Manegement Information System of Project Construction at Construction Company (Case Study PT. Lingga Persada)

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ABSTRACT

PT. Lingga Persada is one of General Contractor, Interior and Supplier in Indonesia, particularly on construction services and sub-areas of the building. In fact the contactor often have projects that can't be resolved in accordance with a predetermined time. The delay is caused by several things occurrence on the implementation of the project, among others neglect of the risks by the project manager that the possibility of a negative impact on the implementation of projects. Scheduling is done by site managers are still traditional and less than optimal because it doesn't show specifically the dependency relationship between the tasks. Lack of supervision by the project manager of the deviation for the evaluation of the progress of the project is only done once a month, because that the project manager have difficulties to implement control so that the project remains on schedule.
Based on that issue, it require a web-based Management Information System (MIS), to simplify the management process at PT. Lingga Persada in the planning, implementation and control of construction projects by performing the risk analysis by using Qualitative Risk Analysis, making an optimal schedule by using Critical Path Method (CPM), making an evaluation of the integrated by using Earned Value Method (EVM) and prepare the control measures by using Time Cost Trade Off (TCTO).

Keywords*: Contractor, MIS, Project, Risk, Schedule, Evaluation, Web*

1. INTRODUCTION

In a construction project required the good cooperation relations between the project owner and the contractor. The project owner would want the project progressing on time and costs have been determined. In fact in the field contactor often have projects that can not be resolved in accordance with a predetermined time. As happened in one of the projects PT. Lingga Persada namely Development Project of Rumah Toko (Ruko), which delayed the implementation time of 30 calendar days from the original schedule. In accordance with the contract documents, commencing on 1 April 2015 with implementation duration of 120 calendar days and a budget of Rp. 688 270 519, - (six hundred eighty-eight million two hundred seventy nine thousand five hundred and eighteen). The delay is caused by several things occurrence on the implementation of the project, among others neglect of the risks by the project manager that the possibility of a negative impact on the implementation of projects such as weather conditions, delays in material and the influence of the surrounding environment. Scheduling is done by site managers are still traditional and less than optimal because it does not show specifically the dependency relationship between the work, making it difficult to determine the focus of management to determine the impact of the delay of a job on the overall project schedule. Lack of supervision by the project manager of the deviation for the evaluation of the progress of the project is only done once a month, causing the project manager have difficulties to implement control so that the project remains on schedule.

1.1 Management Information Systems (MIS)

Management Information Systems (MIS) can be measured by a decision of the organization or group. SIM has been around since the sixties, but because of the development of science pengentahuan, then there is a development of the information system manajamen definition is as follows [2]:
Understanding which refers to the '60s, namely Opera-Management System is a system as a service provider information that is useful in providing support through pengorperasian scope, the scope of management, and the scope of certain organizational decisions.
Understanding which refers to 1993, namely Information Management System is a combination of a set of software and hardware to design the transformation of some of the data collected, later dihadikan one as an important source of information to find a solution or settlement.

1.2 Risk Management

Risks are events or factors that the event will increase the likelihood of not achieving the project objectives are in accordance with the time, cost and performance [4]. Risk management is a process that simantik of identification, analysis, response and control of project risks. The purpose of risk management is to maximize the opportunities and consequences of positive events and minimize the scope and consequences of negative events to project objectives [3].

1.2.1 Probabilty and Impact Matrix

Risks can be prioritized for further quantitative analysis and action (response) based on size (rating) risks. Measurement is performed on the risk based on the likelihood and impact. Evaluation of risk to the level of interest and priority to note is that with the help of tables [5], as in Figure 1:



Figure 1 Boston Square Qualitative Risk Assessment Matrix

Table 1 Qualitative Impact Assessment

Nilai	*Deskripsi*	*Dampak*
1	*Sangat rendah*	*Tidak berdampak*
2	*Rendah*	*Terjadi keterlambatan jadwal < 5%*
3	*Sedang*	*Terjadi keterlambatan jadwal 5%-10%*
4	*Tinggi*	*Terjadi keterlambatan jadwal 10%-20%*
5	*Sangat tinggi*	*Terjadi keterlambatan jadwal >20%*

Tabel 2 Probability Qualitative Assessment

Nilai	*Deskripsi*	*Dampak*
1	*Sangat rendah*	*Selalu terjadi pada setiap kondisi*
2	*Rendah*	*Sering terjadi pada tiap kondisi*
3	*Sedang*	*Terjadi pada kondisi tertentu*
4	*Tinggi*	*Kadang terjadi pada kondisi tertentu*
5	*Sangat tinggi*	*Jarang terjadi, hanya kondisi tertentu*

1.3 Project Scheduling

Scheduling planning project is the elaboration of the project into a sequence of steps that have included work execution time factor to achieve the target. In general it can be said that scheduling is the calculation of the allocation of the available time to the execution of each piece of work or activities, in the context of the completion of such projects, in order to achieve optimal results, taking into account the limitations - limitations that exist [6].

1.3.1 Critical Path Method (CPM)

Critical Path Method or the method of the critical path is the path that has circuit components of activities, with the total amount of time shows the longest and fastest period remerdy project. Thus, the critical path consists of a series of critical activities, starting from the first event until the last activities of the project [1]. The critical path is very important for the contractor because this path is that implementation activities should start on time and finish on time as well.
There are two calculations used in the critical path method, namely calculation of forward and backward calculation. There are some important things that must be considered in the calculation sehubung forward and backward calculation as follows:

1. *Forward Pass*
   Advanced calculations in determining the slowest time starting and completion of each activity, as well as the latest occurrence of each activity.
   $EF = ES + D$
   $EF(i\text{-}j) = ES(i\text{-}j) + D(i\text{-}j)$ *(1-1)*
2. *Backward Pass*
   Countdown is the slowest time of starting and completion of each activity, as well as the latest occurrence of each activity.
   $LS = LF – D$
   $LS(i\text{-}j) = LF(i\text{-}j) - D(i\text{-}j)$ *(1-2)*
3. *Total Float (TF)*
   Total float is the amount of time allowed for an activity can be delayed without affecting the overall project schedule. Total float an activity together with the latest finish time minus the earliest completion time, or the latest start time minus the earliest start time.
   $TF = LS - ES$ *(1-3)*

1.4 Project Controling

Project Controling is a systematic effort to define a standard that is in accordance with the objectives of planning, designing information systems, compares the implementation and standards, then take the necessary corrective action so that resources are used effectively and fuel-efficient in order to achieve the objectives [1]. The benefits of a control function is to reduce the possibility of errors occurring in terms of quality, quantity, cost and time. In construction projects, control is needed to keep the implementation does not deviate from the plan.

1.4.1 Earned Value Method (EVM)

Earned Value Method is a method of calculating the fees according to the budget in accordance with the work that has been completed or implemented Budget Cost Work Performance (BCWP). While the weight of the work is calculated based on the unit

price corresponding to the contract value (excluding VAT 10%). The formula used is as follows:

$$\text{Bobot} = \left(\frac{\text{Harga Pekerjaan}}{\text{Harga Total Pekerjaan}} \right) \times 100\% \qquad (1\text{-}4)$$

When viewed from the amount of work completed then it means this method to measure the amount of units of work completed, at a time when judged by the amount of the budget provided is unknown relationship between what has been achieved physically to the amount of the budget that have been issued.

$$\text{BCWP} = (\%\text{Penyelesaian}) \times (\text{Anggaran}) \qquad (1\text{-}5)$$

Earned value method results can be used to analyze performance and make forecasts the achievement of targets. So we use three indicators, namely:

1. *ACWP (Actual Cost of Work Performed)*
   ACWP is the amount of the actual cost of the work that has been used to carry out the work at a certain time. These costs derived from the data accounting or finance projects at the reporting date, the annals of all actual expenses.
2. *BCWP (Budget Cost of Work Performed)*
   BWCP is an indicator that shows the value of the results from the point of view of the value of the work completed on the budget provided for the job..
3. *BCWS (Budget Cost of Work Schedule)*
   BWCS is a budget for a work package, but compiled and linked with the implementation schedule. To ensure a mix between cost, schedule and scope of work and in each element of the work has been given the allocation of costs and schedules can become benchmarks in project implementation.

Merging the two performance schedule and cost in a single graph makes it easier to analyze the measurement of the performance of a job. Two pieces of analysis that can be used in measuring the performance of a work that is the variance that aims to measure the performance of a job up to the reporting date. The variants analyzed are the schedule (schedule) and cost (cost).

Cost Variance, CV (Cost Varians) :

$$CV = BCWP - ACWP \qquad (1\text{-}6)$$

Schedule Variance, SV (Schedule Varians) :

$$SV = BCWP - BCWS \qquad (1\text{-}7)$$

CPI (Cost Performance Index) :

$$CPI = BCWP/ACWP \qquad (1\text{-}8)$$

SPI (Schedule Performance Index) :

$$SPI = BCWP/BCWS \qquad (1\text{-}9)$$

To calculating the CPI and SPI is to statistically predict the time and cost needed to complete the project. There are many methods in predicting the time (EAS) and the cost of project completion (EAC). However, the calculation of the value of EAS and EAC with SPI and CPI easier and faster use. There are several calculation formula EAS and EAC, are as follows.

To calculate cost estimates for remaining work or Estimate to Completion (ETC), is used as follows:

$$ETC = (BAC - BCWP)/CPI \qquad (1\text{-}10)$$

To calculate an estimate of the final cost of the project or the Estimate at Completion (EAC), use the following formula :

$$EAC = ACWP + ETC \qquad (1\text{-}11)$$

To calculate the approximate time for completion of the remaining work or Temporary Estimate Schedule (ETS), used the following formula :

$$ETS = (Duration - Work\ Duration)/SPI \qquad (1\text{-}12)$$

To calculate the estimated time of completion of the final project or Estimate All Schedule (EAS), use the following formula :

$$EAS = Work\ Duration + ETS \qquad (1\text{-}13)$$

1.4.2 Project Accelerating

Acceleration of the project is an attempt to finish the construction project with a duration of time which is faster than a predetermined schedule. Duration of acceleration (crashing duration) is the shortest time to complete the project activity is still technically possible, assuming the resources are not impediments [1].
There are several alternatives that can be used to accelerate the completion of the duration of the project, namely the addition of working hours, turn the division of labor, more labor, additional tools and replacement method of execution. Any alternative used to perform the acceleration will lead to changes in costs, both total costs, direct costs and indirect costs.

$$Dc = \frac{Dn \times h}{h + (h0 \times e)} \qquad (1\text{-}14)$$

Note :

Dc = Accelerate Duration
Dn = Normal Duration
h = Normal Work Hour per-day
h0 = Normal Extra Work Hour per-day
e =Effectiveness of overtime, with the provision that if h0 is 1 hour, 2 hours, 3 hours, 4 hours, then the values are respectively 0.9, 0.8, 0.7, 0.6.

Extra working hours or overtime decreased productivity due to worker fatigue or limited vision, decreased productivity, overtime can be seen in Figure 2:

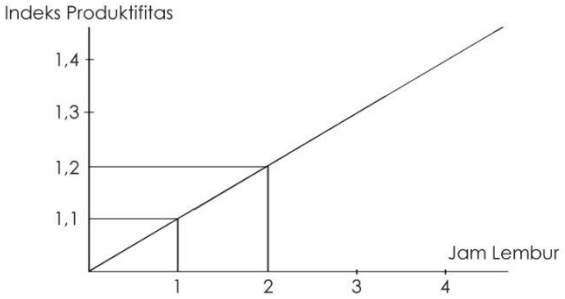


Figure 2. Decreased Productivity Overtime Graph

1.4.3 Time Cost Trade Off (TCTO)

Analysis and calculations used to determine changes in the duration of the project costs is by using Time Cost Trade Off (TCTO). This method is used to analyze how far the schedule or the duration of the work can be speeded up economically. Acceleration is only done on critical jobs that are still likely to be accelerated so as to produce a new shorter duration. With the accelerated long a job will inevitably lead to changes in cost and time, which includes:

1. *Time Normal (Normal Duration) is the time required to conduct complete with a normal level of productivity.*
2. *Acceleration Time (Crash Duration) is the shortest time to complete an activity which is technically still possible.*
3. *Cost of Normal (Normal Cost) are direct costs required to complete a period of normal activities.*
4. *Cost Acceleration (Crash Cost) is the amount of direct costs to complete the activities with the shortest period of time.*
5. *Additional Charges (Cost Slope) is the amount of direct costs per-unit time.*

The equation used to calculate Cost Slope is as follows:

$$\mathbf{Ri} = \frac{\mathbf{Cc - Cn}}{\mathbf{Dn - Dc}} \qquad (1\text{-}15)$$

Note :

Ri = Cost Slope
Dc = Accelerate Duration
Dn = Normal Duration
Cc = Accelerate Cost
Cn = Normal Cost

2. THE CONTENT OF RESEARCH

2.1 Risk Analysis

Qualitative Risk Analysis by identifying the risks resulting from secondary data (literature and journals) and then developed with field observations with the PT. Lingga Persada. Further interviews with the help of a questionnaire regarding the possibility of the risk and impact of these risks to the scale of values. Furthermore, the resulting value will be determined based on the level of risk level matrix. Respondents were drawn from the PT. Lingga Persada is Project Manager, Site Manager, Accounting Manager and Project Supervisor at Rumah Toko (Ruko).

Table 3 Risk Assessment

Risk Variable	*Probability*	*Impact*	*Total*	*Level*
Specifications incomplete picture	*2*	*2*	*4*	*L*
Change owner	*1*	*2*	*3*	*L*
Data geotechnical and soil incomplete	*1*	*2*	*3*	*L*
Not according to the standard	*1*	*1*	*1*	*L*
design flaw	*2*	*2*	*4*	*L*
Availability of material	*2*	*4*	*8*	*M*
Safety or accident	*1*	*2*	*2*	*L*
Nature / extreme weather	*3*	*3*	*9*	*M*
Problems earthworks	*2*	*3*	*6*	*M*
Repetition of work (rework)	*1*	*2*	*2*	*L*
Delays in delivery of materials	*2*	*3*	*6*	*M*
Labor	*2*	*4*	*8*	*M*
Building construction issues	*1*	*2*	*2*	*L*
Quality	*2*	*2*	*4*	*L*
Material price increases	*3*	*3*	*9*	*M*
The increase in fuel	*3*	*3*	*9*	*M*
Lack of funds	*1*	*4*	*4*	*L*
Damage and loss of property	*2*	*2*	*4*	*L*
Regulatory changes	*1*	*1*	*1*	*L*
Protests from certain organizations	*2*	*3*	*6*	*M*
Land acquisition	*1*	*2*	*2*	*L*

Environmental contamination	*1*	*1*	*1*	*L*
Endangered species	*1*	*1*	*1*	*L*

2.2 Analysis of Critical Path Method CPM

Based on the network that has been created, the next step is to calculate the total project completion time, advanced computation (forward pass), countdown (backward pass), and calculate the float. Critical path: A1-B1-B2-B3-C2-D1-D2-D4-E2-E3-F1-F2-F3-F4-H1-H5-H7-J1-J2-J3-L1-L2.

Table 4 Critical Task of Rumah Toko Project

Task	*Code Activity*	*Duration (day)*	*Status*
Pembersihan area proyek	*A1*	*4*	*Critis*
Galian tanah 1 s/d 2 m	*B1*	*3*	*Critis*
Urug pasir	*B2*	*2*	*Critis*
Urugan tanah kembali + pemadatan	*B3*	*2*	*Critis*
Beton K - 225 : Pondasi Tapak	*C2*	*3*	*Critis*
Beton K - 225 : Sloof	*D1*	*7*	*Critis*
Beton K - 225 : Kolom	*D2*	*10*	*Critis*
Beton K - 225 : Plat tebal	*D4*	*25*	*Critis*
Plasteran 1 pc : 5 psr	*E2*	*7*	*Critis*
Pasang dinding keramik	*E3*	*3*	*Critis*
Sumur bor	*F1*	*7*	*Critis*
Pompa air kap. Standar	*F2*	*1*	*Critis*
Gate valve Ex. PVC	*F3*	*1*	*Critis*
Pipa air bersih PVC	*F4*	*2*	*Critis*
Keramik Standar	*H1*	*9*	*Critis*
Waterprofing Membran + Screeding	*H5*	*6*	*Critis*
Ralling tangga	*H7*	*3*	*Critis*
Kusen & daun pintu	*J1*	*6*	*Critis*
Pintu Folding gate	*J2*	*4*	*Critis*
Jendala kusen aluminimum & kaca	*J3*	*5*	*Critis*
Cat dinding luar Ex. Vinilex	*L1*	*4*	*Critis*
Cat dinding dalam & plafond	*L2*	*5*	*Critis*

2.3 Project Evaluation With EVM

Analysis contains project control analysis, evaluation and analysis of the project budget equalization of resources on the Project Home Store (office) is done by PT. Lingga Persada. In this case the evaluation analysis project using Earned Value Method (EVM).

Table 5 Analysis BCWS, BCWP dan ACWP

Wk	*Periods*	*BWCS*	*BWCP*	*ACWP*
1	*01 - 07*	*15.805.580*	*11.512.200*	*11.291.000*
2	*08 - 14*	*47.825.798*	*23.678.135*	*22.964.000*
3	*15 - 21*	*61.422.143*	*55.595.138*	*54.044.000*
4	*22 - 28*	*82.359.824*	*73.386.532*	*71.509.500*
5	*29 - 05*	*152.404.677*	*106.601.006*	*104.643.900*

Based on Table 5 in the previous analysis, the data obtained as follows:

a. *Total Duration = 17 week*
b. *Total Work Duration = 5 week*
c. *Total Budgeted (BAC)= Rp. 688.270.519*
d. *BCWS = Rp. 152.404.677*
e. *BCWP = Rp. 106.601.006*
f. *ACWP = Rp. 104.643.900*
g. *SV = Rp. -45.803.671*
h. *CV= Rp. 1.957.106*
i. *SPI = 0,70*
j. *CPI = 1,02*

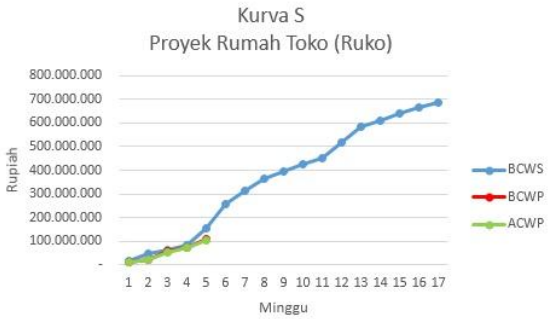


Figure 7 Curve S Rumah Toko Project

2.4 Project Acceleration With TCTO

Accelerate project completion and the estimated time and cost on the Project Home Store (office) using Time Cost Trade Off. Acceleration time and costs are calculated based on the alternative Extra working hours centered on the work that is on the critical path.
Calculation of duration crash, crash costs, and costs slope at Work Plestaran 1 pcs: 5 psr :

a. *Volume = 463,392 m²*
b. *Normal Duration = 7 days*
c. *Normal Cost = Rp. 30.236.768*
d. *The unit cost of wages = Rp. 23.236 /m²*
e. *The unit cost of materials = Rp. 41.938 /m²*
f. *Normal daily productivity / hour = 8,2845 m²/hour*
g. *The daily productivity acceleration = 73,73205 m²/day*

h. *Crash duration = a / g*
= 463,392 / 73,73205
= 6 days

i. *Normal wage / hour = (d x f)*
= 23.236 x 8,2845
= Rp. 192.500 /hour

j. *Normal wage / day = (8 jam x i)*
= 8 x 192.500
= Rp. 1.540.000 /day

k. *Overtime wage/day = (1,5 x 1) x 192.500*
= Rp. 288.750 /day

l. *Wage cost/day = (j + k)*
= 1.540.000 + 288.750
= Rp. 1.828.750 /day

m. *Total wage cost = (h x l)*
= 6 x 1.828.750
= Rp. 11.506.742

n. *Total material cost = (a x e)*
= 463,392 x 41.938
= Rp. 19.456.768

o. *Crash cost = (m + n)*
= 11.506.742 + 19.456.768
= Rp. 30.963.510

p. *Crash slope = (o - c)/(b - h)*
= Rp. 1.026.667

3. FINAL

3.1. Conclusion

Based on the results obtained in this thesis, it can be concluded as follows:

1. *The project management information system can be run fairly in accordance with its objectives, namely to help project managers to identify risks that are likely to have a negative impact on the implementation of the project, as well as preparing for action handling.*
2. *The project management information system can help the site manager to optimize schedules by analyzing the critical work on the project to simplify management focus.*
3. *The project management information system to facilitate project manager in evaluating the progress of the project on time and costs, so that project managers can perform early anticipation in case of project delays.*
4. *The project management information system can help the project manager to carry out control measures such as the acceleration of the project with the addition of alternative working hours or overtime, the action aims to accelerate the completion of projects that experienced delays or project manager intentionally speed up the completion of projects, although not experience delays.*

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