



COST AND TIME ANALYSIS OF THE PONTIANAK MCD BUILDING PROJECT USING TIME COST TRADE OFF (TCTO) METHOD

Oskar Ezra Alan Muin, Hanie Teki Tjendani, Budi Witjaksana

Faculty of Engineering, Universitas 17 Agustus 1945 Surabaya, Indonesia

Email: oskezra@gmail.com, hanie@untag-sby.ac.id, budiwitjaksana@untag-sby.ac.id

ABSTRACT

This study aims to apply the Time Cost Trade Off (TCTO) Method in cost and time analysis for the McDonald's construction project in Pontianak. This method allows project managers to explore the relationship between turnaround time and project cost, with the goal of finding the optimum point that produces the lowest cost with an acceptable turnaround time. The analysis process begins with the identification of project activities, estimation of the cost and duration of each activity, and the creation of an initial project schedule. Next, simulations were carried out using TCTO to evaluate time and cost reduction options. By applying the Time Cost Trade Off Method, it is expected that the McDonald's construction project in Pontianak can be completed with minimal costs and in time in accordance with the targets that have been set. From the results of data processing, it was found that the addition of 2 hours of overtime is the optimum acceleration, which can accelerate work time by 18.30 days with an acceleration cost of IDR 62,002,212, so that the total optimum cost becomes IDR 1,091,128,551,-. Where this result is the optimum result of the project fine of IDR 228,366,605 for a delay of 12,628 days.

Keywords: Time Cost Trade Off, construction project, cost, time

INTRODUCTION

Construction projects in Indonesia are carried out on an ongoing basis to provide facilities and infrastructure that can increase productivity, facilitate economic access and community mobility. Every construction project is planned by considering optimal cost, quality and time. Construction project work often faces challenges in managing costs and time. In accordance with Coordinating Minister for Economic Affairs Regulation Number 21 of 2022, the Ministry of Public Works and

Public Housing (PUPR) has the mandate to carry out the development of 125 National Strategic Projects (PSN) spread throughout Indonesia. This consists of 51 toll roads and bridges, 56 dams and irrigation, 13 drinking water and sanitation projects, 2 housing developments, the Jakarta coastal sea embankment, and the Batang Integrated Industrial Zone. From the target of 125 national strategic projects, until July 2023 the Ministry of PUPR has completed 87 National Strategic Projects (PSN) or 70% of the total target that has been set. According to the Minister of PUPR, national strategic

projects are designed with a priority on infrastructure development which is expected to create a multiplier effect on economic growth and equal distribution of community welfare.

In the field of Water Resources, the PUPR Ministry has completed the construction of 36 dams with a capacity of 1.9 million m³. Then in the Highways sector, 1,500 km of PSN toll road construction has been completed from 27 toll road projects through the Government and Business Entity Cooperation (KPBU) scheme, such as the Cisumdawu Toll Road, Pekanbaru-Dumai Toll Road and Balikpapan-Samarinda Toll Road.

The PUPR Ministry has completed 7 projects in the housing sector and has implemented the PPP scheme in the drinking water supply sector in the Umbulan Regional Drinking Water Supply System (SPAM), West Semarang Regional SPAM and Banjarnegara Regional SPAM. The service capacity is around 5,750 liters per second, and serves around 500 thousand SR. This program has succeeded in accelerating the development of sustainable and resilient infrastructure that is able to encourage economic growth

For this reason, in managing construction projects, it is very important to manage project costs and time efficiently. If there is a delay in work progress, it has a significant impact on the entire project, thus it is important to develop an effective method to optimize the cost and time of project work implementation. One approach used to optimize projects is to use the Time Cost Trade Off (TCTO) method, this method allows projects to be completed more quickly. The time cost trade off method is an exchange of time and costs which is a method used to speed up project implementation time by testing

all activities in a project which is focused on activities that are on the critical path in a deliberate and systematic manner. In this research, it has been limited that activities to accelerate project duration will be carried out by increasing working hours and increasing workforce. The background to using this method can be caused by several things such as uncertainty in the project, time pressure, limited resources (Izzah, 2018).

Uncertainty in the project; In construction or development projects, there are often many factors that can cause delays, such as bad weather, delays in delivering materials, technical problems, or changes in planning. This uncertainty can put projects at risk of delays, strategic decisions and strategic decisions. Time pressure; many projects have tight deadlines to complete, especially if there are factors such as market competition or customer needs that must be met. Project delays can have serious consequences, including financial losses or lost opportunities. Resource limitations; Sometimes, projects face resource limitations, such as limited workforce or limited budget. This can be an obstacle to completing projects on time. Strategic decisions; The use of the Time Cost Trade Off (TCTO) method involves strategic decision making by project management. It involves mathematical analysis and careful planning to determine the optimal trade-off between time and cost that fits the project objectives and available resources.

The background to using the time cost trade off method is to deal with project delays in an effective way, make wise decisions regarding resource allocation, and achieve a balance between time and cost so that the project can be completed according to the desired target.

Realization of project work is related to cost, quality and time control. In managing project control to meet planned quality requirements, both at the planning, supervision or implementation stages; must be carried out in accordance with applicable Indonesian National Standards (SNI). Apart from quality control, things that need to be considered are appropriate time and cost control based on the work plan and terms and conditions (rks) and applicable work agreements.

Factors that influence project delays are as follows: based on labor factors that influence delays, workers do not meet the requirements, worker discipline is not appropriate, workers are less motivated, worker attendance is less, the number of workers is not as needed, replacement of new workers, communication between workers and the head craftsman is not well-organized, based on material factors that influence delays, namely materials not according to schedule, insufficient material sources on the market, material quality not up to standard, material damage in storage, changes in material specifications, availability of rare materials on the market, inaccurate ordering schedule. Based on the characteristics of the location, the following are land conditions that are not supportive, environmental conditions around the project that are not supportive, views that do not support the surrounding buildings, storage areas for materials that do not meet the requirements, road access to the location is not yet adequate, availability of work space is not suitable, the location is not suitable. hard to reach. Quality control management is inadequate, evaluation management and work control are not appropriate, project managers lack experience, material and equipment management errors. Based on equipment,

the following are delays in equipment mobilization, equipment problems that are not running as they should, equipment availability is not appropriate, equipment productivity is not according to its intended purpose, operator's ability to operate equipment is not yet sufficient. Based on finances, it is as follows: there is no incentive for the contractor if it exceeds the planned target, the material price is above the estimated price, the owner's fund allocation is not enough, the payment of wages to workers is not according to schedule. Based on the environment, the following are the intensity of rainfall, the occurrence of major forces such as pandemics, floods, bad weather, storms, earthquakes and landslides. Based on the scope and contract/work documents, the plan drawings are incomplete, changes in the scope of work during implementation, changes to work that have been completed, misunderstandings in reading the drawings by the contractor. Based on planning and scheduling, the following are identification of types of work that are incomplete, work methods are not well prepared, time durations are determined incorrectly, the owner's work plan changes, and construction/work implementation methods are wrong or inappropriate (Astina et al., 2012) and (Wirabakti et al., 2014).

Time control is an important instrument in the series of project work which contains various types of work details in a coherent manner. Work details related to the implementation schedule as a basis for project work for project owners, contractors and consultants with the aim of monitoring the progress of the contractor's work in the field, which can be used as a reference for payment, supporting the allocation of budget costs, consideration if there are additional costs for changes to the

work, supporting, and as supporting material for a request for an extension of time.

In the time control process, the planned schedule can experience delays in realization in the field. Project delays are defined as the time limit for project completion that has been determined in the contract or the time agreed by the parties involved in completing a project (Assaf. Et al., 1995).

The cost and time analysis step uses the time cost trade off analysis method. Time cost trade off method analysis is applied to the Critical Path by assuming supporting variables, namely increasing the optimal number of working hours to speed up time. In conditions like this, cooperation between related parties also determines whether project work can be carried out according to schedule. Delays occur due to considering several things, namely pre-work administration, material supply, mobilization of work equipment to the project location, weather conditions, existing project environmental conditions and psychosocial conditions of the local community.

In the case study, the construction of the McD Pontianak building was faced with a tight schedule with a construction period of 130 calendar days and experienced delays caused by existing building foundations that were still there, which hampered the erection process and local rain, so good cost and time management was needed so that the results obtained according to plan. Therefore, proper cost and time analysis is needed for construction projects, so as to minimize the risk of delays in project work which will be a case study, namely the construction of the McD Pontianak building. The owner of McD Pontianak is Telkom Property, as a

subsidiary of Telkom Indonesia, Tbk has 4 product & service portfolios such as property development, property management, project solutions, & transportation management services. As an integrated property management company, Telkom Properti primarily supports Telkom Indonesia's operations through building management & other supporting infrastructure. However, Telkom Property is also expanding its services to external markets outside the Telkom Group, with the aim of bringing prosperity & added value, until 2022, the company manages 2,283 buildings, 3 hotels and 1 apartment.

Based on the description of the problem formulation above, the aim of writing this research is; (1) analyzing the time for additional working hours (manhour) using the time cost trade off (TCTO) method on McD Pontianak construction project work, and (2) analyzing the cost of additional working hours (manhour) using the time cost trade off (TCTO) method on work on the McD Pontianak construction project.

RESEARCH METHODS

The research method used is a qualitative method involving literature study, secondary data collection, data processing, and accelerated data analysis. Literature studies are carried out to understand the research context, identify knowledge gaps, formulate research questions, identify theories and conceptual frameworks, as well as appropriate research methods. Literature sources used include books, journal articles, research reports, theses, websites, and other sources related to the research topic.

Data collection was carried out by collecting project secondary data, such as Draft Budget (RAB), Time Schedule, and S Curve. This secondary data was obtained from third parties (contractors) and not through direct observation.

Data processing involves processing data related to research, including finding the critical path, data analysis using the time cost trade off method, analysis of additional working hours and labor, and conclusions about the research.

By using qualitative methods, this research is expected to provide an in-depth understanding of the cost and time analysis of the Pontianak McD construction project, as well as contribute to filling existing knowledge gaps in this field.

Time Cost Trade Off (TCTO) method for analyzing personal work costs and time, data analysis techniques involve several important steps, namely:

- 1) Data Processing: The data obtained is processed to determine the critical path, productivity with acceleration, and crash duration. In this step, data must be organized and analyzed to obtain the required information.
- 2) Results Analysis: After the data has been processed and designed, results analysis is carried out to evaluate the use of the TCTO method. In this analysis, changes in project completion time will affect the costs that will be incurred, which can occur due to additional working hours (overtime work) or additional workforce.
- 3) Results Interpreter: Once results analysis is complete, the results must be interpreted to identify patterns, trends, relationships, or information that is useful in decision making or better understanding a phenomenon or problem.

RESULTS AND DISCUSSION

Normal Duration and Normal Cost

Normal duration and normal cost are calculated to determine the normal duration of the project and costs under normal conditions on the critical path.

Normal Duration Calculation

Analysis of the total normal time calculation is obtained from the normal duration of each work item. The following is an example of calculating the normal duration of each work item.

Calculation example 1:

- Work Item Beam formwork work +3,770
- Work Volume: 265.27 m²
- Artisan Coefficient: 0.100
- Number of Handymen: 10 people
- Work productivity/day: (1/Worker coefficient x number of craftsmen)
= $1/0.100 \times 10$
= 100
- Normal Duration of Work: Volume of Work / Productivity per day
= $265.27 / 100$
= 2.65 days

From the results of the calculation above, for beam work +3,770 with a productivity per day of 100, the normal duration is 2.65 days to complete the formwork work.

Calculation of Normal Cost

Normal costs are direct costs incurred during the completion of project activities in accordance with the normal time. To get the Normal Cost the data needed is the volume of work and the unit price of each job. The following is an example of a Normal Cost calculation:

Example 1:

- Work item: **Beam formwork work +3,770**
- Job volume : 265.27 m²
- Unit price of materials: IDR. 120,745

- Unit price of labor : IDR. 40,248
- Normal price : IDR Volume x (unit price of materials + unit price of labor)
= 265.27 x (IDR. 120,745 + IDR. 40,248)
= IDR 42,706,061,-

The normal cost calculation result for formwork work is IDR 42,706,061.

Crashing Scenario

In the concrete structure work, the progress that was delayed was the elevation beam work + 3,770, the elevation beam + 7,200, the canopy plate floor, the gutter work el 7,200, the stair structure work.

Calculation of Crash Duration and Crash Cost

Crash Duration Calculation

In the Crash Duration calculation, the data needed is the worker coefficient on the AHSP and the volume of work. The duration of this acceleration is obtained by calculating hourly productivity and overtime work productivity for 4 hours of work. The following is an example of calculating the acceleration duration:

Calculation example 1, addition of 4 working hours:

Acceleration duration for beam formwork work at an elevation of +3,770

- a. Volume = 265.27 m²
- b. Artisan Coefficient = 0.100
- c. Number of Craftsmen = 10 people
- d. Normal Productivity Per Day
= (1/craftsman coefficient) x number of workers
= (1/ 0.100) x 10 = 100 m²/day
- e. Normal Duration = Normal Volume/ Productivity
= 265.27 / 100 = 2.65 days
- f. Team Productivity Per Hour
= Per-day Productivity / Normal Working Hours

$$= 100 / 8 \text{ hours} = 12.5 \text{ m}^2 / \text{hour}$$

- g. Productivity During Overtime (4 hours)
= 4 x Hourly Productivity x Productivity Reduction Coefficient

$$= 4 \text{ hours} \times 12.5 \text{ m}^2/\text{hour} \times 0.60 = 30$$

- h. Productivity After Crashing
= Normal Productivity + Overtime Productivity

$$= 100 + 30 = 130 \text{ m}^2 / \text{day}$$

- i. Crashing Duration

$$= \text{Volume} / \text{Productivity after crashing} \\ = 265.27 \text{ m}^2 / 130 \text{ m}^2/\text{day} = 2.04 \text{ days}$$

On the +3,770 beam formwork work, 4 hours of working hours (overtime) were added with a total acceleration of the duration to 2.04 days from the original duration of 2.65.

Crash Cost Calculation

In this calculation the data needed is AHSP, unit price and work volume. The first thing that must be obtained is normal productivity and productivity during overtime and then add them up. The costs resulting from overtime working hours are obtained by multiplying the normal hourly wage by two times. The following is an example of pre-calculating acceleration costs:

Acceleration Duration for K-350 Beam Formwork Work

Example of calculating crash cost 1 for overtime duration of 4 hours:

Accelerated Cost Calculation for Elevation Beam Formwork Work + 3,770

- a. Volume = 265.27 m²
- b. Unit price of materials = IDR 120,745
- c. Unit price for workers = IDR 40,248
- d. Number of workers = 10 people
- e. Normal Fees
= Volume x (Unit price of Workers + Unit price Material)
= 265.27 m² x (40,248 + 120,745)
= IDR 42,706,061

- f. Hourly Workers' Wages
 - = HS Workers / Normal working hours
 - = IDR 40,248 / 8 hours
 - = IDR 5,031,-
- g. Workers' Wages During Overtime
 - = (2 x 4 hours x Hourly Wage)
 - = 2 x 4 hours x IDR 5,031,-
 - = IDR 40,248,-
- h. Per-day wages
 - = Worker wages + Overtime wages
 - = IDR 40,248 + IDR 40,248
 - = IDR 80,496,-
- i. Productivity After Crashing = 130 m²/day
- j. Duration After Crashing = 2,041 days
- k. Acceleration Fees
 - = (HS of Materials + HS of Workers after adding overtime) x Productivity After Crashing x Crashing Duration
 - = (Rp. 120,745 + Rp. 80,496) x 130 m²/day x 2,041 days
 - = IDR 53,382,577,-

Crash costs El + 3,770 beam formwork work after adding 4 hours of work is IDR 53,382,577 from the normal cost of IDR 42,706,061.

Cost Slopes

Cost Slope is the increase in costs to speed up an activity per unit of time. To get the Cost Slope, the data needed is Normal Duration, Normal Cost, Acceleration Duration and Acceleration Cost. The following is the formula for obtaining the Cost Slope value and an example of the calculation.

Example of calculating 1 cost slope for an overtime duration of 4 hours:

$$\text{Cost slope} = \frac{\text{Crash cost} - \text{normal cost}}{\text{Normal duration} - \text{crash duration}}$$

Calculation of cost slope for EL beam formwork work + 3,770

- Normal duration : 2.65 days
- Normal cost : IDR 42,706,061,-
- Acceleration duration: 2,041 days
- Acceleration costs: IDR 53,382,577
- Cost slope : (IDR 53,382,577 - IDR 42,706,061) / (2.65 days - 2,041 days)
- = IDR. 17,440,880,- / day

Based on calculations *cost clope* beam formwork work el +3,770 obtained results of 17,440,880,- / day

Project Component Costs

The amount of project component costs needs to be known in order to analyze the Time Cost Trade Off. In construction projects, costs are divided into two types, namely direct costs and indirect costs.

Direct Costs

Direct costs are costs that can change as the volume of work changes and are directly related to the final results of the project. Direct costs include costs required for materials, equipment, and labor. To calculate direct costs, data is collected first, which includes work volume data, resource data, work duration data, as well as the latest unit price data. In this study, the direct costs for concrete structure work were IDR 839,227,822,-

The analysis of direct cost results for normal duration, accelerated duration, normal costs, and accelerated costs for McD Pontianak work, the comparison of additional working hours of 2 hours, 3 hours, and 4 hours is as follows;

Results of cost analysis of additional working hours (manhour) on the McD Pontianak construction project work

- 1) By adding 1 hour of overtime work with a productivity index of 90%, the resulting additional costs are IDR 61,957,184.

- 2) By adding 2 hours of overtime work with a productivity index of 80%, the result is an additional cost of IDR 93,651,965.
- 3) By adding 3 hours of overtime work with a productivity index of 70%, the result is an additional cost of IDR 125,346,746.
- 4) By adding 4 hours of overtime work with a productivity index of 60%, the result is an additional cost of IDR 157,041,526.

Indirect costs

Indirect costs are all costs that can be indirectly expressed as being involved in the project. Indirect costs are used to calculate the additional costs each day which will affect the total costs. Indirect costs include overhead costs, contingencies, profits, and taxes. Non-fixed indirect project costs are costs that can change at any time according to the needs of the project conditions.

Based on the secondary indirect cost data above, both indirect costs for fixed projects and indirect costs for non-fixed projects are IDR189,898,516.39. For calculations after crashing for variable costs attached.

Time Cost Trade Off (TCTO) Analysis

Total Project Cost Analysis

After getting the results of the cost calculation and duration of project acceleration, you will know the value of the increase in direct costs and reduction in indirect costs on the project. The indirect costs and direct costs are then added together to obtain the total project cost.

Example 1:

Total Project Cost = Direct Costs + Indirect Costs

- 1) Normal duration
 - = 839,227,822.29 + 189,898,516.39
 - = 1,029,126,338.68

- 2) Duration plus 1 hour overtime
 - = 901,185,006.31 + 170,695,296.00
 - = 1,071,880,302.31
- 3) Duration plus 2 hours overtime
 - = 932,879,787.11 + 158,248,764.00
 - = 1,091,128,551.11
- 4) Duration plus 3 hours overtime
 - = 964,574,567.90 + 150,414,666.00
 - = 1,114,989,233.90
- 5) Duration plus 4 hours overtime
 - = 996,269,348.70 + 146,075,782.00
 - = 1,142,345,130.70

Note: the figures above are in Rupiah (IDR)

With a normal duration of 109.79 days, the total cost is IDR 1,029,126,338.68,- after adding 1 hour of overtime, the total duration becomes 98.69 with a total cost of IDR 1,071,880,302.31,-

Results Analysis

The analysis of the results of McD Pontianak's concrete structure work compares the addition of working hours of 2 hours, 3 hours and 4 hours.

Analysis of the amount of the fine

The amount of the fine specified in the contract between the owner and the contractor in article 37 paragraph 1 of the agreement in question is 2 ‰ (per mille) of the total price of the work.

Total contract total = IDR 8,146,012,042

Project work duration (structure) = 110 days

11th week delay percentage = 11.48%

Calculate the duration of the delay
 = Overall duration x Percentage of delay
 = 110 days x 11.48% = 12.628 days

Calculating late fines of 12,628 days
 = 2 ‰ x total contract x duration of delay x VAT

$$= (2/1000) \times \text{IDR } 8,146,012,042 \times 12,628 \text{ days} \times (100\% + 11\%)$$

$$= \text{IDR } 228,366,605$$

Based on the calculation above, the fine per eleventh week (M-11) if the project is not accelerated is IDR 228,366,605

Analysis of the amount of additional costs and total time

This analysis was carried out to determine the optimal cost and time trade-off for the delays analyzed by the fines above

Example of calculation to find the difference in additional costs:

$$\Delta \text{Cost} = \text{Total Cost of Crashing Duration} - \text{Total Cost Normal Duration}$$

$$\Delta \text{Cost after 1 hour overtime} = \text{IDR } 1,071,880,302 - \text{IDR } 1,029,126,339 = \text{IDR } 42,753,964$$

$$\Delta \text{Cost after 2 hours overtime}$$

$$= \text{IDR } 1,091,128,551 - \text{IDR } 1,029,126,339 = \text{IDR } 62,002,212$$

$$\Delta \text{Cost after 3 hours overtime} = \text{IDR } 1,114,989,234 - \text{IDR } 1,029,126,339 = \text{IDR } 85,862,895$$

$$\Delta \text{Cost after 4 hours overtime} = \text{IDR } 1,142,345,131 - \text{IDR } 1,071,880,302 = \text{IDR } 113,218,792,-$$

Example of calculation to find the difference in duration reduction:

$$\Delta \text{Duration} = \text{Normal Duration} - \text{Duration After Crashing}$$

$$\Delta \text{Duration after overtime 1 hour} = 109.79 - 98.69 = 11.10 \text{ days}$$

$$\Delta \text{Duration after overtime 2 hours} = 109.79 - 91.49 = 18.30 \text{ days}$$

$$\Delta \text{Duration after overtime 3 hours} = 109.79 - 86.96 = 22.83 \text{ days}$$

$$\Delta \text{Duration after overtime 4 hours} = 109.79 - 84.45 = 25.34 \text{ days}$$

Table 1. Analysis of Total Cost and Duration Results

Number of Overtime Hours	Direct Costs	Indirect Costs	Total Cost	Duration	Δ Total Cost	Δ Duration
Normal Duration	839.227.822	189,898,516	1,029,126,339	109.79	-	-
1	901.185.006	170,695,296	1,071,880,302	98.69	42,753,964	11,10
2	932,879,787	158,248,764	1,091,128,551	91.49	62,002,212	18.30
3	964,574,568	150,414,666	1,114,989,234	86.96	85,862,895	22.83
4	996,269,349	146,075,782	1,142,345,131	84.45	113,218,792	25.34

(Source: Author's Process, 2023)

From the results above, it is found that each additional working hour can increase project acceleration but also has an effect on increasing the cost budget. Then, from the data above, find the optimum time and cost for fines in the contract agreement.

From the results of the data processing above, it is found that the addition of 2 hours of overtime is the optimum acceleration, which can speed up

the work time by 18.30 days and the acceleration costs are IDR 62,002,212, so the total optimum cost is IDR 1,091,128,551,-. Where this result is the optimum result for a project fine of IDR 228,366,605 for a delay of 12,628 days.

CONCLUSION

Based on Cost and Time Analysis of McD Pontianak Development Project Work Using the Time Cost Trade Off (TCTO) Method" The following results were obtained; (1) the results of the time analysis of additional working hours (manhour) using the time cost trade off (TCTO) method on the McD Pontianak construction project work showed that the addition of 2 hours of overtime was the optimal way to speed up the project work time which was delayed by 14, 92 days. Based on the results of the time analysis, it was found that the acceleration was 18.30 days and the duration of work was 91.49 days from the initial duration of 110 days, and (2) the results of the cost analysis for additional working hours (manhours) used the time cost trade off (TCTO) method. in the Pontianak McD construction project work, optimum additional results were obtained acceleration costs amounted to IDR 62,002,212, so the total cost for the project's concrete structure work was IDR 1,091,128,551.

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