a priority for mitigation handling. From the results of the HOR1 calculation, 6 terartas ranked with the largest ARP values were taken to be immediately handled. After identification of risk mitigation, the correlation between risk agents from HOR1 calculation with risk mitigation is then performed to calculate the effectiveness of mitigation selection. Correlation assessment between risk agents and risk mitigation is given a value with a value of 0 indicating no correlation and values of 1, 3, and 9 indicate a correlation of low (low), moderate (moderate), and high (high). The results obtained from HOR2 are mitigation priorities that must be followed up first. For example, risk mitigation "PA2" with Difficulty "4" which has a correlation to two causes of risk namely "A1" with a correlation value of "3" and "A15" with a correlation value of "3", then the TE calculation is performed to assess the effectiveness of mitigation and ETD to determine priority mitigation selection priorities. TE_{PA2} and ETD_{PA2} calculations can be seen as follows.

$$TE_{PA2} = [(ARP_{A1} * E_{A1PA2}) + (ARP_{A15} * E_{A15PA2})]$$
$$= [(1080 * 3) + (615 * 3)]$$
$$= 3240 + 1845$$
$$= 5085$$

$$ETD_{PA2} = TE_{PA2} / D_{PA2}$$
$$= 5085 / 4$$
$$= 1271{,}25$$

ETD value is used to determine the mitigation priorities that must be done first. The greater the value of the ETD shows that mitigation is a priority that must be followed up, the first ranking priority seen from the value of the largest ETD.

The results of the calculation of the HOR2 model can be seen in Figure 4.

	Preventive Action (PAk)														
To Be treated risk agent (Aj)	PA1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	PA10	PA11	PA12	PA13	PA14	Aggregate Risk Potentials (ARPj)
A1	9	3													1080
A11								9							756
A2				9											675
A15		3									9				615
A13													9		546
A10			3											9	480
Total efectiveness of action k	9720	5085	1440	6075	0	0	0	6804	0	0	5535	0	4914	4320	
Degree of difficulty performing action k	3	4	3	4	4	5	4	4	3	3	3	3	3	3	
Effectiveness to difficulty ratio	3240	1271,25	480	1518,75	0	0	0	1701	0	0	1845	0	1638	1440	
Rank of priority	1	7	8	5	9	10	11	3	12	13	2	14	4	6	

Figure 4. Calculation HOR2

Thus, after calculating using the House of Risk method, the results of priority mitigation can be seen as shown in Table 4.

Tabel 4. Hasil *House Of Risk*

Priority	Mitigation Code	Mitigation
1	PA1	Intense design review and analysis
2	PA11	Placement of site managers who have good coordination and communication skills
3	PA8	Recruiting competent new workers
4	PA13	Perform project engine maintenance routinely
5	PA4	The design in the tender document is final data and has been through a process of analysis and design review
6	PA14	Change jobs that can be done first
7	PA2	Placing personnel who have the qualifications and experience in similar projects
8	PA3	Improve communication with third parties

2.3 System Testing

System testing aims to find errors or deficiencies in the system being built and to find out the software being built already meets the criteria in accordance with the software design goals or not. There are two tests namely, Black-Box testing and User Acceptance Testing (UAT).

2.3.1 Black-box testing

Black-box testing is a testing strategy that is commonly used to find out whether software development is in accordance with the expected needs. This test focuses on functional systems.

Based on the black-box test results, it was concluded that the system was running in accordance with the needs of the system that had been designed. Functionally the system can produce the expected output.

2.3.2 User Acceptance Test (UAT) Testing

UAT Testing aims to find out whether the software that is built is in accordance with the requirements of the original purpose or not. The method used in UAT testing is to use interview testing to users of the system. UAT testing is done to find out the user's opinion on the application that has been built.

Based on UAT testing by conducting interviews with directors, site managers, field implementers, and admins it can be concluded that the project's risk management information system helps in the implementation of projects, especially in risk management. This system can assist in identifying risks and determining mitigation priorities that must be carried out, and overall the project's risk management information system is feasible to use.

3. CLOSING

Based on the results of research and testing results that have been done on the Project Risk Management Information System at CV PHILIA WE, it can be concluded that the project risk management information system that is built can help site managers in identifying possible risks to a project that will run, and also can assist Site Managers in determining mitigation priorities that are used to prevent risks when implementing project activities.

Based on the results of system testing, there are suggestions that can be done to add things that can complement the project's risk management information system going forward, including:

1. Add a monitoring feature to the implementation of mitigation in the project's risk management information system.
2. Add a cost estimation feature to the implementation of mitigation in the project's risk management information system.

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