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PREFACE

This souvenir is brought out to mark the International Conference on "Advances in Civil Engineering" (ICACE-23) during July 27–28, 2023, organized by the Department of Civil Engineering, School of Engineering and Technology, Sandip University, Nashik.

The International Conference Advances in Civil Engineering (ICACE-23) provides an ideal platform for new researchers to share their views and experiences in the fields of structural engineering, transportation planning, town planning, construction management, etc. This conference will facilitate the exchange of new perceptions and build a dialogue between academic innovators, researchers, and technologists that will enable discussions on the most recent innovations, challenges, and solutions in the domain of civil engineering.

We wish to thank all the foreign delegates, scientists, panelists, and researchers for their contributions to plenary speeches, keynote lectures, and paper poster presentations. A special thanks to all the guidance and support given by the Vice-Chancellor and Dean(s), HOD's, and faculties at Sandip University. We are highly indebted to the National and International Advisory Board of Advances in Civil Engineering (ICACE-23). Organizing committee for providing valuable guidance in organizing this mega event. We are very thankful to all staff and student volunteers for contributing towards the successful execution of Advances in Civil Engineering (ICACE-23).

The overwhelming response received from scientists and researchers around the world to this Advances in Civil Engineering (ICACE-23) is highly appreciated.

Dr. P. L. Naktode, (CONVENOR, ICACE-23)

Dr. Sachin B. Mulay, (Conference Chair, ICACE-23)

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A System to Track Work Progress at Construction Job sites

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ABSTRACT

The goal of this paper is to provide a summary of how Swedish manufacturing companies manage the downtime costs of equipment and to further examine how it is minimized. The keyfindings of the investigation show that the hourly cost of downtime, whether scheduled or unplanned, is fairly high. There is, however, a lack of statistical models capable of tracking theindividual costs of downtime events. This deficiency has evidently been shown, since 83 per cent of the businesses surveyed do not have a full model adapted to measure their downtime costs. Moreover, only a few organizations are improving their cost accounting approaches, such as activity based costing (ABC) and resource utilization accounting (RCA), to assimilateand expose the actual costs associated with scheduled and unplanned stoppages. Still, the general trend of estimation of idle costs assigned to direct labor and reduced power costs. On the other hand, the attempts to reduce downtime events and thus costs were based onmaintenance schedule tactics supported by the OEE (Overall Efficiency Equipment) tool as an indicator to confirm improvements. However, the review demonstrates the need for streamlined maintenance strategies by complete efficient maintenance (TPM) on company maintenance systems. The maintenance function of reducing downtime impacts is not well known. Ultimately, the lack of fully developed models for evaluating downtime costs and mechanismsfor distinguishing between scheduled and unplanned downtimes are the key reasons for continuing upward cost. As a result, investments would concentrate on areas with fewer cost savings opportunities. As a result, this will affect the production efficiency and effectiveness which in return has its influence on costs and thereby profits margin.

KEYWORDS: (Downtime Equipment's Planning)

1 INTRODUCTION

For most manufacturers, downtime is the single largest source of lost production time. As youprobably already know, Downtime is any time period when a machine is not in production (when it is set up for operation or when repairs are made). Downtime can be categorized to help identify patterns of machine performance. This attracts a high degree of scrutiny becausethe malfunction and malfunction of the facilities are clearly noticeable. However, as often visible as downtime is, most companies significantly underestimate their actual downtime. About 80 per cent of businesses are unable to accurately measure their real downtime costs. There is little doubt that increased efficiency of mechanized road construction methods would reduce construction costs and increase productivity. May factors affect the productivity of the construction equipment, but are some factors easily identifiable prior to construction, while others are anticipated and negatively impact the productivity of the equipment. Downtime (DT) causes a lack of availability of equipment and a breakdown of equipment among the most commonly anticipated factors that have a non-trivial impact on the productivity, project and organizational performance of

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equipment. Equipment Managers are often called upon to make complex economic decisions involving machines in their charge. This decision covers those related to purchases, servicing, rehabilitation, reconstruction, relocation and withdrawal. The equipment manager will also be able to anticipate internal rental levels for their equipment. Repairs and maintenance of the equipment have significant impact on these economic decision and forecasts. Construction equipment is a high cost of capital investment necessary for the successful existence of a private construction company. The highest impact cost factor other than purchase investment is the expenses related to maintenance and repairs. As the equipment ages, the ownership costs decrease and the operating expenses, increase as the maintenance and repair requirements grow. Both the privateand public things desire to manage this high capital investment for optimization of a perceivedprofit.

In construction activities on a large scale, standard equipment is needed for successfuloperations, especially in the area of infrastructure growth. This is the true picture of large construction firms whose physical lucrative activities are focused on people, materials and sophisticated equipment that will maximize the production of operations over a specific periodof use. The efficiency of construction machinery is therefore a major consideration which denounces construction companies in terms of heavy construction and light construction. In today's worrying global competition, the construction industry is determined to make progressand to change its productivity in order to remain competitive. The overall efficiency of the equipment (OEE) of the machine plays an important role where the performance and characteristics of the product are of key importance to the company. The objective of the OEEwas to minimize the breakdown, increase performance and quality and thus improve the efficiency of the machine. The availability rate of the machine, the output rate of the machineand the quality rate of the products are considered parameters when improving the overall Equipment Effectiveness (OEE) of the management system.

2 LITERATURE REVIEW

1. **MaliPritam** A. "Effect of Construction Equipment on Production in Building Costruction Project" International Journal of Engineering Sciences & Research Technology June 2015 Issn: 2277-9655 (I2or), Publication Impact Factor: 3.785
   The contractor's equipment policy and equipment management system have a great impact on the profitability of a firm, especially for contractors with large investment in equipment.
2. **Prasannasangeetha.**A "Equipment Management In Construction Sector" International Journal Of Science And Engineering Research (Ij0ser), Vol 3 Issue 6 June -2015
   Construction equipment plays a significant role in the construction industry, costing up to 36 % of the total cost of the construction project, but the maintenance of the equipment has not been given adequate attention and this contributes to an overrun of around 40 % of the total cost of the construction project.
3. **Amir H. B. "**Simulation-Based Evaluation Of Fuel Consumption In Heavy Construction Projects By Monitoring Equipment Idle Times" Proceedings Of The 2013 Winter Simulation Conference R. Pasupathy, S.-H. Kim, A. Tolk, R. Hill, And M. E. Kuhl, Eds A systemic approach to idle time reduction will dramatically improve the performance of construction machinery over their lifetime, result in higher overall productivity and eventually protect public health and the environment.
4. **Rickey A. Cook "**A Crane And Heavy Equipment Maintenance Plan For Improving Safety And Efficiency" The Graduate College University Of Wisconsin-Stout December 201 Rickey A.Cook "Maintanance plan of heavy equipment" The Graduate College University Of Wisconsin-Stout December *58(2), Pp. 108-116, 2011 Doi: 11.3312/Ppar.12385* The goal of this study was to develop a crane and heavy equipment maintenance plan for improving safety and efficiency .
5. **IliasNaskoudakis "**A Systhematic Review Of The Main Research On Construction Equipment Over Recent Years" *47(2), Pp. 110-118, 2010Doi: 10.3311/Ppar.10384*
   A considerable body of literature has been dedicated to scientific studies on construction equipment.

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Many subjects have been debated and analyzed, and numerous findings have been made. However, the published research papers on construction equipment are highly diversified and there is a lack of systematic review and classification.

3 METHODOLOGY

3.1 Downtime identification, causes and effects:

The term downtime is potently denoted to period when the system is unavailable due to planned or unplanned stoppages. The unplanned stoppages mainly referred to equipment failures or process disruption. On the other hand, scheduled stops regarded to predetermine procedures ofactivities that undertaken as calculated duration for which the machine has to be stopped. For example, the planned maintenance, setups, adjustments, inspections, shutdowns, training, breaks, cleaning, standby state, in addition to software and hardware upgrade / update. As a result, companies attempts to reduce downtime by adopting efficient costing methods that facilitate the improvement process. Nepal and Park claim that equipment breakdown as the most common unforeseen factor that have an intense effect on equipment productivity and organization overall performance. The factors are the site-related factors that include the poorworking conditions, location of the site, and uncertainties during equipment operation. Other important factor involve the equipment-related issues, for example, its age, usability, type, quality, the complexity, Notwithstanding, the discrepancy between the site management actions and the company's adopted policies may occur due to scheduled maintenance performed into a specific machine while the site manager assign the maintenance crews to otheroperations. According to Onawoga and Akinyemi, the causes of equipment breakdown assigned by design deficiencies, inappropriate maintenance, inefficient processing, material defects, excessive demands, etc. The authors grouped the sources of failure is man; methods, materials, and machine. The materials categorized by its quality and compatibility with machine nature for instance, if the purchased material is the right material. The human factor due to lack of training and experience may impose errors during operations. Finally, the instrument required efficient methods for process.

In more details, the report that introduced by Sachs shows the major failure contributor of mechanical equipment is attributed to different primary failure mechanisms. These failure mechanisms are distributed into following proportions: fatigue (44%); corrosion (18%); overload (15%); corrosion fatigue (13%); and wear-out (10 %). During the same study, the fundamental cause that stated as enabler to these failure mechanisms consisted of Maintenanceerrors that score the high rank in comparison with other causes categories. For instance, once the machine became unavailable the first perceptible effect is the resource idleness - operatorsand equipment- and thus the project progress (orders fulfillment) slowdown plus the increasingpressure on work schedule. Example of capacity cost might be a facility, machinery, utilities, and administration or any other indirect functions related cost. The case here is when machineis down the costs of capacity are still incurred even though there is no product produced. Thisdisruption may happen in several ways such as, changing the work sequence by introducing new methods and procedures or by diverting the influenced resources through downtime duration to other site operations. The concern is by diverting the human resources to other sites may encounter the experience level issues in which required a plenty of learning time inconsistent with projected methods. Additionally, the state of congestion site beside the feelings of declined level of experience affects the crew morale and thereby exposed system tostoppage.

This shortfall is the bottom line of the difference between planned and unplanned downtimes,so the frequency of the downtime event and its duration is considered to be a factor that characterizes the downtime type. On the other hand, the planned downtime events are relativelyshort, such as the time spent on inspection and preventive maintenance. However, the quantification of the impact, whether it corresponds to planned or unplanned events, is necessary to facilitate the detection of the actual costs of both events. In the light of this argument, due to its preparation and less exhaustive resources, the internal and external effectof the scheduled downtime is more controlled than unplanned downtime. In addition to the obvious expense groups, and their estimation is simple, for example, the direct cost of labor and materials. Paradoxically, unplanned downtime surrounded by a variety of expense categories that may not be apparent as overhead costs, and its calculation required a more precise cost estimate. Consequently, the limits of the study based on such inquiries must be differentiated between the resonance of the effects of expected and unplanned stops. The distinction was made in order to determine precisely the costs associated with both activities and to list them as overall downtime costs.

3.1.1 Determination of cost categories:

Before revealing the cost categories that imposed whilst a downtime occurs, it is veryimperative to describe how the process activities get influenced by the length of downtime duration. The scenario is about a complex processing machine that considered critical among a serial production line and this equipment experienced sudden stoppage. However, if the directoperators incapable of recuperates the machine into its functioning state the maintenance staffcalled to attend to failed equipment and further endeavor to fix the machine. Hence, the machine become a bottleneck in which has a great downstream processing activities. In more dramatic case, the problem escalated to outsourcing in parallel with adopting alternative methods to replace the system outage. As long as the downtime extended, there is a possibility to send the equipment to the original manufacturer. The consequence of this time consumptionindeed will increase the customers' dissatisfaction in the level of service. The traditional costing methods have piled downtime costs in one overhead bucket and disregard the quantification and tracking the costs individually. As shown in figure 10, in every stage of thedowntime period there is an involvement of new activities in purpose of recovering the systemand each activity accompanied with cost. In other meaning, the rate of cost accumulation is proportional to the participated activities. Therefore, the traditional costing methods are considered inaccurate because the calculation of downtime cost was based on a conventional approach in which emphasized on tangible rather intangible costs. Every activity occupied hasits indirect support and costs incorporated. At a first glance, the direct cost appears clearly butthe hidden costs required more analysis of categories that drives cost. This type of analysis willempower analysts to obtain realistic value of downtime consequential costs. The aim is to launch improvements and through tracking each activity with its individual costs the improvement process becoming more accurate and effective.
Hitherto, the difficulty of tracking downtime cost was closely related to the complexity of thecost metrics that convoluted in manufacturing. So, instead of searching for what make-up the manufacturing costs the trend was to lay-off workers, cut inventory, and implement lean methodologies such as, TPM, PM, and TQM. Those practices are considered effective if theirassessment was counted in the true downtime cost as a key performance indicator used to justify changes. There are many factors affected by equipment downtime, and each one contributes financial loss in that particular event. These factors carrying an intensive cost and mainly classified into three categories or groups, see figure: equipment, labor overhead, and production downtime in addition to the vast array of sub categories. The equipment group consists of people, energy, product, start-up, bottleneck and sales expectation costs. On the other hand, the division of labor comprises management, engineering, repair, quality assuranceand indirect operator costs.

3.2 Cost accounting methods:

3.2.1 Traditional cost accounting:

There are many cost accounting methods exist in manufacturing industries. The evolution of those costing methods is not entirely compatible with the development that intervene production systems.

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The introduction of lean manufacturing strategies Obliges companies to launch a new costing structure, in which can fulfill the requirements of agile production lines.This technological advancement, beside the cultivated automation, made Swedish manufacturing companies aware of the importance of developing their costing methods, as it was monitored at ascending level. Further to that, and in return to the traditional costing accounting methods, Swedish firms were stemmed its accounting method originally from a model that firstly presented by Frenckner and Samuelson. The model viewpoint was meant toascribe the manufacturing costs by the absorption factor of the unit produced. In other words, absorption costing or full absorption method is considered a way for distributing all costs generated to every finished product. The presented model was in the era of mass production.

3.2.2 Life cycle costing (LCC):

LCC is a method that pursues to optimize the cost of physical assets over their valuable lives, through identifying and quantifying all the incorporated costs tangled in that life, and that by using the present value technique. The general procedure for LCC analysis defined in first position the cost elements of interest, or all the cash flows that happened during the lifespan ofthe asset. The process of LCC of an asset, usually, includes all the expenditures that attached to it, and in particular the conversion stage from acquisition until disposal at the end of functioning life. The second step of the procedure is to delineate the cost structure, the structuremainly consists of those costs that can be grouped together so as to identify the potential trade offs and thereby achieving optimum LCC. Similarly, other cost categories distributed into utilization, ownership and administration. Even more, there is proposed cost categorization asengineering, distribution, manufacturing, service costs, sales costs and renovation. Despite such diversion of defining cost structures, the aim in the end is the detailed costs of each component will depend upon an individual item under consideration. The vital point is that thestructure must be designed in a way allows analyst to perform indispensable LCC analysis, andtrade-offs to adequate the project objectives. The third step of the LCC general approach is to estimate the cost relationship, and that expressed mathematically in which describes the cost of the item as a function of one or more independent variables. Finally, the last stage of LCC procedure is by establishing the method of LCC formulation by finding a proper methodologyto appraise asset's LCC.

Hence, a systematic methodology was given as following

3.2.2.1 Operating profile that labels the periodic cycle of equipment or the proportion of time the equipment will be operating, mainly covers the modes of startup, operating and closure.
3.2.2.2 Utilization factors require in what way apparatus will be running within each mode of the mentioned operating profile.
3.2.2.3 Identification of all cost element Determine the factors that control the degree of the costs earned during the life of Equipment. Such factors as energy usage rate, Period ofrepairs, time between overhauls, time between failures and time period For scheduled maintenance.
3.2.2.4 All costs are first deliberated at current rates.
3.2.2.5 Escalate the current calculated costs at assumed inflation rates
3.2.2.6 Discount costs to the base period; the money has a time value and the cash flows arisingin different period should be discounted back to the base period to certify comparability

3.2.3 Resource consumption accounting (RCA):

RCA defined as an emerging management accounting method that composites the benefits of managerial accounting's highlighting on resources with those of the activities and processes vision. Furthermore, RCA takes advantages of an enterprise resource planning system's abilityto track, sustain, and cluster the most detailed information and to successfully assimilate the operational and financial information. The resource pool conception focuses on assemblage thedifferent costs of homogenous resources in a specific area of restraint. White claims that RCAmain concepts can be seen as resource flows and pools, in which the resource flows from resource pools to products. The resource pool in this context is carrying a cost in addition to specific inputs needed to produce an output, and might this output support another cost pool rather than becoming product or service. Flows should also be properly modeled, because oneof the key purposes of RCA is to include knowledge on causality so that decision-makers can make the right decisions. Here, the cause and effect principle ensures that the relationship between resource pools can carry both fixed and proportionate costs. Nonetheless, this was based on the essence of the costs that could be adjusted between the pools of capital. For example, energy has arrived at the business as a marginal cost, but in certain resource pools ithas become a fixed cost. As the cost of heating and lightening the production plant. In addition,the RCA-cost allocation approach deals only with the expense of services that have been usedfor goods and neglects the cost of non-added value. Another problem is the unused and idle cost of capacity; the RCA strategy assigns these costs to the individuals or departments in charge and does not impact the cost of the product. It is very important to establish the causalitybetween resources and resource drivers. Nevertheless, if the costs in one cost pool did not havean effect on the other cost pool or product, there was no need to be included in the cost model.

Work Tracking System (WTS) In the first part of the research, we wanted to understand the information requirements from the different project participants in a construction site, to designa system that manages the information flows more effectively. Specifically, we wanted to know: what information is requiredby the different project participants to perform their job, and what information they have readily available or have to produceas part of their job. To understand this, we performed over twenty unstructured interviews with project managers, superintendents, project engineers, foremen, subcontractors, and field workers at three construction sites. We consolidated the responses around themes that were common across the interviews. An interesting observation was that there were many overlapping information flows between some of the project participants interviewed, which led us to consolidate theminto one user type.

When RCA cost sheet shown for analysis target, there are some features:

- Primary and secondary costs
- Cost driver type if it is resource process
- Origin of the cost (provider)
- Fixed and proportional quantities and costs

Primary costs are the costs that originate in a particular pool of resources, such as direct labour.Secondary costs, on the other hand, are initiated in support of the production of resource poolsrelated to the consuming object. (Maintenance, services, space, etc.)Following this, the type ofcost driver consumed is dependent on the quality of its performance. Furthermore, the cost driver for the secondary cost of human capital is a process type since the performance of this resource is an operation. The input supplier is where the expense is built, it may be the manufacturing department or some other support agency. An example of this is plant maintenance as secondary costs, the driver category is a benefit since the production is maintenance hours. The method used to describe how the overall fixed and proportional cost of the consuming item is calculated under

RCA as follows :

PR- the proportional budget rate

FR- the fixed budget rate for a resource provided by the support department

PQC- the proportional quantity

FQC- the fixed quantity.

The formulation for determining proportional and fixed costs are expressed into two equations:

Proportional cost assigned =PQC*PR

Fixed cost assigned = (FQC*FR) + (FQC*PR) + (PQC*FR)

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3.2.4 Activity-based costing (ABC):

ABC is a cost allocation method mainly pioneered in the area of management accounting. Thismethod has been successfully conducted in manufacturing plants for improving the strategic vision of decisions-making, in addition to enhancing the business cost control and customer profitability. One of ABC role is to supplies management with appropriate information to comprehend the use of scarce resources in various business activities. It helps management tonotice areas of the high cost, identify the elements that stimulus these costs, and develops performance. Furthermore, it allows to measure improvements in the time and cost of the activities performed. This drive forward to better management of resources concerning product costing and customer profitability. In the ABC tactic, resources are traced to activities, and activity are then traced to the targeted object such as products or services based on their intakeof the activities.

ABC model uses different structural blocks in comparison with traditional costing, the traditional costing approach was presented product as a cost object that consumes resources directly. On the contrary, the propose ABC model are adopted the cost objects as a consumer of activities that in turn consume resources. Resources and activities are disbursed in a certain amount, and the rates of consumption are regarded as resource drivers and activity drivers. Resource drivers describe the rate of consumption of each resource when an activity is completed. Activity drivers underlined the rate of consumption of each activity as cost objectsare generated. The idea here is that the activity driver defined on per- job basis for every cost object created, and there is a specific degree of activity consumed ABC designed in aiming toprovide an accurate cost data and information about the root of the cost, which means ABC make overhead traceable. In many cases, ABC has been used in combination with other processimprovement tools to assert progresses initiatives and to track cost improvement. Costs were minimized through the removal of non-value activities, or due to processing enhancement. However, the impressive results of such method and the fact of cost reductions that supportedby its sufficiency of calculating the operating cost, still incurred a deficient in the handling of capital costs. Whilst the depreciation cost is considered in ABC analysis, the interest charges for capital invested in an organization are not been taken seriously.

3.3 Performance measurement systems:

3.3.1 Overall equipment effectiveness (OEE):

OEE is generally defined as one of the appropriate performance assessment tools to quantify the different types of production losses, essentially at the equipment level, and to indicate areas of improvement. This tool provided a quantitative metric of productive and effective machineefficiency; defines and calculates losses in relation to manufacturing factors such as availability, cost and quality. Major losses that have reduced production efficiency and therefore efficiency are classified into three groups: downtime, speed and quality losses. On the same ground, set-up and adjustment losses are incurred as a result of the change in production from one item to another. The second class of losses are speed losses, this categoryof losses split into idling and minor stoppages and reduced speed losses. The idling and minorstoppage losses occur when output is intermittent due to temporary failure, and this may result,for example, in dirty photocells. While this form of stoppage can be resolved easily, a lot of potential is lost in case of repeated occurrence. Reduced speed loss refers to the variance of thedesign speed (theoretical) and actual operating speed of the equipment. An example of this is the inappropriate materials used that contribute to longer processing times and a loss of speed.The last category of production disturbances and losses is the loss of quality, includes quality defects and rework, in addition to the reduced yield during start-ups. Material that is stuck anddamaged during processing. Reduced yield losses are losses that occur from the start-up of thesystem to the steady state period of machine

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operations. This form of reduced yield may be dueto insufficient planning before starting the machine and, in particular, to long-term failure stoppages. According to Muchiri and Pintelon, OEE equation. OEE = A*P*Q. Where: Availability rate (A) = Working time (h) / Filling time (h) Performance efficiency (P) = Theoretic cycle time (h) * Actual output (units) /Working time (h) Quality rate (Q) = Total production–Deficiency amount / Total production * 100 2.3.2 Total equipment effectiveness performance (TEEP): TEEP is a measurement tool similar to OEE, but it deals with equipmentoutput in reference to the total calendar time available rather than the loading time that used inOEE calculations. So, TEEP is adopted to evaluate how well the production. TEEP = Utilization*availability*performance*rate of quality *100

3.4 Maintenance concept and interventions:

3.4.1 Maintenance definition and perspective change:

Maintenance is characterized as the coordination of all technical and managerial activities intended to maintain and restore the item to the state in which it can perform its necessary function. This is, though through downtime occurrences, short stoppages, low efficiency, etc. As a result, the economic paybacks of maintenance strategies can be characterized by an increase in the profit margin as a result of a decrease in manufacturing costs.

3.4.2 Maintenance strategies, policies and tactics:

There are two crucial strategies for maintenance activities. One is reactive maintenance (RM),which attempts to decline the severity of equipment failure once they occur; the form of overhaul or replacement work is only performed when machinery has failed. The other is preventive maintenance (PM) that aims to minimize the risk of failure after maintenance has been carried out over a period of time. In the case of a reactive approach, corrective and forward-looking policies are the variables that make up its substance. Maintenance activities fall into three general categories:

• Routine maintenance:

Activities that are conducted while equipment and system are in service. These activities are predictable and can be scheduled and budgeted. These activities are generally scheduled on a time based or metre-based schedule derived from a preventive or predictive maintenance strategy. Topics include visual inspection, washing, functional testing, and calculation of working quantities, lubrication, oil testing and maintenance of the governor.

• Maintenance testing:

Activities requiring the use of test equipment to reach offline status. All events are predictableand can be prepared and budgeted. It may be scheduled on a time or meter basis, but may be planned to coincide with the equipment shutdown schedule. As this operation is predictable, some offices call it routine maintenance or preventive maintenance. Some ex are governor alignment and balanced and unbalanced gate testing.

• Diagnostic testing-

Activities requiring the use of test equipment to determine the state of the equipment following unexpected incidents, such as failure / repair / replacement / or possible detonation of the equipment. These activities are not predictable and cannot be scheduled because they are required after a force outage. Each office must budget this event. Examples include governor troubleshooting, nits balancing and vibration testing.

3.4.3 Condition-based maintenance (CBM):

This program relies on knowing the condition of individual pieces of equipment .CBM emphases on the current condition of the system. The key role is to moderate downtime at the optimal time.

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Furthermore, Mobley extends the role of CBM into the determination process while problem exists in the equipment, how severe the problem and how long the equipment can perform before breakdown. Some features o CBM include:

1. Monitoring equipment parameters such as temperature, pressure, vibrations, leakage current,dissolve gas analysis etc.
2. Periodic monitoring and/or when problems are suspected, such as dual checking, vibration testing and infrared scanning.
3. Securing result in knowledge maintenance decisions which would reduce overall cost by focusing only on equipment that really needs attention.
4. Drawbacks to CBM include it being very difficult and expensive to monitor some quantities.
5. It requires knowledgeable and consistent analysis to be effective and also condition based monitoring equipment and system themselves require maintenance because of these drawbacks, it is nearly impossible to have an entirely CBM program.

3.4.4 Reliability-centered maintenance (RCM):

RCM defined as a resource optimization method that is conducted in ease of developing and refine maintenance programs. The goal of RCM is to generate maintenance standards or routinethat keep the critical system functions in the most cost-effective mode. The RCM systems aregaining popularity and have been piloted in a few refueling power plants with good success. The purpose of this program is to provide sufficient maintenance at the right time to avoid forceoutage and, at the same time, reducing excessive maintenance. When correctly applied, RCM will remove some of the PM's disadvantages and will result in a more organized, effective maintenance system. RCM tends to be very successful in times of diminishing support for thelack of qualified maintenance workers and pressure to remain online due to eclectic utility deregulation. Some features of RCM are

3.4.4.1 It may be labor-intensive and time-consuming to set up initially
3.4.4.2 It may require additional monitoring of quantities, like temperature and vibration to beeffective. This may a new monitoring equipment with its own PM or more human monitoring with multiple inspection.
3.4.4.3 It may result in a run to failure of differed maintenance philosophy for some equipmentwhich may cause concern for some staff and managers.
3.4.4.4 It may require initial and later revision to the maintenance schedule in a trial and errorfashion depending on the success of initial maintenance schedule and equipment condition.
3.4.4.5 It should result in more manageable maintenance workload focused on the most important equipment.
3.4.4.6 RCM is not an excuse to move to a breakdown maintenance philosophy or to eliminatecritical PM in the name of reducing maintenance personnel / funding. However to mitigate problems associated with a PM program, maintenance manager may choose toapply a consciously chosen, effectively implemented and proper documented RCM program For a viable RCM program at reclamation facilities, it must
3.4.4.7 Be chosen as the local maintenance philosophy by management.
3.4.4.8 Be implemented according to generally accepted RCM practices.
3.4.4.9 Be documented so that maintenance decision are defensible.

3.4.5 Total productive maintenance (TPM):

TPM, it is a lean manufacturing strategy that strive for enhancing the machine efficiency and effectiveness as possible, through optimizing all types of maintenance activities. The overall aims of

TPM are to:

3.4.5.1 Achieve zero losses in downtime events
3.4.5.2 Construct integrated system capable of increase the process efficiency
3.4.5.3 Cover all departments including production, maintenance, administration, etc. Involve all employees from top managers to operators and clerical staff Enable small group activity.

3.4.6 Preventive maintenance (PM):

Preventive maintenance is the practice of maintaining equipment on a regular schedule based on elapse time. The intend of pm is to prevent maintenance problem or failure before they takeplace by following routine and comprehensive maintenance procedure. The aim is to achieve fever, sorting, and more consistent distress. Some advantage of PM are

1. It is predictable, making, budgeting, planning and resource leveling When properly practiced, it generally prevents most major problems, thus reducing forces outage reactive maintenance and maintenance costs in general.

2. It assured manager that equipment is being maintained.

3. It is easily understood and justify PM does have some drawbacks:

1. It is time consuming and resource intensive.

2. It does not consider actual equipment condition when scheduling or performing the maintenance it can cause problems in equipment in addition to solving them (e.g. damaging

seals, striping thread). Notwithstanding these drawbacks, PM has proved to be relatively effective in the past and continues to be the cornerstone of the most maintenance system, and PM has historically been the preferred maintenance procedure in the recommendation. Nonetheless, caution should be taken in applying PM recommendation for wholesale implementation of PM recommendation without considering essential equipment or equipmentrequirements which may result in a workload that is too high to achieve. This results in significant equipment not being provided with the necessary maintenance, which defect the intent of PM management. Climate using a PM, RCM or condition-based maintenance (CBM)system. Or a combination of these, schedule maintenance, should be the primary focus of house maintenance personnel. It eliminates reactive (emergency and corrective) care. Maintenance ofthe schedule should have a higher priority than a specific project and should be the number onepriority.

3.4.7 Combination of Condition-Based and Preventive Maintenance:

Perhaps the most realistic solution is the combination of CBM and PM. Monitoring testing and the use of historical data and PM schedules that provide the best information on the equipment should be maintained by keeping accurate records of the condition of the equipmentwhen it is torn down for maintenance, so that one can decide what maintenance was really required. In this way, maintenance plans may be extended or reduced on the basis of experienceand tracking.

4 CONCLUSION

From the results of the study, it is concluded that companies must be aware of the potential impacts that equipment downtime generates on their product cost and thereby profits. Moreover, the downtime influence on planned production time, downtime hourly cost, and theneed for cultural change and mindsets. Although most of the businesses surveyed do not havea structured model for evaluating and monitoring the individual costs associated with scheduledand unforeseen stoppages. It is explained by the complexity of these models and the length oftime and substantial costs of implementation. For instance, the costs that accompanied with training and learned people. On the other hand, only few companies adopt complete models such as, activity-based costing and resource-consumption accounting for measuring downtimecosts. Consequently, the lack of optimized methods and procedures are the reasons of high downtime hourly cost.

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