The use of Work Study Techniques in Optimizing Manufacturing Plant Maintenance Processes: an Investigation into a Fertilizer Manufacturing Company in Zimbabwe

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Abstract: This paper explores the use of work study techniques in the optimization of manufacturing plant maintenance processes. An overview of work study strategies from literature is first done and then performance indices for maintenances practices are explored. Recommendations for production and other services like supplies and logistics and human resources that support the maintenance function were done. Plant availability, downtime and quality performance figures taken from January to December 2011 have indicated that the company is indeed experiencing problems. Overall, the maintenance system is ineffective. The research managed to bring out some of the causes of the ineffectiveness of the maintenance system.

Keywords: work study, maintenance, maintenance management, productivity, plant availability

1. Introduction

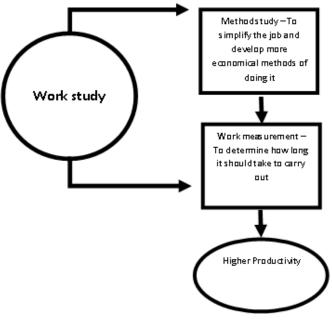
Work study is the systematic examination of the methods of carrying out activities so as to improve the effective use of resources and to set-up standards of performance for the activities being carried out. It is one of the most powerful tools that management can use to improve productivity [1]. There are a number work study techniques such as ergonomics, operations research, work study and time-andmotion study.

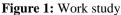
Maintenance Management is an orderly and systematic approach to planning, organizing, monitoring and evaluating maintenance activities and their costs. A good maintenance management system coupled with knowledgeable and capable maintenance staff can prevent health and safety problems and environmental damage; yield longer asset life with fewer breakdowns; and result in lower operating costs and a higher quality of life [2].

The good performance indices of each work study technique should yield improved productivity, improved quality, improved efficiency, reduced downtime, improved employee morale, reduced turnover and absenteeism.

2. Literature review

The term 'work study' embraces method study and work measurement. Method study being the systematic recording and critical examination of ways of doing things in order to make improvements whereas work measurement involves application of techniques designed to establish the time for a qualified worker to carry out a task at a defined rate of working. The figure below shows the relationship between method study and work measurement.





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2.1 Basic Procedure of method study

There are eight steps involved in performing a complete method study:

1. Select the job or process to be studied

2. Record or collect all relevant data about the job or process, using the most suitable data collection techniques so that the data will be in the most convenient form to be analyzed.

3. Examine the recorded facts critically and challenge everything that is done, considering in turn, the purpose of the activity; the place where it is performed; the sequence in which it is done; the person who is doing it; the means by which it is done.

4. Develop the most economic method, taking into account all the circumstances and drawing as appropriate on various production management techniques as well as on the contributions of managers, supervisors, workers and other specialists with whom new approaches should be explored and discussed.

5. Evaluate the results attained by improved method compared with the quantity of work involved and calculate a standard time for it

6. Define new method and related time and present it to all those concerned, either verbally or in writing, using demonstrations.

7. Install the new method, training those involved, as an agreed practice with the allotted time of operation.

8. Maintain the new standard practice by monitoring the results and comparing them with the original targets [1]

Going through these eight simple steps should be able to yield improved productivity, improved quality, improved efficiency, reduced downtime, improved employee morale, reduced turnover and absenteeism

3. Justification of study

The formation of global village as an eventual effect of globalization is shaped primarily by business and economic atmosphere. Business and economic fields envelop the reifications of global village, thus, turning it into a homogenized and unified village wherein distinctions no longer form part of its own culture. The causal effect of globalization victimized the business and economic fields leading to radical reengineering of business' organizational management systems. World over, maintenance management forms the back bone of all the manufacturing plants.

The liquidity crunch and expensive borrowing facilities prevailing in Zimbabwe encourages companies to continuously review their business management tools and adopt survival strategies.

Most of the key business indicators and performance measures have taken a downward trend in the past three years. Increasing talk and concern about effective maintenance management within the fertilizer manufacturing management systems and one of the most powerful tools that can be used to improve productivity is by continuously carrying out work studies on the maintenance management systems. Improved maintenance management systems will help to reduce downtimes which lead to low operating costs hence reducing product price thereby improving the competitive advantage.

There are a number work study techniques such as ergonomics, operations research, work study and time-andmotion study. All of them produce the same output if properly implemented – improved productivity. As such, in this research paper, a random choice on ergonomics was done. Ergonomics pertain to the human element of the system and the interface (s) between the human being, the machine, facilities, and associated software.

Figure 2: Relationship b	between maintenance and
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	ergonomics	
Maintenance Management principle	Benefits of ergonomics and maintenance management (intersection)	Ergonomics principle
Scheduled planned maintenance actions	Increased productivity	Promotion of effective maintenance work processes
Enhancing equipment reliability and improving on plant availability by way of inspecting, testing, reconditioning a system and replacing worn components	Increased efficiency	Design of effective maintenance work processes
Inspecting , testing and reconditioning a system at regular intervals. Inspections, test results and a reconditioned system will help in producing quality product.	Improved quality	Providing on- going feedback and follow-up . Even with the best up-front planning there will be unintended results or consequences, something will vary from the plan hence deviations from the quality specifications. Providing feedback as part of follow-up process is critical to maintain quality within specified range.
Scheduled equipment restoration tasks and scheduled discard tasks help	Reduced downtime	Providing competency based training and design of effective maintenance

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reduce stoppage		processes help to		
time		reduce stoppages	120	
Preserving and				
enhancing		Provision of		
equipment		competency based	100 -	
reliability by		training and		
replacing worn	Improved	promoting health		
components before	employee	and wellness. A		
they actually fail.	morale	trained and		
Employees are	moraie	healthy employee		
motivated if the		is well motivated		
plant is running		to execute their	Plant availability	
smoothly and		duties.		
reliably				
Enhancement of				
equipment		Effective work		
reliability and plant		processes,		
availability by way		provision of	20 -	
of equipment		competency based	20 -	
checks, oil changes,		training and		
lubrication,		promotion of		
painting, cleaning		health and		
and adjusting,	Reduced turn-	wellness helps to	0 2 4 6 8 10 12 14	
partial or complete	over and	keep employees in	Month	
overhauls at	absenteeism	their work places.		
specified periods	ubsenteetsm	Employees feel		
to reduce		motivated to work		
stoppages.		in well	Budget - Plant availability	
Employees are		coordinated and	Actual plant availability - Msasa	
motivated when the		effective	Actual plant availability - Aspindale	
plant is running and		maintenance work		
good quality		processes design	Figure 2: Expected response if preventive maintenance was	
product is coming		Processes design	applied	
out.			Assumptions	
			10-15% increase in productivity	

All other operating conditions remain constant

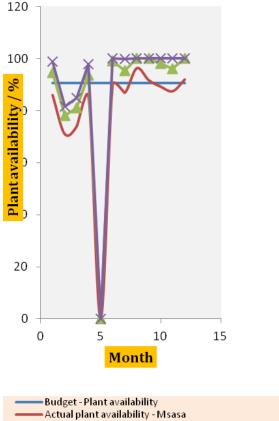
4. Research methodology

Observations, personal interviews, mail surveys, data collection and analysis were used in this research. The performance indexes will be indicative of the maintenance output of a local manufacturing plant.

Performance Index 1

Plant availability analysis for period January 2011 to December 2011

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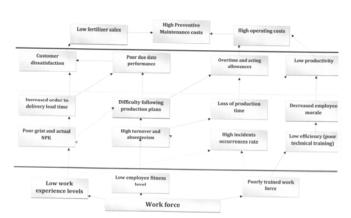


Actual plant availability - Msasa PM implementation through ergonomics response Msasa - 10%

Performance Index 2

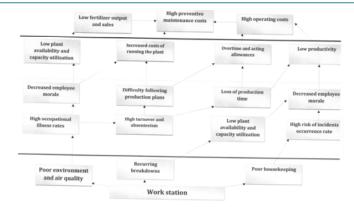
Effect of work force on fertilizer manufacturing process

Assumptions: Work station and work processes are optimal All other things being constant, optimizing maintenance through work force will require high work experience levels, high employee fitness levels and a well trained work force will lead to increased productivity hence good profitability.



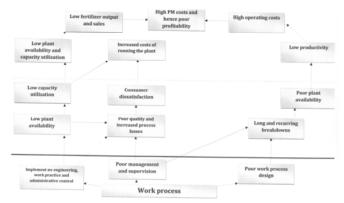
Performance Index 3: Effect of work station design on fertilizer manufacturing process.

Assumptions: Work force and work processes are optimal. All other things being constant, optimal preventive maintenance through work station improvements will require good environment and air quality, non recurring breakdowns and good housekeeping practices.

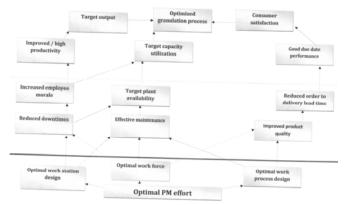


Performance index 4: Effect of work process design on fertilizer manufacturing process.

Assumptions: Work force and work station design are optimal. All other things being constant, optimal preventive maintenance will require good management and supervision, good work process design and implementation of engineering, work practice and administrative controls.



All other things being constant, optimal preventive maintenance will require good management and supervision, good work process design and implementation of engineering, work practice and administrative controls.



5. Recommendations and areas for future research

The recommendations will be grouped into two, those for the Engineering section and for the production section and support sections. The recommendations for engineering are as tabulated below and take a format that gives responsibility of the delivery of a task or recommendation to an individual person and it is the author's intention that the recommendations be conducted in the form of a turnaround programme with target dates.

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5.1 Recommendations for Engineering Section

5.1 Recommendation		
Task & References	Leader / Initiator	Success indicator (s)
Formulate the	Maintenance	Documented
company's	and Projects	maintenance policy
maintenance policy	Engineer	manifemanee poiney
Propose	Manufacturing	Attractive package
maintenance work	Executive	Mildelive package
force package that	LACCULIVE	
will attract and		
retain maintenance		
staff. The proposal		
to be made to the		
Manufacturing		
Executive.		
Fill in vacant posts	Human	Full establishment
in the Engineering	Resources	I'un establisiment
Section	Manager	
Put in place an	Maintenance	Orientation
orientation		
	and Projects	programme
programme for new engineering	Engineer	
employees	Emplana	Successful a
Conduct training	Employee	Successful courses
courses for the	relations	
existing planned	manager	
maintenance system		D
Put in place	Maintenance	Documented
documented	superintendent	procedures
preventive		
maintenance system		
procedures		
Include resources	Maintenance	Maintenance
for setting up	superintendent	budget
preventive		
maintenance system		
as top priority in the		
engineering budget		
Put in place	Maintenance	Preventive
documented	superintendent	maintenance
preventive		manual
maintenance system		
manual		
Conduct training on	Employee	Successful
preventive	relations	Preventive
maintenance system	manager	maintenance
		training course
Conduct a	Maintenance	Successful exercise
companywide	and Projects	
preventive	Engineer	
maintenance		
exercise		
Set preventive	Maintenance	Plant availability
maintenance as a	and Projects	and utilization,
continuous process	Engineer	productivity,
		occupational
		injuries and
		illnesses, budget
		variance for
		maintenance,
		absenteeism and
		staff turnover,

5.2 Recommendations for Production Section

The following recommendations are for production and other services like supplies and logistics and human resources that support the maintenance function.

- ✓ Top management to avail adequate financial resources for the running and maintenance of the preventive maintenance system.
- ✓ Supplies and logistics to make sure that spares re-order levels are maintained to reduce to zero make shift spares.
- ✓ Communication systems need to be improved for example create internal email accounts for all the artisans and production supervisors and also install communication sirens within the plant.
- ✓ Purchasing / procurement committee to include sectional heads who can fully inform the team of the importance of particular spares from an operational point of view. It will help/assist in the purchase prioritization.
- ✓ Work out a package that can attract and retain employees to reduce labor turnover rate.
- ✓ Put in policies and rewarding systems to improve employee motivation and loyalty.
- ✓ Improve manning levels where necessary to reduce overload and minimize error rate
- ✓ Acquire adequate amounts of raw materials like coal to avoid long production stoppages

5.3 Areas requiring future research

To turn around the organizational performance a number of areas need to be studied;

- ✓ Optimal compound fertilizers pricing model.
- A work study to determine the optimal number of employees in the compound fertilizer manufacturing plant.
- ✓ The best model for acquiring spares for the manufacturing company where cash flow is a real problem. Spares and raw materials compete for the scarce financial resources.

6. Conclusion

Plant availability, downtime and quality performance figures taken from January to December 2011 have indicated that the company is indeed experiencing problems. Overall, the maintenance system is ineffective. The research managed to bring out some of the causes of the ineffectiveness of the maintenance system. Lack of maintenance policy to guide the engineering section on how they operate contributed to most of the challenges being experienced. The purpose of a maintenance system is to minimize or reduce the duration of breakdowns thereby increasing plant availability. An effective maintenance system will help to meet or surpass company targets. Fluctuations in availability and productivity can only be attributed to major breakdowns or recurrent minor ones. The three main areas that may be improved in the fertilizer manufacturing plant maintenance system through ergonomics to make-up a workplace that is safe, healthy and productive and address research objectives of improved product quality, improved efficiency, reduced downtime, improved employee morale, reduced turn over

and absenteeism, reduction of occupational injuries and illness and decreasing the loss of law materials are.

- ✓ Work force
- \checkmark Work station
- ✓ Work process

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