Analysis of Time Delay Factors in Multi Storey Building Construction Projects in Indonesia on Professionalism and Work Ethics

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Abstract. One indicator of a successful construction project is the timely completion of the project according to planning. However, delays in construction projects have now grown a commonplace. Many contractors are unaware of unable to predict the potential time delays. Thus, delays in construction projects are difficult to avoid. The biggest impact of time delays is financial losses for various parties involved in the project. This research aims to determine the factors that have a significant influence and the relationship between factors in time delays in multi-storey building construction projects in Indonesia. Data collection was carried out by distributing questionnaires. The respondents in this study were fifteen experts who had experience in the construction sector. The factors causing time delays in this research will be analyzed based on the principles of professionalism and ethics in work. The factors causing time delays are divided into twenty factors. This research uses the Interpretive Structural Modeling (ISM) analysis method. ISM is a method that can describe the structure of complex systems through graphics and words. Through data analysis, it was found that the factors that had the most significant influence on construction project delays in Indonesia. The factors that are the most influential causes are: Through the results shown, time delays in construction projects in Indonesia can be prevented with professionalism and work ethics, specifically having a good work plan and having experienced skilled workers.

Keywords: Time Delay · Professionalism · Ethics

1 Introduction

Construction projects are an illustration of progress and prosperity in a country. A stable and sustainable in construction industry is an important thing that will support economic growth and recovery for a country [1]. A construction project is said to be successful if the time, cost, and quality are in accordance with the agreement on planning [2]. The construction of multi-storey buildings in construction projects has a high level of risk. Multi-storey buildings are buildings that consist of more than one floor and are built vertically, including houses, offices, factories, apartments, and so on. This is due to the large weight of work and the height of the building to be built with a limited implementation time span [3].

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However, the completion of construction projects often does not match the planned time. In some case studies, it has been shown that time delays in implementation against planning result in higher overhead costs [4]. This can be caused by equipment rental costs with a longer period, inflation of material costs, labor costs and so on. The resulting losses can impact contractors, subcontractors, suppliers, owners, and various parties involved in the project.

Time delays in construction projects depend on many factors that are difficult to predict. Factors that can affect time delays in construction projects include inexperienced contractors, resource availability, environmental conditions, subcontractors, and contractual relationships [5]. Factors causing time delays in multi-storey building construction projects can come from the owner, contractor, planning consultant, and external [6]. All parties involved in the project are responsible for ensuring the project runs according to planning [7]. One way to overcome time delays in construction projects is to analyze and determine the relationship between factors that affect time delays. Therefore, this study will conduct research using the Interpretive Structural Modeling (ISM) method to identify and analyze the relationship between various factors that cause time delays in high-rise building projects in Indonesia.

2 Theoretical Foundation

2.1 Factors Causing Time Delays

Time delay in a project is defined as a condition when the actual progress of a construction project is slower than the planned schedule [8]. This research reviews the factors causing time delays in multi-storey building construction projects that come from seven categories, namely labor, equipment, managerial, site characteristics, information, materials, and others [9]. Factors related to labor are the labor turnover rate (F1). Factors related to equipment are equipment availability (F2) and late tools delivery (F3). Factors related to information are poor communication within the contractor organization (F4), design changes before construction (F5), design changes during construction (F6), and late approval of shop drawings (F7). Factors related to materials were material availability (F8), poor material quality (F9), and late delivery of materials (F10). Factors related to site characteristics are bad weather (F11), difficult site conditions related to soil type and water table (F12), poor access to the site (F13), adjacent buildings (F14) and narrow material and equipment storage areas (F15). Managerial-related factors were late payment (F16), project owner intervention (F17), unsuitable working methods (F18), and poor supervision (F19). Other factors are force majeure (F20). Force majeure in the Civil Code is defined as a condition or situation where one party who has an obligation based on an engagement or agreement cannot fulfill its performance or obligations [10].

2.2 Interpretive Structural Modeling (ISM) Method

The Interpretive Structural Modeling (ISM) method was developed by J. Warfield in 1973 to analyze complex economic systems [11]. The ISM method can help develop relationships and determine the hierarchy among various factors based on expert opinions

that are mostly subjectively obtained [12]. The main function of ISM is to transfer unclear and complex systems into easy, organized, and well-defined systems based on the knowledge and experience of researchers [13].

In this research, ISM is used to build a hierarchical structure that models the relationship between sub-factors causing time delays in high-rise building projects. A pairwise comparison questionnaire analyzed by several experts in the field of high-rise buildings will be used to determine the relationship between sub-factors that have a significant effect. The pairwise comparison questionnaire is designed using the decision making trial and evaluation laboratory (DEMATEL) method. The DEMATEL method describes the relationship between factors through a matrix, finds important factors and describes them through a causal diagram [14]. According to [15], the integration of DEMATEL and ISM methods is carried out in ten stages, namely: Creation and Distribution of Paired Questionnaires, Preparation of the Initial Direct-Relation Matrix (X), Compilation of Normalized Direct-Relation Matrix (G), Preparation of Total-Relation Matrix (T), Preparation of Initial Reachability Matrix (K), Preparation of Final Reachability Matrix (FRM), Determination of Reachability set (R), Antecedent Set (S), and Iris set ($R \cap S$), Interpretive Structural Modeling (ISM) Method, Drawing up the MICMAC cartesian diagram, Calculating the D+R (prominence) and D-R (relation) values of the Total-Relation Matrix (T).

3 Research Methodology

Literature study of previous research to determine the factors that cause time delays in construction projects. Through the literature study, twenty factors causing time delays in construction projects were obtained. In this study, the factors causing time delays in construction projects will be specialized in high-rise building projects in Indonesia. The factors obtained will be compiled into a pairwise comparison questionnaire. The questionnaire will be distributed to 15 (fifteen) expert respondents who have more than 7 (seven) years of work experience after completing undergraduate education on multi storey building projects. The selection of respondents is done by judgment sampling or selecting respondents based on predetermined criteria.

The results of the paired questionnaire will be processed with the DEMATEL method. DEMATEL method consists of preparing initial-direct relation matrix, normalizing initial-direct relation matrix, calculating total-relation matrix, calculating prominence and relation values. After obtaining data through DEMATEL, the data results will be processed with the interpretive structural modeling method. At this stage the data will be developed into a structural self-interaction matrix, reachability matrix, and reachability matrix grouping.

The results of the data analysis are directed graph, MICMAC Cartesian diagram, prominence value, and relation value. Directed graph is a representation of the hierarchical structure of sub-factor relationships. The data obtained will be compiled into a narrative that becomes the basis for analyzing the right strategy for the parties involved in the construction project in order to prevent time delays in high-rise building construction projects in Indonesia. The strategy analysis will focus on professionalism and work ethics.

4 Discussion

4.1 Respondent Data

Questionnaire data was collected from fifteen respondents categorized as experts in high-rise building construction in Indonesia. Five of the respondents have master's degrees and the others have bachelor's degrees. Respondents had various job titles, including 53% project manager, 40% site manager, and 7% site engineer. Of the fifteen respondents, 33% have 7–10 years of experience, 27% have 15–20 years of experience, 20% have 20–25 years of experience, and 20% have 10–15 years of experience. A total of 40% have the last experience of high-rise building construction in the form of factories while others have experience in hotels, offices, and malls.

4.2 Analysis and Discussion

Factors causing time delays in high-rise building construction projects in Indonesia are processed using the ISM and DEMATEL methods. This data processing resulted in the hierarchical structure and leveling of each factor, MICMAC Diagram, and *Prominence Net Diagram. The* hierarchical structure consists of twenty factors grouped into seven different levels. The greater the level described further down in the structure means the higher the value of *driving power*.

At Level 7 there is a bad weather factor (F11). Weather factors are the root cause of time delays in high-rise building construction projects in Indonesia. Weather changes can affect factors at level 6 including difficult conditions (F12), poor access to the location (F13), and force majeure (F20). Factors at levels 6 and 7 are factors that are difficult to predict and control. In this case, the principles of professionalism and work ethics are decisive for preventing the impact of these factors. Ethics itself can be interpreted as a *standard of conduct* that leads individuals [16]. A person who has professionalism is a person who has expertise or expertise in a particular field [17]. One of the important things in professionalism and work ethics is planning. Forms of planning that can be done to prevent weather factors are using weather prediction applications, making backup plans in the event of circumstances that are beyond prediction such as preparing tarpaulins on the day of casting, recording weather reports honestly equipped with documentation, and so on. Difficult condition factors related to soil type and water table can be prevented by testing field conditions before project construction begins. The factor of poor access to the site can be prepared by conducting a site *survey* before carrying out the project so that it can estimate the time and costs that need to be prepared. Factors at levels 6 and 7 require a high level of honesty in prevention. Therefore, having high professionalism and ethics is necessary in the development of construction projects.

The MICMAC Cartesian diagram is used to determine factors that can influence and be influenced by other factors. The preparation of the MICMAC cartesian diagram is done by adding the number 1 of each factor bar in the *Final Reachability Matrix* which will produce a *driving power* value. Meanwhile, in the column, each 1 is summed up to obtain the *dependence* value. The *driving power* and *dependence* values of each factor show the position in the Cartesian diagram. The *driving power* value shows the position

of the factor on the Y-axis and the *dependence* value shows the position of the factor on the X-axis.

The MICMAC cartesian diagram was created with the help of Microsoft Excel. In this study, it can be seen that the twenty factors in the study are classified in two quadrants, namely in quadrants four and three.

There are fourteen factors in quadrant three or the linkage category. Factors in quadrant three have strong dependence and driving power values. This means that these factors strongly influence and are influenced by each other. Existing factors tend to be unstable because the effects that occur can have an effect on themselves. Therefore, the factors in this quadrant need more attention. These factors are labor turnover rate, equipment availability, late delivery of tools, poor communication within the contractor organization, design changes before construction, design changes during construction, late approval of shop drawings, material availability, poor material quality, late delivery of materials, late payment, project owner intervention, unsuitable working methods, and poor supervision.

The independent category in quadrant IV is a factor that has a tendency to influence with low dependence. This causes the factors in this quadrant to not be easily affected by other factors. But on the other hand, if a problem occurs in an independent factor, it will have an impact on other factors. There are six factors included in this category, namely bad weather, difficult site conditions, difficult access to the site, adjacent buildings, narrow material and equipment storage areas, and force majeure.

The result of the third data processing is the Prominence Net diagram from the DEMATEL method which places the research factors based on the (D+R) and (D-R) values. In this diagram, it can be seen that important factors are of concern because they have a tendency to influence other factors. Factors that have a tendency to influence other factors are factors that have the highest positive (D-R) value.

The results of *Total Relation Matrix* processing, the force majeure factor is the most dominant factor in the time delay of high-rise building projects in Indonesia. Force majeure factors have the greatest impact on delays in material delivery. The second dominant factor is the bad weather factor which has the greatest influence on late material delivery. The third dominant factor is difficult location conditions that have the greatest influence on late material deliveries. Workers who have good work ethics and professionalism will calculate the risks before the work is carried out, one of which is handling bad weather. Experienced workers who can be said to be professional will check the weather forecast before casting and prepare tarpaulins for prevention if rain occurs unexpectedly. Having professionalism and work ethics will help to understand that force majeure cannot be avoided in the process of building a construction project. One prevention is to have insurance that can cover risks arising from force majeure.

Through the comparison of the *Interpretive Structural Modeling* and DEMATEL methods, there are four factors included in the root causes of both methods. The four factors are bad weather, force majeure, difficult site conditions, and difficult access to the site. The four root causes are factors that are difficult to avoid and predict.

The first factor is bad weather. Bad weather can cause delays in material delivery, construction work to stop, a decrease in material quality, difficult site conditions, and so on. Bad weather can be predicted through weather forecasts. However, the available

weather forecasts are not entirely accurate. In terms of professionalism and work ethics this is certainly very well understood. This is because good planning before construction is important in professionalism and work ethics. An example of what can be done is to do the casting in the morning to prevent the possibility of greater rain in the afternoon during the rainy season.

The second factor that becomes the root of the problem in the delay of high-rise building projects in Indonesia is force majeure. Force majeure is a risk that is very difficult to predict and prevent. This factor will have a broad impact on the sustainability of the entire project. A form of professionalism and work ethic towards this is to prepare emergency funds and project insurance. Another form of planning is to include force majeure in the contract agreement agreed by the *owner* and contractor. In this case both parties have known and agreed on the things that can arise from force and agreed on the things that can arise from force majeure. The third factor is difficult site conditions. This factor can be prevented by testing before the project is carried out. The form of professionalism and ethics required in this factor is to cooperate with parties who are experts in the field of testing. For example, using a nationally verified University soil testing institute. This relates to the level of accuracy of the data obtained to prevent design and method errors used during the construction project.

The fourth factor is that access to the location is difficult. In this case, honesty and planning in professionalism and work ethics are important to note. Access to difficult locations can be known during the *tender* process by conducting a site *survey*. Knowing difficult site access during the early stages of planning can help create the right project planning schedule. The selection of equipment and material use will be greatly influenced by site access. For example, if site access is difficult because the site is located in a rural area, then a *batching plant* can be built at *the project construction* site. Another example is if the project site is located on a narrow road that is not possible to be passed by heavy equipment is to use the *bored pile* method for building construction.

5 Conclusion

Analysis of the factors of time delay in multi-storey building construction projects in Indonesia against professionalism and work ethics shows that there is a relationship between factors that cause time delays in multi-storey building construction projects in Indonesia. The results of data processing were analyzed using three methods, namely ISM, MICMAC diagram, and relation diagram. ISM is divided into seven levels, where level 7 is the root cause of the time delay factor. The factor that is the root of the problem in the ISM method is bad weather. In the MICMAC diagram, it can be seen that the root causes of time delays are bad weather, force majeure, and difficult conditions. Through the relation diagram method, it can be seen that the factors that most affect time delays are force majeure, bad weather, and difficult conditions. The root causes of time delays can be overcome with professionalism and work ethics, including good planning, and having experienced experts. Therefore, professionalism and work ethics are very important in working on high-rise building construction projects in Indonesia, especially to prevent time delays in Indonesia.

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