International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

The Method of Modified Fast-track for the Acceleration of the Highways Construction Project Schedule

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***Abstract*— *The implementation of road projects schedule in Indonesia tends to be slow, this influences the construction cost to rise. The method of fast-track acceleration is often applied in solving such problem, yet, many studies stated that fast-track cannot fully restore the prolonged schedule. On another side, the fast-track acceleration requires additional costs. This article explains the ways acceleration of the implementation period can alter the relationship among the activities on critical path, known as modified fast-track, and the case is the highways construction projects. The CPM method is applied for scheduling and the EVM is applied for cost, the data are processed non-statistically. The finding obtained is that fast-track has an acceleration effectiveness of 9%-12.56%, while modified fast-track is at 16.30%-22.26%. Fast-track can reduce the actual cost up to 6.75%, while on the other hand, modified fast-track can do it better up to 10.55% and is able to project a profit up to 9.56%. Modified fast-track can be considered more effective in accelerating the schedule and more optimized in cost.*

***Keywords*— *Scheduling, CPM model, EVM, fast-track, modified fast-track, highways construction project.*

I. INTRODUCTION

The scheduling on construction projects is a part of project planning on road construction. The projects of highways construction is included in the development priorities of Indonesia, as mandated in RPJMN (National Mid-term Development Plan – *Rencana Pembangunan Jangka Menengah Nasional*) of 2015. The data from the Ministry of Public Works and People's Housing (PUPR – Pekerjaan Umum dan Perumahan Rakyat) stated, until September 2016, the realization of physical development of highways in Indonesia had reached 53.65%. Meanwhile, the financing process had reached 46.9% of the total APBN of 2016 and the APBN-Amendment of 2016, or reached Rp.97 billion [1]. The highways projects have a unique characteristics among the other construction projects, in which the relationship among the activities can overlap with each other due to the activities that are implemented simultaneously with the others. A good scheduling can constitute success, on the contrary, an ineffective system of scheduling can cause a budget leak up to 40% [2].

The acceleration method of project scheduling principally applied to fasten the implementation schedule of a construction project on critical activities paralelly, which eventually known as fast-track method. Generally, in order to cope with the delay, it needs to be conducted an acceleration of project implementation using trade-off method [3] and Crash Program method [4]. However, the acceleration on prolonged road construction projects using Fast-track, Crash Program, and What If methods draw a conclusion that the three methods are unable to restore the project delay to the initial schedule [5].

Generally, the fast-track method does not show the cost details spent due to the activities conducted paralelly. Fast track result show that the cost savings from this method is 2.45%, yet, the savings are based on the indirect cost that has not been utilized [6]. Meanwhile, another acceleration method stated that the combination of fast-track and crash program methods can restore the cost of project delay because the project duration can be returned and it does not bear any delay fine.

II. LITERATURE REVIEW

The project activities can be interpreted as one of temporary activities happening within a limited period of time, using certain allocation of resources, and aimed to manufacture deliverable products which quality criteria have been pre-determined [7]. However, in reality, often there is a rise in cost, as well as implementation delay [8].

A. *Critical Path Method (CPM)*

Broadly, PMBOK elaborates the Critical Path Method as follows [9]:

1) The specification of critical path is determined by a network analysis which calculates the early start, early finish, late stary, and late finish for all activities without considering the limitations on resources using the foward pass and backward pass analysis on the schedule network..
2) Determining the critical path of the project working activities that are marked by the longest path with the longest duration of completion. Therefore, the critical path will thoroughly determine the project completion timeline.
3) This technique will also automatically create a schedule flexibility known as "float". The float is present in every activity that is not critical.
4) CPM is established upon a network that is calculated using certain methods and can also by a software, thus, creating a set of critical works.

B. *Fast Track*

Suanda defines fast-track as a technique that shortens the schedule duration by turning in into two parallels or more activities which initially were not parallel with the full or partial duration [10]. It also stated that the steps or requirements must be conducted in the implementation of fast-track method toward the activities on the critical path as follows: the scheduling must be logical between one activities to the others, thus, it is realistic to be implemented.

1) Implementing fast-track only on activities within the critical path only, especially the ones that have a long duration.
2) The shortest fast-track duration possible is 2 days.
3) The relationship between critical activities that will be fast-tracked: if (a) duration is more than (b) duration, then the (b) activity can be initiated if the remaining duration of i activity is not more than 1 day apart from the duration of (b) activity.
4) Check the float presents in the activities that are not critical whether it is still qualified and not critical after the fast-track is conducted.
5) If after fast-track is implemented in the initial process the critical path moved, do the same steps to the activities on the new critical path.
6) The time acceleration is supposed to be implemented not more than 50% of the normal time.

C. Earn Value Method (EVM)

This study uses the EVM indicator to calculate the cost analysis, such as:

1) Cost Variance (CV)
   CV = BCWP – ACWP
2) Cost Performance Index (CPI)
   CPI = BCWP / ACWP
3) Schedule Variance (SV)
   SV = BCWP – BCWS
4) Schedule Performance Index (SPI)
   SPI = BCWP / BCWS
5) EAC (Estimate at Completion)
   $EAC = \frac{ACWP + (BAC - BCWP)}{CPI \times SPI}$
6) ETC (Estimate to Complete)
   ETC = EAC – ACWP

III. Research Method

This study is a descriptive research by taking a case study on the project of highways construction in Pasuruan and Pandaan. The data collected to be used in the study include Time Schedule, Budget Plan, Work Breakdown Structure (WBS), Work Analysis, Actual Cost, and Monthly Certificate..

The analysis conducted after the data collection is as follows:

1) Identification of work using WBS.
2) Project scheduling using the CPM method.
3) Determining critical path using Microsoft Project.
4) Implementing a work progress update and identifying the prolonged activities.
5) Acceleration analysis using the fast-track method
6) Acceleration analysis using the modified fast-track method, such as:
   - Relationship of between activities in the critical path changed from finish to start (FS) into start to start (SS).
   - Relationship among jobs is separated into 2, including: (a) a relationship with a continuous sequence that cannot be changed. (b) a relationship with a continuous sequence that can be changed.
   - A continuous sequence, then the end of directly interconnected jobs cannot be the same and/or faster than the activities they carry on.
   - SS on jobs with direct relationship is implemented using 2-day lag or SS+2 or more (PMI, 2013).
   - SS on jobs with indirect relationship can be implemented without using lags.
   - The relationship of SS can only be implemented on 1 successor of an activity.
7) On every step of time acceleration, conducted an analysis of cost optimization using the EVM method and acquired EAC (Estimate at Completion*)* and ETC (Estimate to Complete).
8) Time optimization is shown based on the amount of time acceleration and percentage of acceleration from the initial duration.
9) Cost optimization is shown based on the actual cost stated and the percentage of actual cost to the normal work cost.

IV. Result and Discussion

This study takes a case study on the project of highways construction in Pasuruan and Pandaan, Indonesia. The project of highways in Pasuruan has a total length of 34.15 km, which is an integration of toll road of Gempol Pasuruan.

The highway project in Pasuruan has a total length of 8.5 km with a contract value of Rp.447,880,760,000, which is planned to be completed within 450 calendar days.

The highway project in Pandaan has a total length of 3.5 km with a contract value of Rp. 165,846,866,000, which is planned to be completed within 475 calendar days.

A. Analysis of Schedule and Planning Cost

The S-Curve that becomes the baseline of the highway project in Pasuruan is the 46th week when the work progress reached 68.87% with a deviation of -3.99%.

On another side, the S-Curve of the highway project in Pandaan that becomes the baseline is the 38th week when the work progress reached 35.40% with a deviation of -5.98%..

The details of cost spent by each project is shown in the table I.

TABLE I. EVM Cost Indicator

No	Description	Total Cost (Rp)	Progress (%)	Value (Rp)
1	**Pasuruan Highway Project**			
	a. ACWP	-	-	260,335,114,305
	b. BCWP	447,880,760,000	68.87 %	308,455,479,412
	c. BCWS	447,880,760,000	72.86 %	326,325,921,736
2	**Pandaan Highway Project**			
	a. ACWP	-	-	48,075,008,593
	b. BCWP	165,846,866,000	35.40 %	58,709,790,564
	c. BCWS	165,846,866,000	41.38 %	68,627,433,151

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The calculation of EVM analysis on highways in Pasuruan includes the following:

CV = BCWP – ACWP = Rp. 48,120,365,107
SV = BCWP – BCWS = - Rp.17,870,442,324
CPI = BCWP / ACWP = 1.18
SPI = BCWP / BCWS = 0.95

The calculation of EVM analysis on highways in Pandaan includes the following:

CV = BCWP – ACWP = Rp. 10,634,781,971
SV = BCWP – BCWS = - Rp. 9,917,642,587
CPI = BCWP / ACWP = 1.22
SPI = BCWP / BCWS = 0.86

The analysis of project working indication based on EVM on both projects obtains the value of CV > 0 & CPI > 1.0 and SV < 0 & SPI < 1.0, which indicates that the project is delayed and the cost spent is under the planned budget.

B. Schedule and Actual Cost

The actual scheduling as seen from the progress update on both highways projects, which later conducted a cost analysis.

1) *Pasuruan Highways*

The progress update on the project of Pasuruan highways is conducted on the 46th week, which when the realization of work progress was at 68.87%. the result of the progress update is that the actual project duration became 530 days or delayed for 118 days. The critical path after the progress update includes the Rigid Pavement (rigid pavement) of the main road and sideline, solid sodding, guardrail, end section guardrail, and cleaning work.

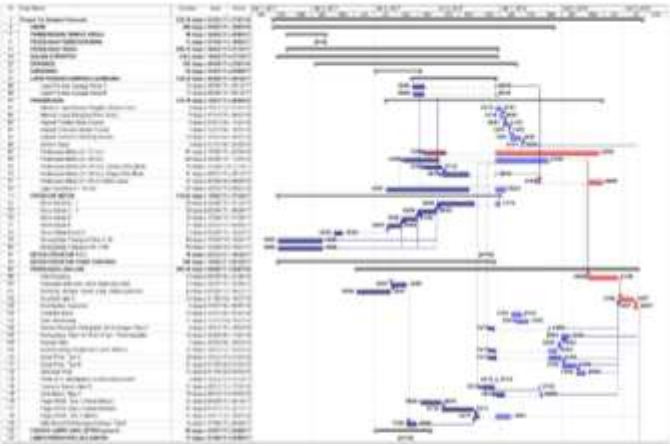

Fig. 1. Progress Update of Pasuruan Highways Project.

2) *Pandaan Highways*

The progress update on the project of Pasuruan highways is conducted on the 38th week, which when the realization of work progress was at 35.40%. the result of the progress update is that the actual project duration became 589 days or delayed for 96 days. The critical path after the progress update includes the Rigid Pavement of the main road and sideline, solid sodding, guardrail, end section guardrail, and cleaning work.

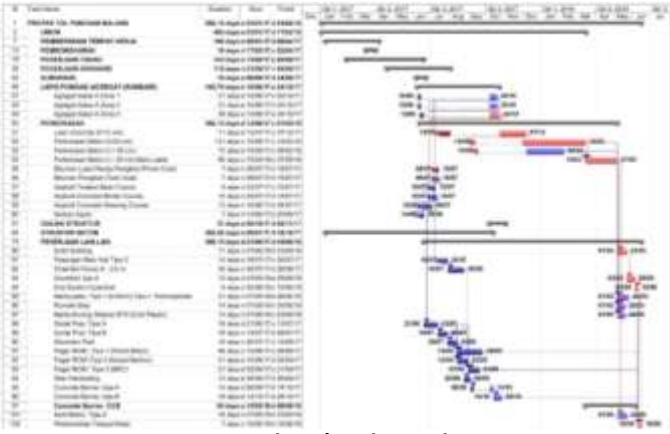

Fig. 2. Progress Update of Pandaan Highways Project.

3) *Cost Analysis*

The cost change occurred due to the project delay is the fine calculated based on the number of days delayed. The fine is mandated in Presidential Regulation No. 70 of 2012 regarding Sanction for Delay article 120 stated that the contractor is subject to 1/1000 of the project value for every delay [11].

TABLE II. Total Cost/BAC after Progress Update

Description	Delay (day)	Initial Cost (Million Rupiahs)	Fine (Million Rupiahs)	BAC (Million Rupiahs)
a	b	c	d = 1/1000 x b x c	e
Pasuruan Highways	118	447,880	52,849	500,730
Pandaan Highways	96	165,846	15,921	181,768

Estimate at Completion (EAC)

a) *Pasuruan Highways*

$$EAC = \frac{ACWP + (BAC - BCWP)}{CPI \times SPI}$$

$$= \frac{260.335.114.305 + (500.730.689.680 - 308.455.479.412)}{1{,}18 \times 0{,}95}$$

= Rp. 404,132,522,064

b) *Pandaan Highways*

$$EAC = \frac{48.075.008.593 + (181.768.165.136 - 58.709.790.564)}{1{,}22 \times 0{,}86}$$

= Rp. 163,806,375,084

Estimate to Complete (ETC)

a) Pasuruan Highways Project

ETC = EAC – ACWP
= 404,132,522,064 – 260,335,114,305
= Rp. 143,797,407,759

Remaining progress = Rp. 447,880,760,000 x 31.13%
= Rp. 139,425,280,588

Thus, the cost analysis is formulated as follows:

BACt = Progress Cost - ETC – Fine
= 139,425,280,588 - 143,797,407,759 – 52,849,929,680
= - Rp. 57,222,056,851

The project had a loss because of the delayed schedule which reached 57 million

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b) *Pandaan Highways Project*

ETC = EAC – ACWP
= 152,059,156,428 - 48,075,008,593
= Rp. 115,731,366,491

Remaining progress = Rp. 165,846,866,000 x 64.60 %
= Rp. 107,137,075,436

Thus, the cost analysis is formulated as follows:

BACt = Progress Cost - ETC – Fine
= 107,137,075,436- 115,731,366,491- 15,921,299,136
= - Rp. 24,515,590,191

The project had a loss because of the delayed schedule which reached 24 million.

C. *Fast-track*

The fast-track is conducted on both highway projects to be further analyzed the cost occurred.

1) *Pasuruan Highways Project*

The fast-track on the highways project in Pasuruan is conducted on the critical path as identified on the progress update.

TABLE III. Fast-track Analysis on Pasuruan Highways Project

Work Items	Duration (day)	Type	Predecessor	Initial Lead (day)	FT Lead (day)
Rigid Pavement (20 cm)	21	FS	Rigid Pavement (31 cm)	14	19
Solid Sodding	43	FS	Rigid Pavement (20 cm)	20	42
Type A Guardrail	23	FS	Solid Sodding	-	23
End Section Guardrail	6	FS	Type A Guardrail	-	-
Cleaning Works	7	FS	End Section Gurdrail	-	-

The result of fast-track conducted on the highways project in Pasuruan has reached the optimized point because the work on the critical path is unable for additional leads and there are no new critical paths.

2) *Pandaan Highways Project*

The fast-track on the highways project in Pandaan is conducted on the critical path as identified on the progress update.

TABLE IV. Fast-track Analysis on Pandaan Highways Project

Work Items	Duration (day)	Type	Predecessor	Initial Lead (day)	FT Lead (day)
Rigid Pavement (20 cm)	60	FS	Rigid Pavement (30 cm)	-	40
Solid Sodding	17	FS	Rigid Pavement (20 cm)	-	16
Type A Guardrail	15	FS	Solid Sodding	-	11
Type A Concrete Curb	18	FS	Rigid Pavement (20 cm)	7	14
Cleaning Works	7	FS	End Section Gurdrail	-	6

The result of fast-track conducted on the highways project in Pandaan has reached the optimized point because the work on the critical path is unable for additional leads and there is no new critical paths.

The fast-track on both projects is summarized in Table V wherein both projects experienced a schedule delay.

TABLE V. Fast-track Acceleration Result

Description	Schedule (day)	Actual (day)	*Fast-track* (day)
Pasuruan Highways Project	412	530	482
Pandaan Highways Project	493	589	515

3) Cost Analysis

The cost analysis is conducted on the fast-track acceleration, such cost analysis principle is similar to the one conducted before, such as in the B sub-chapter.

TABLE VI. Total Cost/BAC after Fast-track

Description	Delay (day)	Initial Cost (Million Rupiahs)	Fine (Million Rupiahs)	BAC (Million Rupiahs)
a	b	c	d = 1/1000 x b x c	e
Pasuruan Highways	70	447,880	31,351	479,232
Pandaan Highways	22	165,846	3,648	169,495

Estimate at Completion (EAC)

a) *Pasuruan Highways Project*

$$EAC = \frac{ACWP + (BAC - BCWP)}{CPI \times SPI}$$

$$= \frac{260.335.114.305 + (479.232.413.200 - 308.455.479.412)}{1,18 \times 0,95}$$

= Rp. 384,936,864,736

b) *Pandaan Highways Project*

$$EAC = \frac{48.075.008.593 + (169.495.497.052 - 58.709.790.564)}{1,22 \times 0,86}$$

= Rp. 152,059,156,428

Estimate to Complete (ETC)

a) *Pasuruan Highways Project*

ETC = EAC – ACWP
= 384,936,864,736 - 260,335,114,305
= Rp. 124,601,750,431

Remaining progress = Rp. 447,880,760,000 x 31.13%
= Rp. 139,425,280,588

Thus, the cost analysis is formulated as follows:

BACt = Progress Cost - ETC – Fine
= 139,425,280,588 - 124,601,750,431 – 31,351,653,200
= - Rp. 16,528,123,043

After fast-track, the project still faces a loss due to the schedule delay that reached 16 million.

b) *Pandaan Highways Project*

ETC = EAC – ACWP
= 152,059,156,428 - 48,075,008,593
= -Rp. 103,984,147,834

Remaining progress = Rp. 165,846,866,000 x 64.60 %

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International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

= Rp. 107,137,075,436

Thus, the cost analysis is formulated as follows:

BACt = Progress Cost - ETC – Fine
= 107,137,075,436- 115,731,366,491- 3,648,631,052
= - Rp. 495,703,450

After fast-track, the project still faces a loss due to the schedule delay that reached 495 million.

D. Modified Fast-track

Modified Fast-track which changes the relationship among activities is conducted on the two delayed projects essential to point 6 of the research analysis method.

1) *Highways Project in Pasuruan*

The modified fast-track on the highways project in Pasuruan is conducted on the critical path as identified on the progress update. After the initial change, the critical path has not had any changes. This indicates the need of another modification of the relationship in the work of Solid Sodding and the prior activities, including the work of Rigid Pavement with the thickness of 31, 28, and the sideways. The changes by considering the essence of modified fast-track constitute new relationships as presented in Table VII.

TABLE VII. Analysis of Modified Fast-track on Pasuruan Highways Project

Work Items	Duration (day)	Predecessor	Initial Type (day)	Mod.FT Type (day)
Rigid Pavement (31 cm)	181	*Lean Concrete*	FS	SS
Solid Sodding	43	Rigid Pavement (31 cm)	FS-60 days	SS
		Rigid Pavement (28 cm)	FS	SS
		Rigid Pavement (20 cm)	FS-20 days	SS-14 days
Type A Guardrail	23	Solid Sodding	FS	SS+2 days
		Signposts and Type A Prohibition	FS	FS-8 days
End Section Guardrail	6	Type A Guardrail	FS	SS+18 days
Cleaning Works	7	End Section Gurdrail	FS	SS

Note : (+) mark indicates Lags
(–) mark indicates Leads

The fast-track analysis result indicates that the project delay can be restored to the initial schedule as shown in Fig.3.

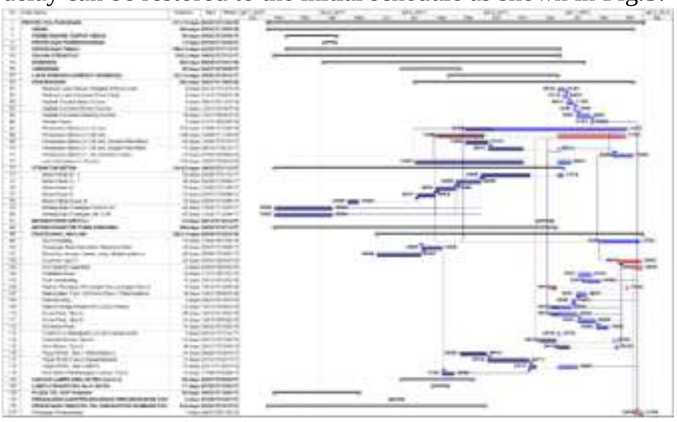

Fig. 3. Result of Modified Fast-track in Pasuruan Highways Project

2) *Highways Project in Pandaan*

The modified fast-track is conducted on the critical path as identified on the progress update. The initial modification caused a change in the critical path as shown in Table VIII.

TABLE VIII. Analysis of Modified Fast-track 1 on Pandaan Highways Project

Work Items	Duration (day)	Predecessor	Initial Type (day)	FTm Type (day)
Lean Concrete	181	Sub-base	FS	-
Rigid Pavement (28 cm)	43	Lean Concrete	FS	-
Concrete Barrier, Zone 1	31	Rigid Pavement (28 cm)	FS-40 days	FS-60 days
Concrete Barrier, Zone 2	31	Concrete Barrier, Zone 1	FS	-
Concrete Barrier, Zone 3	31	Concrete Barrier, Zone 2	FS	-

The modified fast-track cannot be implemented on new critical paths. The Lean Concrete work is related to the previous work, Sub-base, which had been done, therefore, it is not qualified for a new relationship modification, as well as with the Rigid Pavement with a thickness of 28. Meanwhile, the Concrete Barrier on every zone does not fulfill the requirements of modified fast-track because this job is in direct and continuous sequences. Besides, fast-track can only be implemented on Concrete Barrier work on Zone 1, which causes changes of critical paths to its initial.

TABLE IX. Analysis of Modified Fast-track 2 on Pandaan Highways Project

Work Items	Duration (day)	Predecessor	Initial Type (day)	FTm Type (day)
Rigid Pavement (20 cm)	60	Rigid Pavement (30 cm)	FS	SS+151 days
Solid Sodding	17	Rigid Pavement (20 cm)	FS	SS+44 days
Street Signs Type 1	14	Rigid Pavement (30 cm)	FS	FS-12 days
		Rigid Pavement (28 cm)	FS	FS-12 days
Rumble Strip	14	Rigid Pavement (30 cm)	FS	FS-12 days
		Rigid Pavement (28 cm)	FS	FS-12 days
Yellow Marks, GTO	14	Rigid Pavement (30 cm)	FS	FS-12 days
		Rigid Pavement (28 cm)	FS	FS-12 days
Type A Guardrail	15	Solid Sodding	FS	SS-4 days
End Section Guardrail	6	Type A Guardrail	FS	SS+10 days

The fast-track analysis result indicates that the project delay can be restored to the initial schedule as shown in Fig.4.

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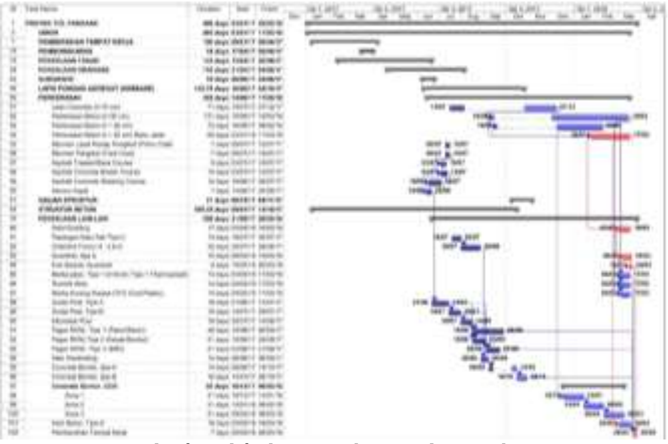

Fig. 4. Result of Modified Fast-track in Pandaan Highways Project

The modified fast-track from the two projects is summarized in Table X wherein the result had an optimized acceleration.

TABLE X. Fast-track Acceleration Result

Description	Schedule (day)	Actual (day)	Fast-track (day)
Pasuruan Highways Project	412	530	412
Pandaan Highways Project	493	589	493

3) *Cost Analysis*

The cost analysis is conducted on the modified fast-track acceleration, such cost analysis principle is similar to the one conducted before, such as in the B sub-chapter.

The changes in the project's final cost did not happen, this was due to the absence of delay after the modified fast-track. The two projects have completion total cost or BAC that are in accordance with the initial budget plan.

Estimate at Completion (EAC)

a) *Pasuruan Highways Project*

$$EAC = \frac{ACWP + (BAC - BCWP)}{CPI \times SPI}$$

$$= \frac{260.335.114.305 + (447.880.760.000 - 308.455.479.412)}{1{,}18 \times 0{,}95}$$

= Rp. 356,943,197,798

b) *Pandaan Highways Project*

$$EAC = \frac{48.075.008.593 + (165.846.866.000 - 58.709.790.564)}{1{,}22 \times 0{,}86}$$

= Rp. 148,566,740,070

Estimate to Complete (ETC)

a) *Pasuruan Highways Project*

ETC = EAC – ACWP
= 356,943,197,798 - 260,335,114,305
= Rp. 96,608,083,493

Remaining progress = Rp. 447,880,760,000 x 31.13%
= Rp. 139,425,280,588

Thus, the cost analysis is formulated as follows:

BACt = Progress Cost - ETC
= 139.425,280,588 - 96,608,083,493
= Rp. 42,817,197,095

After modified fast-track, the project can project a profit of 42 million.

b) *Pandaan Highways Project*

ETC = EAC – ACWP
= 148,566,740,070 - 48,075,008,593

= Rp. 100,491,731,477

Remaining progress = Rp. 165,846,866,000 x 64.60 %
= Rp. 107,137,075,436

Thus, the cost analysis is formulated as follows:

BACt = Progress Cost - ETC
= 107,137,075,436 - 100,491,731,477
= Rp. 6,645,343,959

After modified fast-track, the project can project a profit of 6 million.

E. Time and Cost Optimization

The two highways projects are known for having a delay in the schedule. The result of fast-track and modified fast-track acceleration shows a difference. The fast-track method cannot restore the delayed schedule, meanwhile, the modified fast-track can.

TABLE XI. Schedule Acceleration Effectiveness

Description	Fast-track (day)	Modified Fast-track (day)	Fast-track (%)	Modified Fast-track (%)
Pasuruan Highways Project	48	118	9.06%	22.26%
Pandaan Highways Project	74	96	12.56%	16.30%

This study shows a result where the effectiveness of acceleration restoration of fast-track method is on the range of 9% - 12.56%, which also supports the previous studies [12, 13, 14]. On another side, the modified fast-track method can give more significant effectiveness, which also indicates that the acceleration of modified fast-track as more effective compared to the fast-track method implemented on the projects of highways construction.

TABLE XII. Comparison of Acceleration Cost Reduction

Description	Fast-track (rupiahs)	Modified Fast-track (rupiah)	Fast-track (%)	Modified FT (%)
Pasuruan Highways Project	21,498.276.480	52.849.929,680	4.29%	10.55%
Pandaan Highways Project	12,272,668,084	15,921,299,136	6.75%	8.76%

The two methods create a comparison of cost reduction during the acceleration, which is a percentage of the number of each acceleration in comparison to the number of realization cost as shown in Table XII

On another side, the analysis result of cost comparison from the acceleration on both projects shows that the project realization and fast-track potentially create a loss of the implementation cost. Meanwhile, the method of modified fast-track potentially projects profit.

TABLE XIII. Comparison of Profit-Loss of Schedule Acceleration Funding

Description	Realization (%)	Fast-track (%)	Modified FT (%)
Pasuruan Highways Project	-12.78%	-3.69%	9.56%
Pandaan Highways Project	-14.76%	-0.30%	4.01%

Note : (+) mark indicates profit
(–) mark indicates loss

The result of the cost analysis shows that the cost aligns with the schedule wherein the method of modified fast-track has a high delay acceleration effectiveness which also has a high level of cost reduction and can project profits thoroughly. On another side, the method of fast-track has low acceleration effectiveness and create a level of acceleration cost reduction below the method of modified fast-track.

V. CONCLUSION

The conclusion of this study is presented below:

A. Acceleration using the fast-track method

The acceleration result of the fast-track method implemented on the highways construction projects has a schedule acceleration effectiveness on the range of 9% - 12.56%, yet this method cannot restore the delayed project schedule in accordance with the planned schedule. This acceleration can reduce the cost as much as 4.29% - 6.75% of the actual cost.

B. Acceleration using the modified fast-track method

The acceleration result of the modified fast-track method implemented on the highways construction projects has a schedule acceleration effectiveness on the range of 16.30% - 22.26%, this method can restore the delayed project schedule in accordance with the planned schedule and can reduce the cost as much as 8.76% - 10.55% of the actual cost.

C. Acceleration Cost Optimization

The method of fast-track still projects a loss in cost overall up to 3.69%, yet reduces a loss from the delay up to 12.48% of the actual cost. On another hand, the method of modified fast-track can project a cost optimization with a profit up to 9.56% of the total cost of the overall project.

The optimization result shows that the projection of profit is in line with the acceleration, on the contrary, the potential loss is bigger when the schedule acceleration happening cannot restore the delay.

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