The Correlation of Uncertainty Variables on Project Time Estimation in Banda Aceh, Indonesia

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ABSTRACT

Estimate the duration of detail is done by the contractor or the owner, among others, aims to obtain a project execution time. In estimating the duration of the work, can not be known with certainty the length of time the job at the time of construction. It is very closely related to the variables that can not be estimated with certainty or uncertainty during the implementation phase of construction, which will lead to a bias in estimating the duration of the work, which can result in delays in the work and the different duration of the work carried out in the field with that stated in contract. The objectives of this study was to obtain the most influential uncertainty variables in estimating the duration of the work, in order to obtain a job execution time realistic. The result is expected to be able to provide a great benefit for interested parties such as contractors, in recognition of the uncertainty of the most influential variables, it is expected that the contractor can estimate the time of execution of work in a more realistic project which later will affect the cost and quality of the project.

INTRODUCTION

As argued by Howick (2003), the delay and disruption caused by the uncertainty associated with estimates (as well as their presumed certainty) can drastically affect the cost, quality, and duration of the project. Although the objective should be developing the most accurate estimates, the inaccuracy inherent in estimation needs to be accounted for through some flexible mechanism (Khamooshi 1999), or the impact may cause more damage than would be tolerated by the stakeholders, leading to project failure. To solve the problem of unwanted scheduling iterations in design and development, Ballard (1999, 2000) and the Lean Construction Institute (LCI) at Berkeley introduced the concept of so-called phase scheduling, in which much emphasis is put on team work and on the reliability of the estimate. Ballard goes further and suggests, “The key point is to deliberately and publicly generate, quantify, and allocate schedule contingency”. The time needed to complete individual tasks or work packages is almost always greater than or at best equal to the original estimates used for establishing the baseline schedule. In other words, Parkinson’s law (Parkinson 1957) holds: work expands to fill available time. Work can be further delayed because of the student syndrome, i.e., waiting until the end to finish a task.

Statistics on classical project management success, that is, delivering the project on time, within budget, and per specification, show that most projects finish late (Eden et al. 2005) and overrun their budgeted costs (Hughes 1986; Standish Group 2009).

Inaccurate estimation has long been identified as one of the major causes of project failure (Flyvbjerg et al. 2009), and Standish Group reports (1998,2009) show more projects failing and fewer successful projects. Not easily achieved are good measures of worker pro-ductivity and the total amount of the work, which when combined determine task durations. For a specific activity, underestimation is generally caused by oversight or lack of familiarity or understanding of the job at hand, but it may even be driven by organizational culture or political causes. Estimating errors on work packages or activities may delay achieving a milestone and disrupt the remaining project schedule.

The delay and disruption caused by bad estimation may lead to project failure (Lee et al. 2009) or at best to project management failure, that is, not delivering the project on time, within budget, and per specifications. Abundant literature provides statistics on project management failure that link the failure to an absence of good planning and scheduling, the causes of which are either the

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estimates or the process used for planning and scheduling (e.g., Ritch et al. 2002; De Meyer et al. 2002; Herroelen and Leus 2004,2005). Williams (2005) provides overwhelming literature on project management failure and project overruns.

In anticipation of the implementation time delays that will occur as a result of the variables that cannot be estimated with certainty or uncertainty at the time of estimation, it needs to be allocated a certain amount of time is the time on risk, in this case positioned as a contingency time (Ervianto, 2004). The problems that a rise in this study are what variables and how the level of influence in estimating the duration of the project work. The purpose of this study was to obtain the most influential variable uncertainties in estimating the duration of the work to obtain a job execution time realistic.

**Estimated duration:**

According to Ervianto (2004) in the preparation of construction projects were usually not produced an ideal schedule, one purpose of preparation is to produce a time schedule that is realistic based on a reasonable estimate. In the PERT method, known to three kinds of estimates duration of each activity, where as in the CPM method and PD Monly obtained one estimate the duration, the third estimate is:

- Optimistic Estimate, is the duration required to complete an activity if everything goes well.
- Pessimistic Estimate, is the duration required to complete an activity if everything is in bad condition (not support).
- Most Likely Estimate, is the duration required to complete an activity among Optimistic and Pessimistic Estimate Estimated or known to the median duration.

**Uncertainty Variables in Construction Projects:**

The accuracy and the resulting reliability of estimates should be taken into account more seriously in developing project schedules. After the early stages of selection and approval, planning for a project continues with defining the scope of the project in greater detail, developing a work breakdown structure, and establishing estimates for the tasks and activities inside the work packages in preparation for schedule creation. The estimation process is used to specify the effort: the product of the duration needed to deliver the work-package products and the types and quantities of resources needed to achieve these objectives. The figures developed in this process are only estimates that are subject to uncertainty and, hence, inaccuracy. The lower the certainty, the higher the chance of exceeding the planned duration.

At the system and project levels there is also ample evidence of optimism bias in time and cost estimation (Flyvbjerg 2008; Wook and Rojas 2011). These observations suggest that the planned duration at best is almost always perceived as, and ends up being, the minimum actual time needed to do the job even if the worker may know, for example, that the planned duration is the most likely value (the mode), per historical data. Thus, the possible values to the left of planned durations become very unlikely as soon as the planned duration is confirmed. This problem does not exist when the system (project) is simulated mechanically, where all values above and below the planned value have their probabilities of occurrence as per given assumed distribution.

**External Uncertainty Factors:**

The uncertainty factors are defined externally, as factors of uncertainty that come from outside the project environment. External factors are factors that are outside the project environment and influence the project activities (Yeo, 1990). The uncertainty of these external factors can be divided into several variables: economic variables, sociocultural variables, geographic variables, and government policy variables in the construction sector.

**Internal Uncertainty Factors:**

Internal uncertainty factors are factors of uncertainty that arise from within the project environment. Yeo (1990), concluded that the uncertainty in construction projects is affected by environmental conditions within the project (internal factors). Variables in internal uncertainty factors can be divided into two: complexity of the project variable and project management-handling variable.

**Contingency:**

Contingency time allocated to anticipate delays execution time would occur as a result of the uncertainty variables that cannot be estimated with certainty or uncertainty at the time of estimation. This can be one of the risks that would be faced in the implementation of the future, should the allocation of time is minimized, by performing the best possible estimate. According to Makand Picken (Mak, S., D. Picken, 2000)], contingency is the amount of funds / times available in reserve to face the uncertainties related to construction projects. Contingency is very important if previous experiences related to costs indicate that there may be events that cannot be predicted that occurred resulting in increased costs.

**Methodology:**

The location of this study shows where the research is conducted to obtain the required data. This study carried out on contractor companies that are domiciled in the city of Banda Aceh, Indonesia. Uncertainty in construction projects can be pointed as departure from the inventory events that occur, which are not predictable at the time of implementation, and the impact or influence of these events to necessary resources (such as materials, equipment, labour, capital, and the method of
implementation). The inventory of these events can be studied to identify the causes of the uncertainty.

Table 3.1: Variables of Uncertainty in Estimating the Cost of Construction Project Offers

<table>
<thead>
<tr>
<th>Factors</th>
<th>Variable</th>
<th>Indicator of Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>External</td>
<td>Economics</td>
<td>1. The inflation rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. The interest rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Exchange rate</td>
</tr>
<tr>
<td></td>
<td>Social and Cultural</td>
<td>4. Regional Minimum Wage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Limitation the provision of credit</td>
</tr>
<tr>
<td></td>
<td>Geography</td>
<td>6. Cultural conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Behaviour or society order</td>
</tr>
<tr>
<td></td>
<td>Government</td>
<td>8. Behaviour of labour</td>
</tr>
<tr>
<td>Internal</td>
<td>Complexity of the project</td>
<td>9. Affecting the geographical location of accessibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10. Scarcity of resources due to geographical location.</td>
</tr>
<tr>
<td></td>
<td>Project management handling</td>
<td>11. The physical condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12. Interpretation and implementation of government policy on construction sector</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13. Scale / scope of project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14. The project site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15. Factors clarity / completeness of documents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16. Design Changes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17. Managerial ability of the team involved</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18. The ability of a contractor resource</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19. Availability and the working relationship between the contractor with the supplier</td>
</tr>
</tbody>
</table>

**Spearman Rank correlation coefficient**

Nazir (1988) said that if the observations of the two variables, X and Y is in the form of ordinal scale, the degree of correlation is calculated with the Spearman correlation coefficient. According to Conover (1980) the size of the correlation on ordinal data, the correlation size distribution function does not depend on the distribution function of \((X, Y)\) so that this correlation is classified in non-parametric statistics. The procedure for calculating the Spearman rank correlation coefficient is as follows:

1. Develop observational data of two variables in the form of ranking, \(R(Xi)\) where \(i = 1, 2, 3, \ldots, n\). Rated \(R(Xi)\) is the second smallest value of \(X1, X2, X3, \ldots, Xn\). Rated \(R(Xi) = 2\), if the value of \(Xi\) is the largest value. These stages are also performed on variable \(Y\).

2. Calculate the difference between the value of the ranking of each of the observations that have been paired.

3. Calculate the Spearman correlation coefficient. Spearman correlation calculation concept, has been linked with Pearson correlations were used in the parametric statistical analysis, it can be seen in some of the steps below:

\[
\rho = 1 - \frac{6 \sum_{i=1}^{n} (X_i - \bar{X})(Y_i - \bar{Y})}{n(n^2 - 1)} \quad \text{(2.1)}
\]

**Testing the hypothesis:**

Hypothesis testing is done to examine the relationship between two variables. In fact, the correlation Rank Spear mean, insensitive to relationships, so it needs to be tested. Testing can be done in two directions (two-tailed test)

\(H_0 = X_i\) and \(Y_i\) is a free relationship (mutually independent), it means that there is no correlation between the variables \(X\) and \(Y\).

\(H_1\) showed a trend of rising values with \(X\) followed by the \(Y\) value of rising or declining tendency of rising value of \(X\) followed by the \(Y\) value or vice versa.

Conover (1980) says that measures hypothesis testing on the Spearman rank correlation \((\rho)\), is to test the value of \(T\) and the value of \(\rho\). With a confidence level \((1 - \alpha /2)\), and the amount of data \((n)\), then through the table quantiles of Spearman test \(T\) Table Statistics obtained value. \(H_0\) hypothesis is rejected if \(T < T_{\text{Table}}\) as well as the value of \(\rho < \rho_{\text{table}}\). Testing of the above analysis can be done in 2 ways, namely on the value of the correlation coefficient \((\rho)\) and the value \(\Sigma d^2 \) or \(T\). [Conover 1980]

Hypothesis testing: (Two-Tailed test)

a) \(H_0 = X1\)and \(Y1\) are independently of one another, or null hypothesis

b) \(H_1\) = The existence of a relationship between the \(X1\)and \(Y1\), as increasingly rising \(X1, Y1\) followed by higher variable or vice versa for a confidence level=0.05 and \(n = 28\), the value \(\rho = 0.3749\). As theo test by checking the value of \(T\), and for a confidence level of 0.05 and \(n = 28\), the value of \(T=1890\).

**Conclusions:**

From Table 3.2, shows the correlation values \((\rho)\) is \(0<\rho <1\), then showed a positive relationship where the more influential a variable uncertainty, the greater the contingency time allocated. The largest correlation value resulting from relationship between economic variable on the time of contingency \((\rho = 0.7666)\). This value indicates that there is a strong agree of correlation between two variables, which means that the influential variables of economic
uncertainty, the greater the time contingency allocated. Analysis of correlation coefficient indicates economic uncertainty variables on contingency time ($\text{p}^2 = 0.5877$) is able to explain the variability (explained variation) of the value of contingency in the amount of $\pm 60\%$. This value can be said to provide at is factory results compared to the coefficient of determination in relation variables other uncertainties. In the other uncertainty variables relationships produce the coefficient of determination ($\text{p}^2 < 0.500$) meaning the relationship between the two variables is only able to explain the variability of the amount of time of less than 50% contingency. So it can be said there are still many unexplained variability of relations between the two variables. Despite producing a low coefficient of determination, but each of the uncertainty variables capable of providing a significant impact on the contingency time. This is evidenced by the rejection of the hypothesis (Ho) on any relationship between uncertainty variables on contingency time. So it can be stated that the two variables have a relationship.

### Table 3.2: Hypothesis Testing On The Value of The Correlation Coefficient.  

<table>
<thead>
<tr>
<th>var</th>
<th>(\gamma^2) atau (r^2)</th>
<th>$\rho$</th>
<th>$\rho^*$</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1, Y$</td>
<td>853</td>
<td>0.7666</td>
<td>0.5877</td>
<td>$T &lt; T_{table}, \rho &gt; \rho_{table}$</td>
</tr>
<tr>
<td>$X_2, Y$</td>
<td>1571.5</td>
<td>0.5705</td>
<td>0.3255</td>
<td>$T &lt; T_{table}, \rho &gt; \rho_{table}$</td>
</tr>
<tr>
<td>$X_3, Y$</td>
<td>1793.5</td>
<td>0.5096</td>
<td>0.2597</td>
<td>$T &lt; T_{table}, \rho &gt; \rho_{table}$</td>
</tr>
<tr>
<td>$X_4, Y$</td>
<td>1360</td>
<td>0.6065</td>
<td>0.3977</td>
<td>$T &lt; T_{table}, \rho &gt; \rho_{table}$</td>
</tr>
<tr>
<td>$X_5, Y$</td>
<td>1724</td>
<td>0.5286</td>
<td>0.294</td>
<td>$T &lt; T_{table}, \rho &gt; \rho_{table}$</td>
</tr>
<tr>
<td>$X_6, Y$</td>
<td>1197.5</td>
<td>0.6731</td>
<td>0.4551</td>
<td>$T &lt; T_{table}, \rho &gt; \rho_{table}$</td>
</tr>
</tbody>
</table>

### REFERENCES


