

Downtime Cost of Equipment Used In a Construction Industry

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Abstract: The purpose of this paper is to present a sample of how Construction companies deal with equipment downtime cost, and further how they analyze its reduction. The study was performed by conducting a web-based survey within construction firms that have at least 200 employees. The main results obtained from the investigation show that the estimated downtime cost constitutes about 23.9 % from the total manufacturing cost ratio, and 13.3 % from planned production time. Additionally, the hourly cost of downtime, whether planned or unplanned, is relatively high.

Finally, the lack of fully integrated models for assessing the downtime costs and frameworks for distinguishing the difference between planned and unplanned stoppages are the main reasons behind the continuation of cost in ascending form. Due to that, the improvements will emphasize on areas with less cost saving opportunities. As a result, this will affect the production efficiency and effectiveness which in return has its influence on costs and thereby profits margin.

1. Introduction

The opening chapter mainly displays the motivation factors behind the thesis topic and the intention of approaching such a subject. Further, the introduction context enclosed by different constituent elements namely background, problem discussion, objective, research questions, delimitations, limitations, and finally a chapter summary. The report structure consists of eight chapters, and at the end of the first three chapters brief summary will be provided. The purpose is to facilitate the process of idea flow and content coherence; especially the first three chapters address the theoretical background of this study. Consequently, the overall goal of this chapter is to furnish the reader with a general understanding about the proposed topic.

In today's competitive manufacturing market, production efficiency and effectiveness are among top business priorities. Thus, production equipment becoming the central focus of interest as it is the backbone of the manufacturing process and key performance indicator of productivity. The requirements of outstanding performance force companies to substantially consider reducing their machines downtime frequency and its consequential costs.

Equipment downtime occurs due to planned or unplanned stops. However, the unplanned stops caused by failures and disturbances occurrence are the most common unexpected factors that have the non-trivial influence on the overall productivity. Also, this interrelation between downtime events and productivity lies in gist of economic connotation, in which cost and profit variables are inversely proportional by means of decreasing downtime cost and thereby increasing production profit. To this end, in order to decrease the downtime cost, suitable and developed costing methods are needed to calculate and trace every single cost disbursed during the stoppage juncture. All activities and resources that have depleted whilst retrieving the production equipment function should be allocated based on their real costs.

For instance, one explicit trade-off is between costing methods and maintenance applications. Productive maintenance strives for minimizing downtime events and hence cost. On the other hand, proper costing method can be of much beneficial to maintenance managers through assessing the efficiency of the adopted maintenance policy. Moreover, it allows the use of series mathematical modeling and simulation as an input to optimizing maintenance strategy, in particular, the preventive maintenance strategy.

There upon, a real case study is very urgent in approaching this topic in a logical manner. According to that, Swedish manufacturing industry was chosen for this issue as it has perceived vast technological progress within production facilities. Moreover, the infrastructure of such development was based on the installation of robotic systems. Nevertheless, these sophisticated and complex systems exposed to frequent stoppages wherein are some of these stoppages has a significant impact on production outage and so lost profit

2. Problem statement

According to Traditional cost accounting method the downtime cost of equipment's was so high as they were using the Traditional costing method.

In Traditional cost accounting method the action were taken after the breakdown of equipment's.

3. Case study

3.1. Study of Previous Research Paper

In this step I got a detailed idea about the previous thesis done, after the detailed study it was noted that there are some laggings which are still affecting the cost of construction project. This encouraged me to get into the subject and do the detailed thesis, so that downtime cost of equipment's used in a construction industry to be minimized.

3.2. Appointment of site

To complete the thesis actual work was to be done and hence I approached the site “AVAANTI RESIDENCES” at swargate Pune. There I got a permission for thesis and I started working on the same.

SITE DETAILS:

Name of site: Avaanti Residences
Site Address: In Front of Jayshreej Garden Restaurant, Hirabaug Chownk, Shukrawar Peth, Pune.
Client: ABIL Corporation
Contractor: Capacite Infra projects Ltd.
Type of Building: Commercial cum Residential Building
Name of Project Manager: Mr. Babu Shigula Sir, Mr. Anand Aswale Sir
Name of Engineer: Mr. Gaurav Deokar Sir, Mr. Pravin Bhende Sir
Area of building: 2500 sq.m.

3.3. Observation, Study & Analysis of the existing process

In this step I observed the whole ongoing system which is used in daily construction practice. The record such as activity log book, work hindrance register, etc. were studied in detail. After the study of the ongoing system it was noted that there were some lags in system which cases downtime of construction equipment’s.

3.4. Discussion

A brief discussion meeting was held at site with site team as well as some of the staff from head office. In this meeting results of observation and its study were presented in front of them. After seeing the results, they were agreed to do some changes in the system, and for the same I suggested them to follow the system which were designed by me and Babu Sir. Some suggestion was agreed by them so as to reduce downtime cost of equipment’s.

3.5. Implementation

Implementation of a new system was started after the approval of management immediately. In this system some changes were done which are as follows:

1. Social Changes
2. Reduction of Communication Gap
3. Changes in Maintenance Strategy
4. Daily Inspection Process

3.6. Analysis

After the Implementation of new system, the work measurements were recorded on monthly basis. This data

recorded were analyzed for the final results and the results of analysis were submitted to the Project Manager.

3.7. Study of Analysis

After the analysis of the record which is gathered and recorded after making changes in the system, the detailed study of analysis were done and presented in front of the authority.

3.8. Result

The result of work measurement were found so useful to minimize downtime cost as it reduces 20-25% more downtime cost with compare to previous method.

4. Result & discussion

Table no.1.Actual Onsite Equipment

No	Name of equipment’s
1	Bar Bending Machine
2	Bar Cutting Machine
3	Tower Crane
4	Transit Mixer
5	Total Station
6	Ply Cutting Machine
7	Needle
8	Diesel Generator
9	Concrete Pump

4.1 Name of Equipment: Tower Crane

Figure.No.4.1 Tower Crane

4.1.1. Activity: Concreting

Concreting by tower crane is one of the most efficient task, the efficiency depends upon the structure concreting to be done. For a structure like column, the tower crane can lift about 6 cu.m of concrete per hour.

- Cost of concrete/cu.m = Rupees 4000
- Cost of concrete done per hour= 6*4000 = 24000

If the tower crane is sudden breakdown for an hour, it will affect the cost of the project as follows:

Cost of concrete + Labor Cost (1mason, 2helper); i.e. = 24000 + 500 + 2*350 = 25,200.

We can also find the affected cost on project if the tower crane is breakdown for 1 day: In 1 day if you are planning to do a concrete quantity 24 cu.m of a column & beam and your tower crane suddenly breakdown after the 2 concrete vehicles reach at site, in this case the total affected cost on your project is 12*4000 + 500*2 + 350*3 = 50,050.

Sometime tower crane is idle as the operator of tower crane is on a shore break or lunch break. A short break takes 30 min to resume his work where Lunch break takes 1.5 hours to resume the work. If an operator is on a short break tower crane remains idle for half hour which will affect the cost of the project.

4.1.2. Considering above points I have made some changes in our system:

a. Social Changes:

In this we have arranged the alternate operator for tower crane, also the shift wise working system was implemented. In this system before any one operator goes for a break, he gives charge to the another one so as to not keep tower crane idle. By implementing this system we achieved our desired goal with full efficiency and utilization of machine. Due to this implementation our cost of idleness reduced by 20 to 25%.



b. Maintenance Strategy:
We made some

changes in our maintenance strategy, now the maintenance is done forth nightly as well as AMC is given to third party for monthly maintenance. Also the daily inspection is done by our MEP team so as to avoid any sudden break down. Due to this system the sudden breakdown of tower crane comes to 0%.

4.2 Name of Equipment: Bar Bending Machine



Figure.No.4.2 Bar Bending Machine

4.2.1. Activity: Reinforcement work

The capacity of bar bending machine is to bend 4-5 tonne of steel per 8 hours , this mean the capacity of bending machine per hour is equals to $5/8=0.625$ tonne per hour .

In this case there is only one operator and two helpers to execute the work, if the operator goes for a break the helper

and the machine is idle for that time period. If your machine is idle for an hour your project cost affect as follows:

$$1\text{operator} + 2\text{helpers} + 2\text{fitter} + 2\text{ helper} = 600 + 350*2 + 2*500 + 2*350 = 3,000 \text{ Rs. (Labour Charges)}$$

As the reinforcement work is delayed the shuttering can't be done due to which carpenter and there helper also have to sit idle, i.e. $2*500 + 2*350 = 1700\text{Rs.}$

As these activity gets delayed all further activity gets delayed and finally your project gets delayed which leads you the increase the construction cost.

4.2.2. Considering above situation I have done some changes in our existing working system:

a. Preventive Maintenance:

Here we use preventive maintenance so that sudden breakdown of the machine does not occurs and the work goes on fluently. AMC is given to third party for monthly basis maintenance as well as daily inspection of machine is done by our MEP incharge so as to prevent any sudden breakdown.

This helps us to reduce downtime of machine till 20-30%.

b. Social Changes:

The operator was given one helper who was trained with the job (Bar Bending Operation) he have to do in absence of operator. In this case when the operator goes on a short break or Lunch break, the helper continues the job so as to not keep the machine idle at that time. Due to this the capacity of machine was fully achieved and the production was increased to 4.5 tonne per day.

4.3 Name of Equipment: Bar & Steel Cutting Machine



Figure.No.4.3 Bar & Steel Cutting Machine

4.3.1. Activity: Reinforcement

The capacity of bar cutting machine is to cut 8 tonne of steel per 8 hours , this mean the capacity of cutting machine per hour is equals to $8/8=1.0$ tonne per hour .

In this case there is only one operator and two helpers to execute the work, if the operator goes for a break the helper and the machine is idle for that time period. If your machine is idle for an hour your project cost affect as follows:

$$1\text{operator} + 2\text{helpers} + 2\text{fitter} + 2\text{helper} = 600 + 350*2 + 2*500 + 2*350 = 3,000 \text{ Rs. (Labour Charges)}$$

As the reinforcement work is delayed the shuttering can't be done due to which carpenter and there helper also have to sit idle, i.e. $2*500 + 2*350 = 1700Rs.$

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This helps us to reduce downtime of machine till 20-30%.

b. Social Changes:

The operator was given one helper who was trained with the job (Bar cutting Operation) he has to do in absence of operator. In this case when the operator goes on a short break or Lunch break, the helper continues the job so as to not keep the machine idle at that time. Due to this the capacity of machine was fully achieved and the production was increased to 7 tonne per day from 4-5 tonne per day.

4.4 Name of Equipment: Transit Mixer



Figure.No.4.4 Transit Mixer

4.4.1. Activity: Concreting

Transit mixer plays an important role in the activity of concreting; it acts as a mediator between RMC plant & Construction site. Averagely transit mixer carries 6cu.m of concrete which cost 24,000 Rupees, the workability of concrete is of 3 hours and the transit mixer takes approximate 1.5 hours for transportation from RMC plant to construction site. If a transit mixer fails at the time of transportation and not able to reach site within 3 hours, the concrete is rejected and it cost as follows:

Concrete Cost +Driver Charges +Fuel Charges +Breaking of concrete by breaker which is set in transit mixer due to failure of transit mixer (2 labour for 3 days).

i.e. = $24,000 + 600 + 300 + 800*3 = 27,300$ Rupees.

Considering above loss I finalize the maintenance system and stream lined it, the finalized system was as follow:

- 1) Every driver will check the Transit Mixer before leaving the plant and after completion of work when he parks the vehicle to plant.
- 2) Monthly maintenance of a vehicle to be done.
- 3) Checking of the mixer to be done on daily basis.
- 4) Checklist to be done on everyday basis.

By applying above system it was observed that the failure of transit mixer was very minor than it was before & it saved a cost about 27,300 Rs. for a project.

4.5 Name of Equipment: Diesel Generator



Figure.No.4.5 Diesel Generator

This is the machine which is used as a backup in case of cutoff of light supply, but in case if the Diesel Generator is not working the most labor on site will be idle and the work will be stopped.

This stoppage of work will affect very high on the site budget which is shown below:

Fitter and there helper are not able to cut and bend the steel which cost Rs. 9400, as well as Carpenter are not able to cut the ply which will cost Rs. 10200.

Also the tower crane operator (2 nos) remains idle. i.e.= $600*2= 1200.$

Total impact of breakdown of Diesel Generator = $9400+10200+1200 = 20800.$

This impact is very high for one day breakdown.

4.5.1. Considering above points I have made some changes in our system:

a. Maintenance Strategy:

We made some changes in our maintenance strategy, now the maintenance is done forth nightly as well as AMC is given to third party for monthly maintenance. Also the daily inspection is done by our MEP team so as to avoid any sudden break down. Due to this system the sudden breakdown of tower crane comes to 0%.

4.6 Name of Equipment: Ply Cutting Machine



Figure.No.4.6 Ply Cutting Machine

Ply cutting machine plays an important role in the field of construction, if a ply cutting machine is not working for a day, the carpenter gang is not able to do the shuttering work. For example If a carpenter gang is doing shuttering for a slab and they need to cut a ply which they want to fix but due to breakdown of ply cutting machine they are not able to do the shuttering work as well as fitter is not able to do the reinforcement work which affects the cost of project as follows:

Carpenter- 6nos. + Helper 6nos. + Fitter- 6nos. + Helper 6nos. + Delay of slab casting
 $500*6 + 350*6 + 500*6 + 350*6 + \text{Overhead cost due to delay of slab casting}$
 $= 10200 + \text{overhead costs}$

4.6.1. Considering above points I have done some changes which are as follows:

As the cost of Ply cutting machine is not so expensive, we purchased one spare Ply cutting machine which is useful when the other machine is breakdown.

The electric supply of machine is checked on day to day basis so as to prevent breakdown of machine.

4.7 Name of Equipment: Total station



Figure.No.4.6 Total station

Total station plays the key role in the field of construction, total station is used on daily basis at site as we have to fix column, retaining wall, building line, etc.

If the error occurs at the time of fixing of coordinate which are given as per drawing the whole building gets shifted. If such error occurs it is not acceptable as per drawing and the whole casted structure is to be demolished which will highly affect the cost of project.

Cost of concrete+ cost of shuttering + cost of reinforcement + cost of concreting+ cost of demolishing + cost of housekeeping

i.e. (cost of concrete) + (carpenter*1+helper*2) + (fitter*1+helper*2) + (mason*1+helper*2) + (2helper*2days) + (2helper)

i.e. (5000) + (500*1+350*2) + (500*1+350*2) + (500*1+350*2) + ((350*2)*2) + (350*2)

Therefore;

Total cost which affect the project is = 10700 rupees.

To reduce this cost the calibration of Total station is done by every six month which helps in maintaining accuracy of total station and reduces the above mentioned cost.

4.8 Name of Equipment: Vibrator Needle



Figure.No.4.6 Vibrator Needle

Vibrator needle is used for compaction of concrete at the time of casting. If the vibrator needle is breakdown at the time of casting, the concrete is not well compacted and the honeycomb occurs after deshuttering of structure.

If the honeycomb occurs it is to be rectified with chemical mortar and in case of major honeycombing in column the structure is to be broken.

The above activity will affect your project cost as follows:

4.8.1. In case of minor honeycombing:

Repairing cost+ chemical mortar cost (Fairmate)
 (1mason+1helper) + (4000 per bag) i.e (500+350+4000)
 Total cost in case of minor repairing = 4850 Rupees.

4.8.2. In case of major honeycombing:

Shuttering cost +Concrete cost + Labor cost + Demolishing Cost + Housekeeping cost + Re shuttering cost + Concrete cost + Labor cost
 $(500+350*2) + (5000) + (500+350*2) + (350*2) + (350*2) + (500+350*2) + (5000) + (500+350*2)$

Therefore total cost = 16200 Rupees.

4.9 Name of Equipment: Concrete Pump

4.9.1. Activity: Concreting

Pumping capacity of concrete pump per hour is 14cu.m where as it on an actual it pumps 6-8 cu.m of concrete, this lag of pumping of concrete affects financially on the project. Per cu.m rate of pumping of concrete is Rs. 300 means per hour cost is $14 \times 300 = 4,200$. Actual production cost per hour is $8 \times 300 = 2400$. The difference between actual and theoretical cost is $4200 - 2400 = 1800$ + labour (Rigger) sits idle which cost $300 \times 5 = 1500$.

4.9.2. After analyzing why there is difference between actual & theoretical cost it was observed that there

was a communication gap between the site team and plant team for ordering the concrete.

By eliminating this communication gap the ordering sequence of concrete is stream lined.

After eliminating this communication gap it was observed that the pouring capacity of concrete pump was increased to 12-13cu.m per hour where as prior it was 8cu.m per hour.

The lag is now 1cu.m which cost 300 Rs.

In this case we have achieved 90% of efficiency of a concrete pump.

The 1 cu.m lag occurs due to time which transit mixer takes for movement to pump which is accepted.

Table no 2: Losses in production due to Equipment Downtime

Loss	Category	Loss Category Example	Comment
Breakdown	Downtime Losses	Equipment failure, unplanned maintenance, tooling damage	Loss due to breakdown of equipment
Setup & Adjustment	Downtime Losses	Setup/Changeover, Operator shortage	Time loss due to adjustment in equipment
Idling & minor stoppage	Speed losses	Component jams	Small stop losses occur when equipment stops for a short time as a result of temporary problem
Reduced Speed	Speed losses	Operators inefficiency under design capacity	Reduced speed refers to the difference between design speed & actual operating speed
Startup loss	Quality loss	Equipment warm up	Some equipment requires warm up time & certain adjustment to obtain optimum output

4.9.3. Considering above points we have done some changes which are as follows:

As the cost of vibrator needle machine is not so expensive, we purchased two spare needle machines which are useful when the other needle is breakdown.

The electric supply of needle is checked on day to day basis so as to prevent breakdown of vibrator needle.

Training was given to the labor those who are operating the needle at the time of concreting so as to prevent sudden breakdown due to short circuit due to high pressure on it.

4.10 Summary

Table 4: Represents difference in cost before breakdown of equipment and after breakdown of equipment

Sr. No	Name of equipment	Cost without failure	Cost with failure	Difference in cost
1	Bar bending machine	3000	4700	1700
2	Bar cutting machine	3000	4700	1700
3	Tower crane	25,200	49,200	24000
4	Transit mixer	2,000	26,500	24,500
5	Diesel generator	1,500	20,800	19,300
6	Total station	5000	10700	5700
7	Ply cutting machine	1800	10200	8400
8	Vibrator needle	25,050	50100	25050
9	Concrete Pump	2400	3300	900
	TOTAL	68,950	1,80,200	1,11,250

4.11 Result:

By using Activity based costing method we have reduced cost due to downtime of equipment by about 62%.

Before using ABC method we were using Traditional method in which we used to cost 1,80,200 as downtime cost whereas after using ABC method the downtime cost were reduced to 68,950.

As the downtime is decreased the overall delay in work due to downtime is decreased which results in the Timely completion of the project.

4.12 Suggestion:

1. By using Activity based costing method we have reduced cost due to downtime of equipment by about 62%. This method is useful for all the construction projects those whose overhead cost is getting more in account of company.
2. Before using ABC method we were using Traditional method in which we used to cost 1,80,200 as downtime cost whereas after using ABC method the downtime cost were reduced to 68,950. This help us in reducing the total amount up to 1,11,250.

3. As the downtime is decreased the overall delay in work due to downtime is decreased which results in the Timely completion of the project.
4. Delay reduced due to downtime also helped us in fulfilling the RERA norms, budgetary completion of project.

From the above result I will suggest you that construction industry should use Activity Based Costing method for break less and smooth construction.

5. Conclusion

1. By using Activity based costing method we have reduced cost due to downtime of equipment by about 62%. This method is useful for all the construction projects those whose overhead cost is getting more in account of company.
2. Before using ABC method we were using Traditional method in which we used to cost 1,80,200 as downtime cost whereas after using ABC method the downtime cost were reduced to 68,950. This help us in reducing the total amount up to 1,11,250.
3. As the downtime is decreased the overall delay in work due to downtime is decreased which results in the Timely completion of the project.
4. Delay reduced due to downtime also helped us in fulfilling the RERA norms, budgetary completion of project.

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