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PROJECT PERFORMANCE ANALYZED USING JAVA APPLICATION IN STEEL TOWER BUILDING

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ABSTRACT

The parameters of project success Studies conducted by project management science experts on project success reveal that cost, time, and quality are the three basic and most important indicators of performance in a project. Other parameters such as safety, functionality, and the client's satisfaction have begun to be considered lately. These parameters must be known by the project manager, client, and all stakeholders as a reference for implementing the project. Successful projects are measured in terms of timeliness, cost-efficiency, and optimal quality. In this study, a case was taken in PT. XYZ. However, in the implementation of development, there are often delays in the process, so the impact on the production process is detrimental to the industrial owner. Therefore, it is necessary to accelerate the development in this case of the construction of a feedmill tower with an alternative to the addition of overtime work in 3 ways, namely the addition of 1 hour overtime, 2 hours overtime, and 3 hours overtime. The data used in the analysis of the feed mill development project data with the normal time of the project for 360 days with a normal cost of US$ 5,149,297.20. From the results of the analysis of cost optimization due to the addition of overtime hours to accelerate the implementation, the optimum time to accelerate project completion is added 1 hour of overtime. Crash cost of required US$ 5.178.658,-. The time reduction to complete the project is 330 days. The additional cost is US$ 29.360, and the cost slope is US$ 26.913.

Keywords: project, java, application, steel, building.

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1. INTRODUCTION

Broadly speaking, countries in the world are grouped into three parts, namely developed countries, developing countries, and underdeveloped countries. The characteristics of these country groups are often associated with the level of industrial progress. The World Bank, gives the term developed countries"/industrial countries/industrially advanced countries," which describes countries that have high incomes and high standards of living.

Project success based on studies conducted by project management science experts reveals that cost, time, and quality are the three basic and most important measures of performance indicators in a project [1] [2]. Other parameters, such as safety, functionality, and client satisfaction have begun to be considered lately. This parameter must be known by the project manager, client, and all stakeholders as a reference for implementing the project [3] [4] [5].

However, we need to know that the development of the animal feed industry requires capital costs that are not small. PT. XYZ, budgeted for the development of a new factory with a value of ± 500 billion. With this relatively large value, of course, the owner or investor would want an industrial development project at the cost of their success and success. Success in the sense of fulfilling the elements by the planning in terms of time, cost, and quality achieved.

However, in the implementation of development in this case the steel tower construction project for the feed industry often results in construction delays caused by internal and external factors so that various risks arise both for the owner and the implementing contractor. Therefore it is necessary to accelerate development. Project acceleration in addition to reducing the duration of implementation, will increase project costs. To maintain the balance of the project constraint between time and cost, the strategy must be carried out that has the impact on the most possible acceleration where the additional costs incurred are as small as possible and still meet the requirements. So further research needs to be carried out on "Project Performance Analyzed Using Java Application in Steel Tower Building”.

2. LITERATURE REVIEW

a) Project definition

Every project is unique, not even two projects are the same. A project is an effort to mobilize available resources, which are organized to achieve certain important goals, objectives, and expectations and must be completed within a limited period by the agreement [6]. Project is a job that has special signs as follows, namely [7] [8]:

a. The start and end times are planned.

b. Is a work unit that can be separated from the others?

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c. Usually large volumes of work and relationships between complex activities.

Projects are temporary activities of personnel, materials, and means to realize goals projects within a certain period of time which then ends. Projects in network analysis are a series of activities aimed at producing unique products that are only carried out within a certain period (temporary) [9] [10] [11].

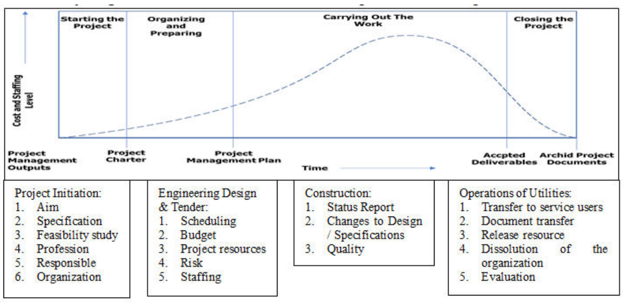

Figure-1. Project stages cycle.

b) Project performance

Project success reveals that cost, time, and quality are the three basic and most important performance indicators in construction [12] [13] [14] [15].

c) Project acceleration

The project acceleration strategy is identical to the risk response in risk management. It's just a risk that has occurred. The strategy is applied based on priority if there are a large number of factors causing project delays. By looking at the specific characteristics of construction projects and the factors that cause project delays, based on experience it is suggested that strategy recommendations in accelerating construction projects are:

1. Managerial
2. Scope of Work
3. Critical Method
4. Material and Supplier
5. Tools
6. Subcontractor
7. Labor and Hours of Work
8. Design and Implementation Methods
9. Contract
10. Site
11. Crashing method

The first step that can be taken to shorten the project implementation time is to perfect the relationship or logic of dependency between one activity and another. If this step has not been successful, then the steps usually taken are to accelerate the time of critical activities. Several alternatives can be used to accelerate the duration of the project such as adding labor, overtime, adding/replacing more productive tools, or also by changing existing implementation methods [16].

Any alternative steps taken to accelerate will result in changes in costs, both total costs, direct costs, and also indirect costs of the project itself. Changes in costs that occur vary, could have increased costs, could have remained the costs without changes, or even decreased after acceleration.

A. Time Performance

The project implementation time criteria are divided into 3 conditions, namely:

a. Slow duration

Slow duration is a duration which for one reason or another has a duration that is slower than the normal duration.

b. Normal duration

Normal duration is the time of project implementation that utilizes the greatest effective and efficient capabilities of workers who work normally, which is 7 hours a day and 1 hour rest (by Indonesian Labor Law).

c. Fast duration

Fast duration is the time of project that utilizes the maximum capabilities of the workforce plus overtime or rotating work.

B. Cost Performance

One important thing in planning a project is cost. Costs incurred in a project are:

a) Direct cost

Direct costs are costs that arise and are directly related to ongoing project activities. Direct costs include:

- Material costs
- Wage Fee
- Equipment Costs

b) Indirect costs

Indirect costs are costs that are not directly related to ongoing project activities, including:

- Cost Overhead
- Unexpected costs
- The advantage

C. Quality Performance

Quality, whether it concerns the product or process, has been considered both a criterion for project success and a factor by various researchers. Some researchers call this quality performance and consider it a criterion for the success of large projects. On the other hand, several other researchers consider the quality management process as a factor in project success.

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a) Java Net Beans application program

Net Beans is an open-source Integrated Development Environment written in Java. The development of NetBeans has accelerated since it became part of the Apache project. The NetBeans IDE can be used to develop in Java, but also supports other languages [17] [18]. These include PHP, C/C++, and HTML5. NetBeans is a successful open project with a huge user base, a growing community, and nearly 100 partners (and counting!). The Netbeans IDE is written in Java - but can support other programming languages. There are many modules to Extend Netbeans IDE. Netbeans IDE is a free product with limitations on how to use it. There is also the NetBeans Platform, a modular and extensible foundation that can be used as a software base for creating large desktop applications. ISV Partners provide value-added plug-ins that can be easily integrated into the Platform and can also be used to build their tools and solutions [19].

b) Steel tower building

Steel tower building can be done vertically or horizontally. The vertical design is made by placing processing equipment in the tower and placing as much horizontal equipment as possible on the floor. Some owners mainly choose vertical designs because there are several benefits including:

a) Does not require a large area of land for buildings.
b) The machines can be arranged as effectively as possible from the top floor to the bottom
c) Save on building costs, because horizontal buildings will require generally more expensive licensing costs

3. METHODS

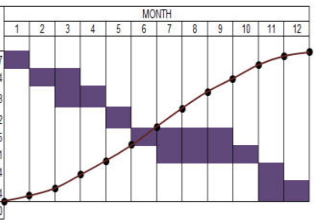
The research object is the project of PT. XYZ. The details of the cost and duration of work are as follows in Table-1 and Table-2:

Table-1. Project cost.

NO	WORK ITEM	VOLUME	UNIT	PRICE UNIT	TOTAL PRICE (US $)
1	Preparation	1,00	ls	106.10.50	106,810.50
2	Concrete Pile	13,440.00	m '	40.00	537,600.00
3	Concrete Foundation	1,001.76	m3	500.00	500,880.00
4	Concrete Floor	133.54	m3	200.00	26,707.20
5	Column	808,471.05	kg	1.50	1,212,706,57
6	Beam / Floor	,600,000.08	kg	1.50	2,400,000.12
7	Stair	155,701.87	kg	1.50	233,552.81
8	Galvalume Wall / Roof	6,552.00	m2	20.00	131,040.00

Table-2. Project schedule.

NO	WORK ITEM	VOLUME	UNIT	NORMAL DURATION (DAYS)	WEIGHT (%)
1	Preparation	1,00	ls	30,00	2,07
2	Concrete Pile	13.440,00	m'	60,00	10,44
3	Concrete Foundation	1.001,76	m^3	60,00	9,73
4	Concrete Floor	133,54	m^3	30,00	0,52
5	Steel Column	808.471,05	kg	120,00	23,55
6	Steel Beam / Floor	1.600.000,08	kg	120,00	46,61
7	Stair	155.701,87	kg	30,00	4,54
8	Galvalume Wall/Roof	6.552,00	m^2	60,00	2,54
					100,00



Stages of data analysis crashing with the acceleration of the addition of overtime:

1. Make a Network Planning / Network Planning with CPM
2. Determine the Critical Path
3. Bring activities or activities that are included in the critical path to be accelerated
4. Calculate daily productivity

$$\text{Daily productivity} = \frac{\text{Work volume}}{\text{Normal Activity Duration}} \quad \text{.......... (1)}$$

5. Calculate the daily productivity of all work items and make a table summary.
6. Calculate hourly productivity

$$\text{Hourly Productivity} = \frac{\text{Days Productivity}}{\text{Normal Hours Activity Per Day}} \quad \text{.... (2)}$$

7. Calculate all hourly productivity of all work items and make a table summary.
8. From the recapitulation of the hourly productivity table, then calculate the daily productivity after crashing (the work plan that will be carried out in accelerating the duration of a job using the overtime method is as follows:
a. Normal activity uses 8 hours of work and 1 hour of rest (8:00 to 17:00), while overtime is done after normal working time for 2 hours and 3 hours per day (18.30 - 20.30).
b. The price of workers' wages for overtime work is calculated to be 1.5 times the hourly wage of normal work time and for the next hours 2 times the hourly wage of normal time.
c. Productivity for overtime work is calculated at 60% of normal productivity. This decrease in productivity is due to fatigue, limited vision at night, and cooler weather conditions (Soeharto, 1997).
9. Daily productivity crashes = (Normal work hours x Normal hour productivity) + (Total Overtime Hours x 0.6 x Normal hourly productivity) ...3)
10. Calculate all daily productivity after crashing and make a table
11. Calculate the duration of the activity after crashing with overtime

$$\text{New Duration} = \frac{\text{Work Volume}}{\text{Daily productivity after crashing}} \quad \text{........ (4)}$$

12. Calculate all work durations after crashing and create table summaries
13. Then calculate the normal cost of the worker

a. Calculate normal daily work wage = Productivity per day x unit price wage per day (5)

Or:

b. Calculate normal hourly wage =

Hour productivity x unit price wages of hour .... (6)

14. Calculate worker crash cost:
a. Crash cost Workers is the amount of costs/wages of workers required to complete activities with an accelerated time period (crash duration), in this study the acceleration of the duration is done by the overtime method.
b. The work plan of the worker's crash cost calculation is the same as the work plan in the work duration crash calculation with the method of applying overtime hours as described previously.
15. Calculate all worker's crash costs and make a table summary
16. Make a normal time, crash time, normal cost, and crash cost table

Research flowchart for analysis project performance using crashing java application program as Figure-2:

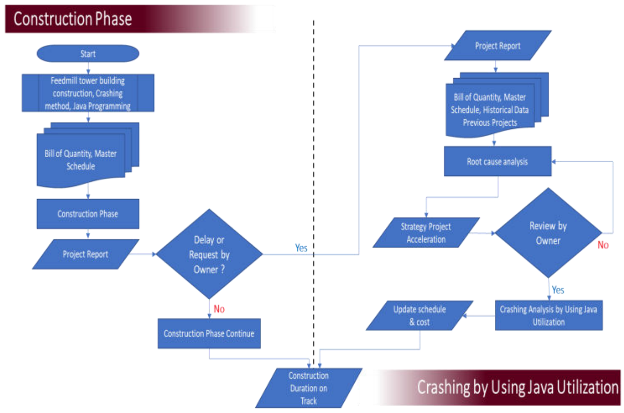


Figure-2. Research flowchart.

4. RESULT

Based on data analysis for overtime effect on project performance using Java crashing software application in Steel Tower Building. Project performance with 1 hour, 2 hour, and 3 hour overtime. When an activity is accelerated, the direct costs for the activity will increase. Direct costs such as labor costs, materials, and equipment directly related to the installation or construction of the project. Crashing causes indirect costs to increase because of inefficiencies by accelerating work faster than the normal average. Project acceleration can result in bonus additions, can prevent damage payments to the owner, or can save indirect additional costs. The number of bonuses to be received should be explained in the contract.

a) Project performance with 1 hour overtime

Table-3. Percentage of normal cost (direct and indirect cost).

NO	WORK ITEM	CRITICAL PATH	VOLUME	UNIT	COST	NORMAL COST				CHECK
						DIRECT COST			INDIRECT COST	
						MATERIAL	WAGE	TOOL		
			A		B	C (78%)	D (12%)	E (10%)	F (25%)	B=C+D+E+F
1	Preparation	-	1,00	ls	106.811	62.484	9.613	8.011	26.703	OK
2	Concrete Pile	Critical	13.440,00	m'	537.600	314.496	48.384	40.320	134.400	OK
3	Concrete Foundation	Critical	1.001,76	m3	500.880	293.015	45.079	37.566	125.220	OK
4	Concrete Floor	Critical	133,54	m3	26.707	15.624	2.404	2.003	6.677	OK
5	Steel Column	Critical	808.471,05	kg	1.212.707	709.433	109.144	90.953	303.177	OK
6	Steel Beam / Floor	Critical	1.600.000,08	kg	2.400.000	1.404.000	216.000	180.000	600.000	OK
7	Stair	-	155.701,87	kg	233.553	136.628	21.020	17.516	58.388	OK
8	Galvalume Wall/Roof	Critical	6.552,00	m2	131.040	76.658	11.794	9.828	32.760	OK

From Table-4, direct costs are taken at 75% and indirect costs 25% of the total normal cost. Then direct costs are divided into materials is 78%, wages at 12%, and tools at 10%.

Table-4. Normal and crash duration based on overtime productivity.

NORMAL DURATION		NORMAL COST PER DAYS				PRODUKTIVITAS			CRASH DURATION	NEW DURATION
		DIRECT COST			INDIRECT COST	DAYS	HOUR	DAYS+OVERTIME		
DAYS	HOUR	MATERIAL	WAGE	TOOL				1		
G	H=G*8	I=C/G	J=D/G	K=E/G	L=F/G	M=A/G	N=M/8	O=M+(JL*N)	P=A/O	S=G OR P
30	240	2.083	320	267	890					30
60	480	5.242	806	672	2.240	224,00	28,00	252,00	53	53
60	480	4.884	751	626	2.087	16,70	2,09	18,78	53	53
30	240	521	80	67	223	4,45	0,56	5,01	27	27
120	960	5.912	910	758	2.526	6.737,26	842,16	7.579,42	107	107
120	960	11.700	1.800	1.500	5.000	13.333,33	1.666,67	15.000,00	107	107
30	240	4.554	701	584	1.946					30
60	480	1.278	197	164	546	109,20	13,65	122,85	53	53
										330

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Table-5, based on normal productivity with an additional 1 hour of overtime, shows the new duration of work in column S and the new schedule from the MS project in Figure-3 as follows:

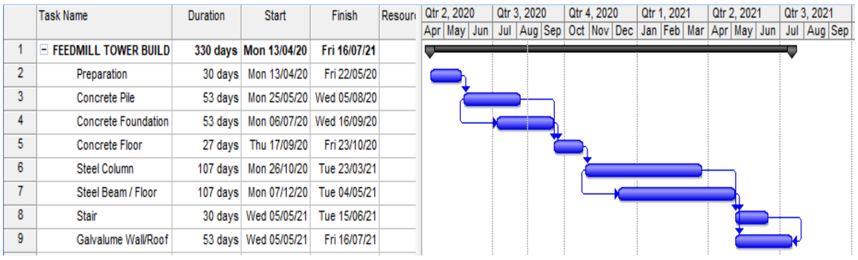

Figure-3. New schedule of 1 hour overtime.

Result analysis for 1 hour overtime effect on project performance using Java crashing software application, can be seen in Table-5 and Table-6 recapitulation below:

Table-5. Recapitulation of normal cost for 1 hour overtime.

Normal

Code	Work	Volume	Unit	Cost ($)	Critical	Normal Duration		Direct Cost			Indirect Cost Per Day					
						Days	Working Hours	Material ($)	Wage ($)	Tool ($)	Retention ($)	VAT ($)	Profit ($)	Others		Total ($)
							8 Hours	78%	12%	10%	5%	10%	7.5%	Value ($)	Description	
P0001	Preparation	1.00	ls	106,811	0	30 Days	240 Hours	64,568	9,933	8,278	5,341	10,681	8,011	0		24,032
P0002	Concrete Pile	13,440.00	m	537,600	1	60 Days	480 Hours	324,979	49,997	41,664	26,880	53,760	40,320	0		120,960
P0003	Concrete Foundation	1,001.76	m3	500,880	1	60 Days	480 Hours	302,782	46,582	38,818	25,044	50,088	37,566	0		112,698
P0004	Concrete Floor	133.54	m3	26,707	1	30 Days	240 Hours	16,144	2,484	2,070	1,335	2,671	2,003	0		6,009
P0005	Steel Column	808,471.04	kg	1,212,707	1	120 Days	960 Hours	733,081	112,782	93,985	60,635	121,271	90,953	0		272,859
P0006	Steel Beam / Floor	1,600,000.08	kg	2,400,000	1	120 Days	960 Hours	1,450,800	223,200	186,000	120,000	240,000	180,000	0		540,000
P0007	Stair	155,701.87	kg	233,553	0	30 Days	240 Hours	141,183	21,720	18,100	11,678	23,355	17,516	0		52,549
P0008	Galvalume Wall / Roof	6,552.00	m2	131,040	1	60 Days	480 Hours	79,214	12,187	10,156	6,552	13,104	9,828	0		29,484
TOTAL ($)								3,112,751	478,885	399,071						1,158,591
GRAND TOTAL ($)																5,149,298

Table-6. Recapitulation of crash cost for 1 hour overtime.

Crashing

Code	Work	Volume	Unit	Cost ($)	Productivity				Crash Duration	Overtime Cost		Crash Cost				
					Days	Working Hours	Days + Hours			Wage ($)	Tool ($)	Direct Cost			Indirect Cost ($)	Total Cost ($)
						8 Hours						Material ($)	Wage ($)	Tool ($)		
P0001	Preparation	1.00	ls	106,811	0.03	0.00	0 Hours	0.03	30 Days	0	0	64,568	9,933	8,278	24,030	106,809
P0002	Concrete Pile	13,440.00	m	537,600	224.00	28.00	1 Hours	246.40	55 Days	156	87	324,979	58,590	46,438	110,880	540,887
P0003	Concrete Foundation	1,001.76	m3	500,880	16.70	2.09	1 Hours	18.37	55 Days	146	81	302,782	54,588	43,266	103,290	503,926
P0004	Concrete Floor	133.54	m3	26,707	4.45	0.56	1 Hours	4.90	28 Days	16	9	16,144	2,919	2,312	5,600	26,975
P0005	Steel Column	808,471.04	kg	1,212,707	6,737.26	842.16	1 Hours	7,410.98	110 Days	176	98	733,081	132,166	104,754	250,030	1,220,031
P0006	Steel Beam / Floor	1,600,000.08	kg	2,400,000	13,333.33	1,666.67	1 Hours	14,666.67	110 Days	349	194	1,450,800	261,563	207,313	495,000	2,414,676
P0007	Stair	155,701.87	kg	233,553	5,190.06	648.76	0 Hours	5,190.06	30 Days	0	0	141,183	21,720	18,100	52,530	233,533
P0008	Galvalume Wall / Roof	6,552.00	m2	131,040	109.20	13.65	1 Hours	120.12	55 Days	38	21	79,214	14,282	11,320	27,005	131,821
TOTAL ($)												3,112,751	555,761	441,781	1,068,365	
GRAND TOTAL ($)																5,178,658

b) Project performance with 2 hour overtime

Table-7. Percentage of normal cost (direct and indirect cost).

NO	WORK ITEM	CRITICAL PATH	VOLUME	UNIT	COST	NORMAL COST				CHECK
						DIRECT COST			INDIRECT COST	
						MATERIAL	WAGE	TOOL		
			A		B	C (78%)	D (12%)	E (10%)	F (25%)	B=C+D+E+F
1	Preparation	-	1,00	ls	106.811	62.484	9.613	8.011	26.703	OK
2	Concrete Pile	Critical	13.440,00	m'	537.600	314.496	48.384	40.320	134.400	OK
3	Concrete Foundation	Critical	1.001,76	m3	500.880	293.015	45.079	37.566	125.220	OK
4	Concrete Floor	Critical	133,54	m3	26.707	15.624	2.404	2.003	6.677	OK
5	Steel Column	Critical	808.471,05	kg	1.212.707	709.433	109.144	90.953	303.177	OK
6	Steel Beam / Floor	Critical	1.600.000,08	kg	2.400.000	1.404.000	216.000	180.000	600.000	OK
7	Stair	-	155.701,87	kg	233.553	136.628	21.020	17.516	58.388	OK
8	Galvalume Wall/Roof	Critical	6.552,00	m2	131.040	76.658	11.794	9.828	32.760	OK

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From Table-8, direct costs are taken at 75% and indirect costs 25% of the total normal cost. Then direct costs are divided into materials is 78%, wages at 12%, and tools at 10%.

Table-8. Normal and crash duration based on overtime productivity.

NORMAL DURATION		NORMAL COST PER DAYS				PRODUKTIVITAS			CRASH DURATION	NEW DURATION
		DIRECT COST			INDIRECT COST	DAYS	HOUR	DAYS+OVERTIME 2		
DAYS	HOUR	MATERIAL	WAGE	TOOL						
G	H=G*8	I=C/G	J=D/G	K=E/G	L=F/G	M=A/G	N=M/8	O=M+(JL*N)	P=A/O	S=G OR P
30	240	2.083	320	267	890					30
60	480	5.242	806	672	2.240	224,00	28,00	280,00	48	48
60	480	4.884	751	626	2.087	16,70	2,09	20,87	48	48
30	240	521	80	67	223	4,45	0,56	5,56	24	24
120	960	5.912	910	758	2.526	6.737,26	842,16	8.421,57	96	96
120	960	11.700	1.800	1.500	5.000	13.333,33	1.666,67	16.666,67	96	96
30	240	4.554	701	584	1.946					30
60	480	1.278	197	164	546	109,20	13,65	136,50	48	48
										306

Table-9, based on normal productivity with an additional 2 hours of overtime, shows the new duration of work in column S and the new schedule from the MS project in Figure-4 as follows:

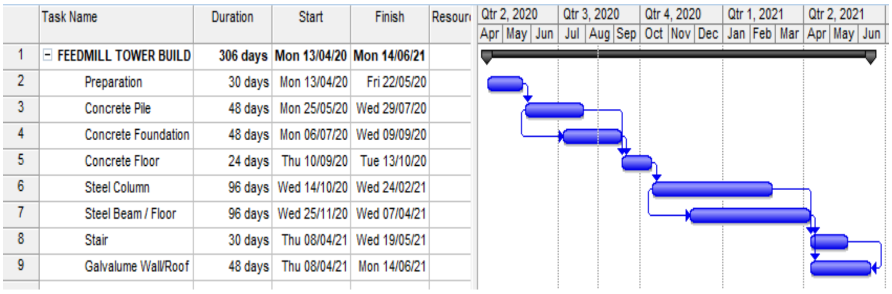

Figure-4. New schedule of 2 hour overtime.

Result analysis for 2 hour overtime effect on project performance using Java crashing software application, can be seen in recapitulation Table-8 and Table-9:

Table-9. Recapitulation of normal cost for 2 hour overtime.

Normal

Code	Work	Volume	Unit	Cost ($)	Critical	Normal Duration		Direct Cost			Indirect Cost Per Day					
						Days	Working Hours	Material ($)	Wage ($)	Tool ($)	Retention ($)	VAT ($)	Profit ($)	Others		Total ($)
							8 Hours	78%	12%	10%	5%	10%	7.5%	Value ($)	Description	
P0001	Preparation	1.00	ls	106,811	0	30 Days	240 Hours	64,568	9,933	8,278	5,341	10,681	8,011	0		24,032
P0002	Concrete Pile	13,440.00	m	537,600	2	60 Days	480 Hours	324,979	49,997	41,664	26,880	53,760	40,320	0		120,960
P0003	Concrete Foundation	1,001.76	m3	500,880	2	60 Days	480 Hours	302,782	46,582	38,818	25,044	50,088	37,566	0		112,698
P0004	Concrete Floor	133.54	m3	26,707	2	30 Days	240 Hours	16,144	2,484	2,070	1,335	2,671	2,003	0		6,009
P0005	Steel Column	808,471.04	kg	1,212,707	2	120 Days	960 Hours	733,081	112,782	93,985	60,635	121,271	90,953	0		272,859
P0006	Steel Beam / Floor	1,600,000.08	kg	2,400,000	2	120 Days	960 Hours	1,450,800	223,200	186,000	120,000	240,000	180,000	0		540,000
P0007	Stair	155,701.87	kg	233,553	0	30 Days	240 Hours	141,183	21,720	18,100	11,678	23,355	17,516	0		52,549
P0008	Galvalume Wall / Roof	6,552.00	m2	131,040	2	60 Days	480 Hours	79,214	12,187	10,156	6,552	13,104	9,828	0		29,484
TOTAL ($)								3,112,751	478,885	399,071						1,158,591
GRAND TOTAL ($)																5,149,298

Table-10. Recapitulation of crash cost for 2 hour overtime.

Crashing

Code	Work	Volume	Unit	Cost ($)	Productivity				Crash Duration	Overtime Cost		Crash Cost				
					Days	Working Hours	Days + Hours			Wage ($)	Tool ($)	Direct Cost			Indirect Cost ($)	Total Cost ($)
						8 Hours						Material ($)	Wage ($)	Tool ($)		
P0001	Preparation	1.00	ls	106,811	0.03	0.00	0 Hours	0.03	30 Days	0	0	64,568	9,933	8,278	24,030	106,809
P0002	Concrete Pile	13,440.00	m	537,600	224.00	28.00	2 Hours	268.80	50 Days	365	174	324,979	68,225	50,344	100,800	544,348
P0003	Concrete Foundation	1,001.76	m3	500,880	16.70	2.09	2 Hours	20.04	50 Days	340	162	302,782	63,565	46,905	93,900	507,152
P0004	Concrete Floor	133.54	m3	26,707	4.45	0.56	2 Hours	5.34	25 Days	36	17	16,144	3,390	2,501	5,000	27,035
P0005	Steel Column	808,471.04	kg	1,212,707	6,737.26	842.16	2 Hours	8,084.71	100 Days	411	196	733,081	153,900	113,565	227,300	1,227,846
P0006	Steel Beam / Floor	1,600,000.08	kg	2,400,000	13,333.33	1,666.67	2 Hours	16,000.00	100 Days	814	388	1,450,800	304,575	224,750	450,000	2,430,125
P0007	Stair	155,701.87	kg	233,553	5,190.06	648.76	0 Hours	5,190.06	30 Days	0	0	141,183	21,720	18,100	52,530	233,533
P0008	Galvalume Wall / Roof	6,552.00	m2	131,040	109.20	13.65	2 Hours	131.04	50 Days	89	42	79,214	16,630	12,272	24,550	132,666
TOTAL ($)												3,112,751	641,938	476,715	978,110	
GRAND TOTAL ($)																5,209,514

c) Project performance with 3 hour overtime

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Table-11. Percentage of normal cost (direct and indirect cost).

NO	WORK ITEM	CRITICAL PATH	VOLUME	UNIT	COST	NORMAL COST				CHECK
						DIRECT COST			INDIRECT COST	
						MATERIAL	WAGE	TOOL		
			A		B	C (78%)	D (12%)	E (10%)	F (25%)	B=C+D+E+F
1	Preparation	-	1,00	ls	106.811	62.484	9.613	8.011	26.703	OK
2	Concrete Pile	Critical	13.440,00	m'	537.600	314.496	48.384	40.320	134.400	OK
3	Concrete Foundation	Critical	1.001,76	m3	500.880	293.015	45.079	37.566	125.220	OK
4	Concrete Floor	Critical	133,54	m3	26.707	15.624	2.404	2.003	6.677	OK
5	Steel Column	Critical	808.471,05	kg	1.212.707	709.433	109.144	90.953	303.177	OK
6	Steel Beam / Floor	Critical	1.600.000,08	kg	2.400.000	1.404.000	216.000	180.000	600.000	OK
7	Stair	-	155.701,87	kg	233.553	136.628	21.020	17.516	58.388	OK
8	Galvalume Wall/Roof	Critical	6.552,00	m2	131.040	76.658	11.794	9.828	32.760	OK

From Table-11, direct costs are taken at 75% and indirect costs 25% of the total normal cost. Then direct costs are divided into materials is 78%, wages at 12%, and tools at 10%.

Table-12. Normal and crash duration based on overtime productivity.

NORMAL DURATION		NORMAL COST PER DAYS				PRODUKTIVITAS			CRASH DURATION	NEW DURATION
		DIRECT COST			INDIRECT COST	DAYS	HOUR	DAYS+OVERTIME		
DAYS	HOUR	MATERIAL	WAGE	TOOL				3		
G	H=G*8	I=C/G	J=D/G	K=E/G	L=F/G	M=A/G	N=M/8	O=M+(JL*N)	P=A/O	S=G OR P
30	240	2.083	320	267	890					30
60	480	5.242	806	672	2.240	224,00	28,00	308,00	44	44
60	480	4.884	751	626	2.087	16,70	2,09	22,96	44	44
30	240	521	80	67	223	4,45	0,56	6,12	22	22
120	960	5.912	910	758	2.526	6.737,26	842,16	9.263,73	87	87
120	960	11.700	1.800	1.500	5.000	13.333,33	1.666,67	18.333,33	87	87
30	240	4.554	701	584	1.946					30
60	480	1.278	197	164	546	109,20	13,65	150,15	44	44
										287

Table-12, based on normal productivity with an additional 3 hours of overtime, shows the new duration of work in column S and the new schedule from the MS project in Figure-5 as follows:

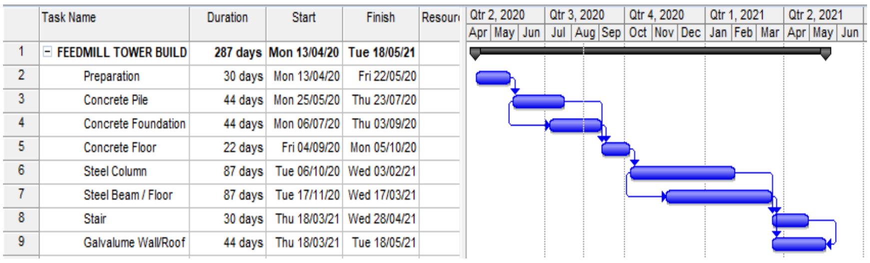

Figure-5. New schedule of 3 hour overtime.

Result analysis for 3 hour overtime effect on project performance using Java crashing software application, can be seen in recapitulation as below:

Table-13. Recapitulation of normal cost 3 hour overtime.

Normal

Code	Work	Volume	Unit	Cost ($)	Critical	Normal Duration		Direct Cost			Indirect Cost Per Day					
						Days	Working Hours	Material ($)	Wage ($)	Tool ($)	Retention ($)	VAT ($)	Profit ($)	Others		Total ($)
							8 Hours	78%	12%	10%	5%	10%	7.5%	Value ($)	Description	
P0001	Preparation	1.00	ls	106,811	0	30 Days	240 Hours	64,568	9,933	8,278	5,341	10,681	8,011	0		24,032
P0002	Concrete Pile	13,440.00	m	537,600	3	60 Days	480 Hours	324,979	49,997	41,664	26,880	53,760	40,320	0		120,960
P0003	Concrete Foundation	1,001.76	m3	500,880	3	60 Days	480 Hours	302,782	46,582	38,818	25,044	50,088	37,566	0		112,698
P0004	Concrete Floor	133.54	m3	26,707	3	30 Days	240 Hours	16,144	2,484	2,070	1,335	2,671	2,003	0		6,009
P0005	Steel Column	808,471.04	kg	1,212,707	3	120 Days	960 Hours	733,081	112,782	93,985	60,635	121,271	90,953	0		272,859
P0006	Steel Beam / Floor	1,600,000.08	kg	2,400,000	3	120 Days	960 Hours	1,450,800	223,200	186,000	120,000	240,000	180,000	0		540,000
P0007	Stair	155,701.87	kg	233,553	0	30 Days	240 Hours	141,183	21,720	18,100	11,678	23,355	17,516	0		52,549
P0008	Galvalume Wall / Roof	6,552.00	m2	131,040	3	60 Days	480 Hours	79,214	12,187	10,156	6,552	13,104	9,828	0		29,484
TOTAL ($)								3,112,751	478,885	399,071						1,158,591
GRAND TOTAL ($)																5,149,298

Table-14. Recapitulation of crash cost for 3 hour overtime.

Crashing

Code	Work	Volume	Unit	Cost ($)	Productivity				Crash Duration	Overtime Cost		Crash Cost				
					Days	Working Hours	Days + Hours			Wage ($)	Tool ($)	Direct Cost			Indirect Cost ($)	Total Cost ($)
						8 Hours						Material ($)	Wage ($)	Tool ($)		
P0001	Preparation	1.00	ls	106,811	0.03	0.00	0 Hours	0.03	30 Days	0	0	64,568	9,933	8,278	24,030	106,809
P0002	Concrete Pile	13,440.00	m	537,600	224.00	28.00	3 Hours	291.20	47 Days	573	260	324,979	76,922	53,903	94,752	550,556
P0003	Concrete Foundation	1,001.76	m3	500,880	16.70	2.09	3 Hours	21.70	47 Days	534	243	302,782	71,668	50,221	88,266	512,937
P0004	Concrete Floor	133.54	m3	26,707	4.45	0.56	3 Hours	5.79	24 Days	57	26	16,144	3,850	2,691	4,800	27,485
P0005	Steel Column	808,471.04	kg	1,212,707	6,737.26	842.16	3 Hours	8,758.44	93 Days	646	294	733,081	172,874	121,299	211,389	1,238,643
P0006	Steel Beam / Floor	1,600,000.08	kg	2,400,000	13,333.33	1,666.67	3 Hours	17,333.33	93 Days	1,279	581	1,450,800	342,124	240,056	418,500	2,451,480
P0007	Stair	155,701.87	kg	233,553	5,190.06	648.76	0 Hours	5,190.06	30 Days	0	0	141,183	21,720	18,100	52,530	233,533
P0008	Galvalume Wall / Roof	6,552.00	m2	131,040	109.20	13.65	3 Hours	141.96	47 Days	140	63	79,214	18,750	13,139	23,077	134,180
TOTAL ($)												3,112,751	717,841	507,687	917,344	
GRAND TOTAL ($)																5,255,623

5. CONCLUSIONS

When an activity is accelerated, the direct costs for the activity will increase. Direct costs such as labor costs, materials, and equipment directly related to the installation or construction of the project. Crashing causes indirect costs to increase because of inefficiencies by accelerating work faster than the normal average. Project acceleration can result in bonus additions, can prevent damage payments to the owner, or can save indirect additional costs. The number of bonuses to be received should be explained in the contract.

Based on the analysis of the effect of overtime on the project performance of to feed mill tower building project, the most efficient cost slope is the addition of 1 hour of overtime. The time reduction of 30 days with the added cost is US$ 29.360,-, and the cost slope is US$ 26.913,-. But if the owner needs to time reduction for a complete project of 60 days, can be done 2 hours overtime with an additional cost is US$ 60.126,- and the cost slope is US$ 51.183.

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