

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

Mutombozana Tapiwa<sup>1</sup>, Mugwindiri Kumbirayi<sup>2</sup>, Chikuku Tauyanashe<sup>3</sup>

<sup>1</sup>Process Engineer, ZFC Limited  
P. O. Box 385 Harare, Zimbabwe  
mutombozanat@zfc.co.zw

<sup>2</sup>Postgraduate Coordinator: Mechanical Engineering Department, University of Zimbabwe  
P. O. Box MP167, Mount Pleasant, Harare, Zimbabwe  
kmugwindiri@eng.uz.ac.zw

<sup>3</sup>Lecturer  
Mechanical Engineering Department,  
University of Zimbabwe  
P. O. Box MP167, Mount Pleasant, Harare, Zimbabwe  
tchikuku@eng.uz.ac.zw

**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 maintenance 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-and-motion 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.

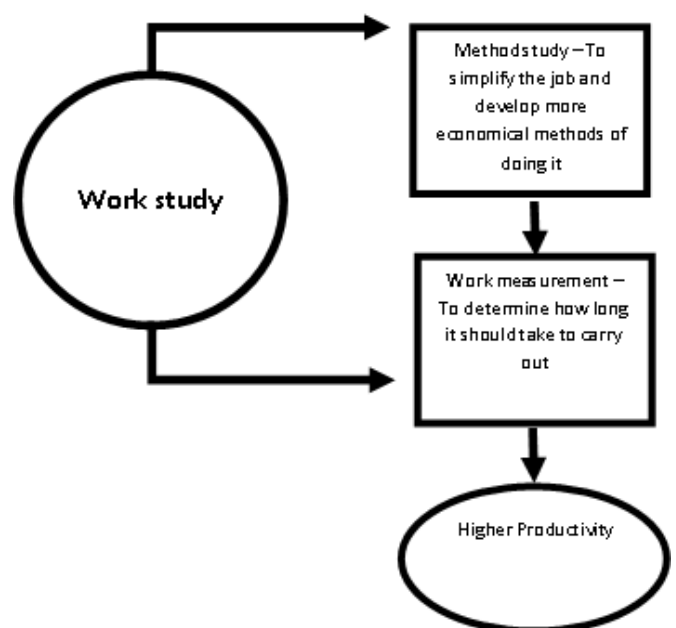


Figure 1: Work study

**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.

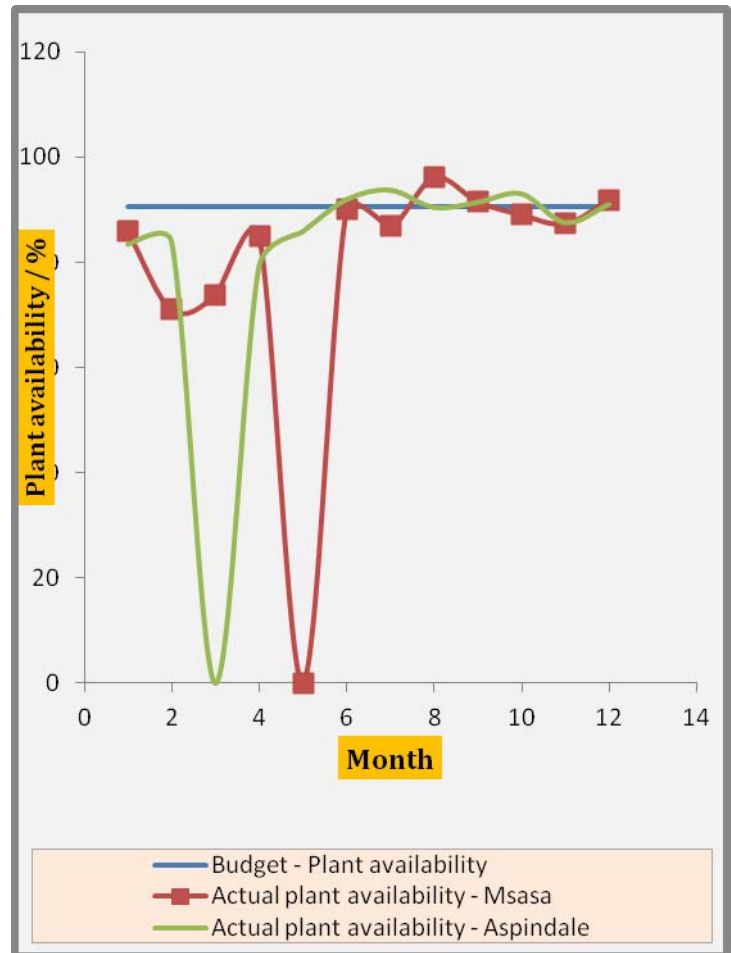
Improved maintenance management systems will help to reduce downtimes which lead to low operating costs hence reducing product price thereby improving the competitive advantage.

There are a number work study techniques such as ergonomics, operations research, work study and time-and-motion 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 between maintenance and ergonomics

Maintenance Management principle	Benefits of ergonomics and maintenance management (intersection)	Ergonomics principle
Scheduled <b>planned maintenance actions</b>	<i>Increased productivity</i>	Promotion of <b>effective maintenance work processes</b>
Enhancing equipment <b>reliability</b> and improving on plant availability by way of inspecting, testing, reconditioning a system and replacing worn components	<i>Increased efficiency</i>	Design of <b>effective maintenance work processes</b>
<b>Inspecting, testing and reconditioning</b> a system at regular intervals. Inspections, test results and a reconditioned system will help in producing quality product.	<i>Improved quality</i>	Providing on-going <b>feedback and follow-up</b> . 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	<i>Reduced downtime</i>	Providing competency based training and design of effective maintenance

reduce stoppage time		processes help to reduce stoppages
Preserving and enhancing equipment reliability by replacing worn components before they actually fail. Employees are motivated if the plant is running smoothly and reliably	<i>Improved employee morale</i>	Provision of competency based training and promoting health and wellness. A trained and healthy employee is well motivated to execute their duties.
Enhancement of equipment reliability and plant availability by way of equipment checks, oil changes, lubrication, painting, cleaning and adjusting, partial or complete overhauls at specified periods to reduce stoppages. Employees are motivated when the plant is running and good quality product is coming out.	<i>Reduced turn-over and absenteeism</i>	Effective work processes, provision of competency based training and promotion of health and wellness helps to keep employees in their work places. Employees feel motivated to work in well coordinated and effective maintenance work processes design



**Figure 2:** Expected response if preventive maintenance was applied

Assumptions

10-15% increase in productivity

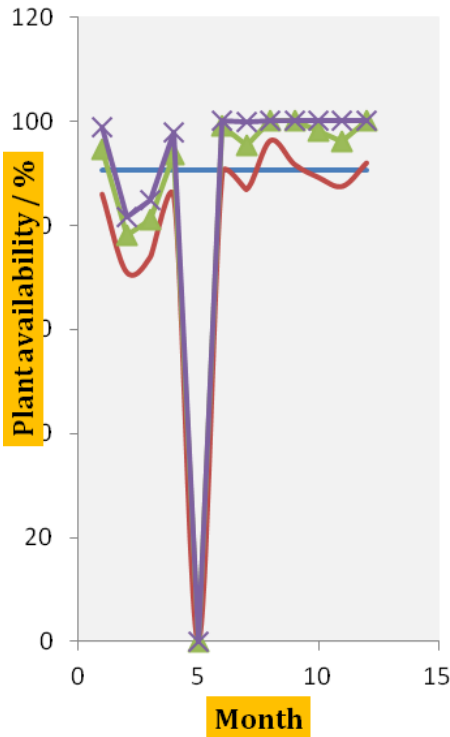
All other operating conditions remain constant

#### 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**

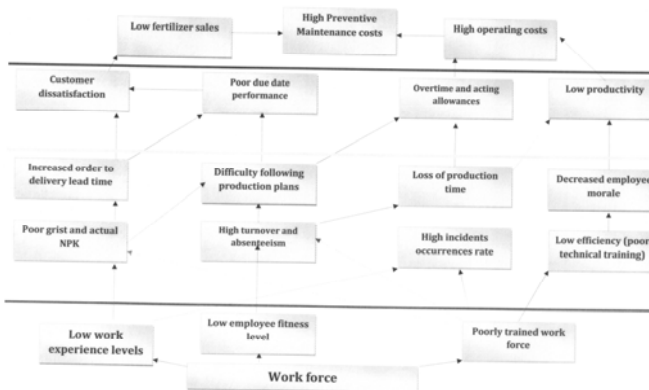


— Budget - Plant availability  
 — Actual plant availability - Msasa  
 ▲ PM implementation through ergonomics response Msasa - 10%

**Performance Index 2**

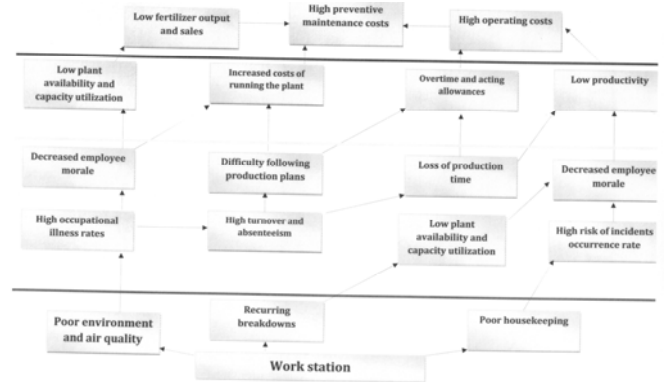
**Effect of work force on fertilizer manufacturing process**

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.



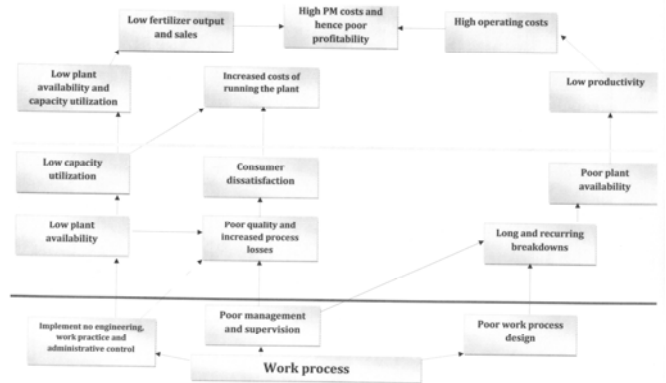
**Performance Index 3: Effect of work station design on fertilizer manufacturing process.**

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.

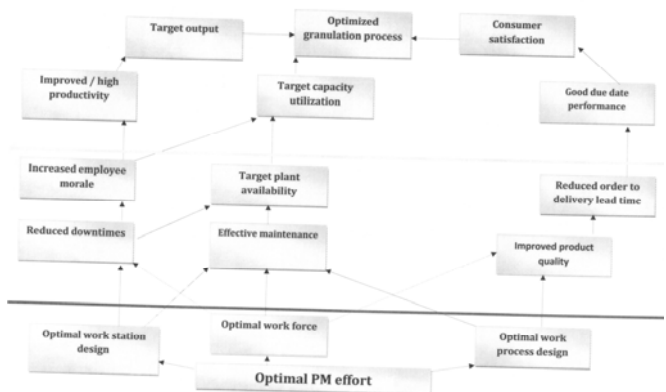


**Performance index 4: Effect of work process design on fertilizer manufacturing process.**

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.

**5.1 Recommendations for Engineering Section**

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

- ✓ Work force
- ✓ Work station
- ✓ Work process

### Author Profile

**Mutombozana T** is a Process engineer at a fertilizer company in Zimbabwe.

**Chikuku T** did Bsc Mechanical Engineering Honors and Masters in Manufacturing Systems at the University of Zimbabwe, He is currently teaching mechanical Engineering design at the University of Zimbabwe.

**Mugwindiri K** did Bsc Mechanical Engineering Honors at the University of Zimbabwe, and Masters in Manufacturing Systems at Cranfield University, England. He is currently teaching Engineering Management at the University of Zimbabwe.

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