Construction industry project planning information system

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Abstract. The planning processes in construction industry nowadays develop the project management plan and the projects documents to carry out the project. The system being built is purposed to help project manager do project planning such as analyse risks probability and risks impact on projects using Probability Impact Matrix (PIM), and for project scheduling by showing the relationship between activities using Precedence Diagramming (PDM) method in order to project manager know the optimal project timing estimation. Based on the analysis and the results of system testing already done, it can be concluded that the system could help the project manager in identifying the risks that are likely to negatively affect project implementation and help project manager in scheduling project. The cause of delay in project are there are no risk recorded, ignoring the risks that could have negative impact on the implementation of project, and there is no risk handling, and then the scheduling done by the project manager did not show the specific relationship between the project activity. Then system is expected could help project managers to implement monitoring and controls in project execution.

1. Introduction
The process undertaken of the construction industry in managing the project are begin with scheduling project activities, the creation of a progress report, and reports on the results of the project work. The project management plan that has been developed by project managers might have risks that have not been identified, so that the implementation schedule was delayed. Then planning process is to develop projects documents that will be used to project execution [1].

Each projects have to expected scheduling in project implementation on time, but according to Tina K [2] project manager and team projects have to change their work routine in order to handling parallel projects, and according to Hong L [3] to ensure the projects have good performance outcomes, project manager have to calculating planned value and actual cost value, and then according to Prodromos D [4] the experience of team projects might affect during the development process and it seems that attention to some other technical factors such as use of methodologies are limited. Additionally, according to Dede [5] each project has a definite risk that will happen, but in some construction, industries have not done risk planning that may occur in project implementation, when problems or risks occur, project managers must figure out how to solve them, and requires additional costs to handle risks, so that the project delays occur. While the success of projects is affected by the differences of organizational sizes [6,7]. However, the use of information technology to solve the problem has not been done by many industries, so to make the project planning becomes obstructed.
Based on the problems that have been described, industries need a system to perform project planning, such as job scheduling, risk planning. The following are some of the methods that are able to meet these objectives: Probability Impact Matrix (PIM), a method used to analysis the probability of risks and their impact on a job by weighting the risks that arise [1]. Precedence Diagramming Method (PDM) is a method for planning and project scheduling by showing the relationship of activity. PDM uses graphical representation techniques to define the minimum project duration [8]. Then project planning information system is purposed to help project manager to develop an optimal project plan and project documents.

2. Research methods
The methodology used in this research is descriptive method. The methodology carried out in this research can be seen in the figure 1.

![Figure 1. Research method.](image)

3. Results and discussion
Project planning process begin with scheduling processes and risk management plan, the first step is project manager have to develop project scheduling planning using method in order to the project that would be implemented can be known which jobs should be completed first.

3.1. Analysis of project scheduling planning
Time management is the management of activities and work required to complete the Settlement Project of Parking Places in a specific time frame, in which each activity must be carried out in order to complete the project on time. The following data is for the example on the activities of the Settlement Project of Parking Places can be seen on the table 1.
Table 1. Project activities.

| Job Description             | Activity code | Predecessor activities | Duration (days) |
|-----------------------------|---------------|------------------------|-----------------|
| Preparation                 | I             | -                      | 7               |
| Paving the parking lot      | II            | I                      | 28              |
| Stone installation          | III           | I                      | 14              |
| Installation of gravel      | IV            | II, III                | 28              |
| diameter 20                |               |                        |                 |
| Finishing and settlement    | V             | IV                     | 7               |

Based on the activities in the Settlement Project of Parking Places on Table 1, the next step is to calculate the estimate duration of early start (ES), early finish (EF), latest start (LS), latest finish (LF), and slack time (SL) [8]. The results can be seen in the Table 2 and Figure 2.

Table 2. Calculation result.

| Activities code | Duration | ES | EF | SL | LS | LF |
|-----------------|----------|----|----|----|----|----|
| I               | 7        | 0  | 7  | 0  | 0  | 7  |
| II              | 28       | 7  | 35 | 0  | 7  | 35 |
| III             | 14       | 7  | 21 | 14 | 21 | 35 |
| IV              | 28       | 35 | 63 | 0  | 35 | 63 |
| V               | 7        | 63 | 70 | 0  | 63 | 70 |

Based on the table, the conclusion is that the activity of number III has slack time or the maximum working time is 14 days, while the slack for activities number I, II, IV, V is 0 (zero), then the four activities are included into the critical path (show in red lines) that the work should not be late. The critical path can be seen in the figure 2.

Figure 2. Critical path diagram.

Based on Figure 3 it can be concluded that paths I, II, IV, V are critical paths, so the activities through that path should not be delayed. Based on this network diagram, project manager can plan which jobs can be done simultaneously and know which jobs should not be delayed.

4. Analysis of project risk planning

The risk management process has several stages of identifying risk, determining the probability value and impact of risk and handling the risk.
4.1. Risk identification

The process of identifying this incident is done with a discussion approach and an interview with the project manager. Examples of the results of risk identification can be seen in the table 3[5].

| No | Risk                                    | Risk code |
|----|-----------------------------------------|-----------|
| 1  | Incomplete design specification         | R1        |
| 2  | Change of design specification          | R2        |
| 3  | Delay in delivery of materials          | R3        |
| 4  | Bad weather                             | R4        |
| 5  | Changes in equipment rental rates       | R5        |

4.2. Determine risk probability and impact

Assessment is done by the project manager by assigning a scale of value using the matrix (Boston Square Matrix) [1]. Based on the Boston Square Matrix, the assessment of each risk probability and its impact is made in one scale, i.e. 1 to 25, as explained in the table 4.

| No | Scale  | Risk category |
|----|--------|---------------|
| 1  | 1 – 5  | Low           |
| 2  | 6 – 14 | Medium        |
| 3  | 15 – 25| High          |

The value of the possibility and the impact of risks based on table 3 and table 4 can be seen in table 5.

| Risk code | Risk                                    | Probability | Impact |
|-----------|-----------------------------------------|-------------|--------|
| R1        | Incomplete design specification         | 2           | 2      |
| R2        | Change of design specification          | 4           | 4      |
| R3        | Delay in delivery of materials          | 4           | 5      |
| R4        | Bad weather                             | 3           | 3      |
| R5        | Changes in equipment rental rates       | 2           | 3      |

4.3. Determine level of risk

After determining the probability value and the impact of risk, then do the calculation of risk interest level using Probability Impact and Matrix method. The importance of risk is calculated using the Risk Exposure formula.
Level of risk = probability (outcome) * Loss (outcome)  
\[ (1) \]

The following calculation of risk level can be seen in table 6.

| Table 6. Risk exposure value. |
|-----------------------------|
| Probability | Impact | Level of risk |
|---|---|---|
| R1 | 2 | 2 | 4 |
| R2 | 4 | 4 | 16 |
| R3 | 4 | 5 | 20 |
| R4 | 3 | 3 | 9 |
| R5 | 2 | 3 | 6 |

Based on the calculation above is grouped according to Boston Square Matrix risk category in Figure 4. Here is the risk level category can be seen in table 7.

| Table 7. Result of risk category. |
|-----------------------------|
| Risk code | Risk | Level of risk | Risk category |
|---|---|---|---|
| R1 | Incomplete design specification | 4 | Low |
| R2 | Change of design specification | 16 | High |
| R3 | Delay in delivery of materials | 20 | High |
| R4 | Bad weather | 9 | Medium |
| R5 | Changes in equipment rental rates | 6 | Medium |

Based on these known risk categories, it can help project managers to know the results of risk planning by knowing what risks are likely to occur in the project and their risk level. Then the system could show the risk identification and help project managers to implement risk management plan and created the risk management plan documents.

The risk management practice could affect the success of a project, but according to research results of Daranee [6] the differences organizational types and sizes affected project success in all aspects. Then according to Mirjana K [9], the implementation of project management information system should be aligned with organizations strategies, and then according to Young H [10] the advancement of project management enables us to implement the information system that helps project manager on project planning process. However, the implementation of the project planning information system in construction industry must be adapted to data used in planning scheduling and risk management plan.
5. Conclusion
Based on the results of research and test results that have been done on the construction industry project planning information system, the system could assist the project manager in scheduling by analyse the critical work on the project to find out the work that could be accelerated and the system could help project manager in identifying risks that are likely to have a negative impact on project implementation.

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