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**AN ANALYSIS OF THE EFFECTIVENESS OF THE
ASSET MAINTENANCE PLAN AT SPOORNET:**

**Case Study: Class Diesel Locomotives
(Traction and Rolling Stock)**

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THE PENINSULA TECHNIKON

BELLVILLE

An Analysis of the Effectiveness of the Asset Maintenance Plan at Spoornet:
Case Study: Class Diesel Locomotives (Traction and Rolling Stock)

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by

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An Analysis of the Effectiveness of the Asset Maintenance Plan at Spoornet:
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DECLARATION

Hereby I Hendrik Petrus De Wet Vorster declare that this is my own original work and that all sources have been accurately reported and acknowledged, and that this document has not previously in its entirety or part been submitted in order to obtain an academic qualification.

Signature Hendrik Petrus De Wet Vorster

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ABSTRACT

Maintenance of locomotives is the main function of Bellville Locomotive Traction Depot in the Western Cape. Therefore, it is important to have a sound maintenance plan in place, to prevent a negative impact on the availability and reliability of locomotive supply for hauling power to train services.

The purpose of the research is to determine the causes of the increased frequency of maintenance through a case study relating to 35-class locomotives. The abnormal increased frequency of wheel change and inter-bogie control repairs on 35-class diesel locomotives is investigated.

A research survey was adopted, which included questionnaires and personal interviews based on the literature search. The target group is L&N section, which includes below-deck maintenance, overhaul and change out, repairs to locomotive bogies, frames, wheels, snubbers, inter-bogie control and traction motors. Sixteen people are responsible for all below-deck repairs and service of 52 locomotives.

The results of the research will expose the shortcomings of the maintenance plan and propose solutions. This will be achieved by testing the effectiveness of the existing maintenance plan at Spoornet through the identification of the causes for the abnormal increase in wheel changes and inter-bogie control repairs on 35-class diesel locomotives.

The outcome from this case study research will be to quantify the benefits arising from the effective application of a maintenance plan.

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GLOSSARY

The definition of the following terms and concepts will be referred to regularly in the text and is included hence for ease of reference.

Preventive failure: The term refers to the examination of the component at a set time thereby monitoring the condition of wear to the part.

Bogie frame error: The term refers to deviations from normal conditions, example, a cracked frame or a twisted frame due to derailment.

Construction accuracy: This refers to the way the inter-bogie control is manufactured and assembled (put together) in the factory or workshop.

Workload: The term refers to the amount of defective locomotives with failures to components that was placed for the day for the division under research (back shop)

Heavy-duty road: The term refers to the division where heavy or big repairs are done to locomotives. Normally required lifting the locomotive off its bogies. (the components are big weigh a lot, therefore “heavy-duty road”).

CHAPTER 1

PURPOSE OF PROPOSAL

1. INTRODUCTION

Maintenance is a process where equipment is kept in their original condition and that restores the production function after equipment and machinery have broken down in order to prevent further breakdowns. These maintenance functions either repair or replace the defective units to restore the production process. All machinery or equipment is subjective to wear due to continuously moving components. The industrial environment can cause equipment and machinery to wear more quickly, and hence more maintenance is required. Maintenance is one of the largest costs in the total operational management function of the Bellville Locomotive traction depot in the Western Cape and should be strictly managed so as to remain within budget.

The electronic costing system reflects the increased frequency of maintenance of 35-class locomotives by registering the abnormal expenditure on material and labour costs. The Sprint System, a management operational electronic application asset movement data-capturing tool that detects and monitors assets performance, reveals abnormal downtime for certain locomotives. This had a negative impact on the availability and reliability of locomotive supply for hauling power to train services.

The purpose of the research is to determine the causes of the increased frequency of maintenance through a case study relating to 35-class locomotives. The research

approach that was adopted will be a survey, which will include questionnaires and personal interviews based on the literature research.

The anticipated results of the research will expose the shortcomings of the maintenance plan and propose solutions.

To achieve the foregoing, this document will provide the background to contextualise the research project as well as attempt to explain the following:

- The concept of maintenance;
- The research problem;
- The purpose of the research;
- The research objective;
- The case study;
- The approach and methodology; and
- The significance of the research.

2. BACKGROUND

Locomotives are located in the Traction Spoornet, a Division of Transnet, which includes locomotives, trucks and wagons. The train service department hires the locomotives from the Traction Division to haul their freight and passenger trains on a daily basis.

The locomotive wheels run on a rail track in various shunt yards as well as on branch lines and mainline routes while hauling heavy freight and commodities for clients. The environment varies for different routes, which has a different wear

effect on the wheels. Certain routes have many curves and mountain passes, which increases the load on the wheel flanges that wear with the load. This load is in turn transferred to where the curve angle is the largest. The inter-bogie control acts to assist in minimising wear on the wheel flanges.

Severe wear on wheel flanges is dangerous and can cause an accident through the derailment of the locomotive. Therefore, there is a need to test the existing scheduled maintenance programme for locomotives so as to assess the effectiveness of reducing the failure of these components.

In view of this high frequency of wear and maintenance of components, Jain (1997:65) raises some interesting questions concerning production in relation to maintenance such as:

- Are the workers capable of working with new machines, new processes and new designs, which may be developed in the future?
- What new plant, equipment and facilities are needed?
- What are the basic facts about each product (for example, cost structure, quality control and work stoppages)?
- Does production perform its part effectively in the manufacturing of new products?
- How flexible are operations?
- What is the Budget constraint per section of operations?

In the Spoomet environment the importance of workers being trained in all departments of tool technology usage in order to perform the job is stressed. If the workers are not familiar with all the tools and equipment in operation, the result could be injury on duty, which could be very costly for the organisation. The knowledge to operate machinery is not the only requirement. Workers must also know the procedures and the specifications for each operation. Furthermore, control and supervision over workers who operate dangerous equipment or tools while performing their duties are also required.

William D. Perreault, Jr. and E. Jerome McCarthy. (1996:303-304) is of the opinion that customer service guarantee is becoming more common to attract and retain customers. There is a greater risk in offering a service guarantee with a physical product, as a service breakdown can lead to high expenses. When customers collect on a guarantee, the company can clearly identify the problem. The problem can then be addressed and rectified so that it does not recur.

In the Traction Division it is important to supply reliable locomotives to our clients. If the locomotive fails in the section or on a train, this has enormous consequences for train operations. The client's freight or the passengers do not arrive at their destinations on time. This produces a negative image and undermines the public's faith in the train services as a reliable means of transport.

Pycraft, M. Singh, H and Phihlela, K. (1997:698) states that failure originates as some kind of human failure. Failures are not the result of a random chance, because humans are usually the cause. The implications of this are that failures can be controlled and organisations can learn from these failures and modify their

behaviour accordingly. Pycraft et al (1997:698) refers to failure as an opportunity concept. The “culprit” who is to be blamed and held responsible is not the issue, but the opportunity to examine why the failure occurred and implement procedures that will eliminate or reduce the probability of it recurring.

It is always difficult to prevent failures from occurring in any environment, as production and maintenance plants do experience breakdowns of equipment and machinery due to wear and tear of moving parts, or due to ageing.

The Industrial Revolution generated a secondary industry that is geared to the maintenance of machines and equipment. The information revolution has arrived as an avalanche of ever-increasing technological complexity, with an ever-growing pressure for higher productivity. Because of the profit motive, there is a constant rise in the level of the requirements of the manufacturing companies.

When pressure is placed on workers to increase production in certain areas, the risk is that the quantity as opposed to the quality of a product becomes paramount. In the locomotive environment the same applies to the workers, who must increase productivity to get the locomotives back to normal operational status and availability. Normal operational status is regarded as the most critical period of the maintenance process and operational tasks, as the workers do not keep within the standard procedures as prescribed by the maintenance plan because they feel pressurized to honour the due dates.

According to Flanagan and Finger (2000:311) it is better to include quality measures and then adjust the out of synchronization processes as required. Very

often it will cost more to fix a problem than to prevent one. One of the Total Quality Management (TQM) principles is the continuous assessment of processes and the adjustment of those that appear to be out of synchronisation. Rather take preventive than corrective measures. TQM addresses quality at the mission and strategy stages. TQM emphasises the elimination of mistakes and waste while working, such as cutting back on unnecessary memos, files, photocopying, eliminating time-consuming meetings or preventing mismatching staff and tasks.

Quality workmanship plays a big role in the availability of the locomotives in the Spoomet environment. Whenever a locomotive fails in the section, the reliability factor decreases. Train services are receiving more complaints from the public (clients) and business is lost due to unreliable consignment time arrival. Quality control is a good tool to help minimise costs due to bad maintenance outputs. Therefore, it is important to have a sound quality system in place so as to deliver a quality product – locomotives, in Spoomet's case.

Technology is advancing at a tremendous speed and changes are very rapid and therefore the need to keep up with the latest available information on equipment and components and the training of workers are essential.

Before a training plan can be developed, the existing needs must be determined. However, poor performance does not mean training will provide the answer. Other problems could include lack of motivation, aged equipment, poor supervision, and/or defective skills and inadequate knowledge.

Griffin (1996:345) refers to training as teaching operational or technical employees how to do the job for which they are hired. Development refers to teaching managers and professionals the skills needed for both present and future jobs. Most organizations regularly provide training and development programmes for managers and employees.

No company can afford not to have a training programme in place. This is because technology changes daily and competitors may therefore gain the competitive edge and niche advantage in the marketplace. But a training programme must be evaluated after it has been completed. Follow-up analysis should be undertaken to ascertain if the training material has been communicated correctly to employees at all time.

3. NORMATIVE EXPLANATION OF MAINTENANCE

The normative explanation of maintenance is aimed at providing a better perspective on, and understanding of, what maintenance entails.

Maintenance refers to the process of the restoration of non-current or capital physical assets to their original condition reference. Maintenance inevitably incurs cost and for this reason it is necessary to pay attention to minimising these costs. Maintenance is also related to profitability through equipment output and equipment running costs. It also raises the level of equipment performance and availability. If proper maintenance is sometimes neglected, it may cost the business dearly after a certain period, with a negative impact on profitability, availability of locomotives and service delivery to customers. The objective of the business is to

achieve the optimum balance that maximizes the division's contributions to profitability.

Machinery and equipment that are in poor condition because of inadequate maintenance can fail at any stage. Therefore, it is very important for machinery and equipment to be properly maintained so as to eliminate all the disadvantages that faulty machinery and equipment could hold for the business.

Maintenance may be presented as the operation of a pool of resources (human resources, spares and equipment) directed towards controlling the level of plant availability. The resources are divided between preventive maintenance where equipment is kept in their original condition. For the implementation thereof the equipment is required to be taken off-line (which might include design, maintenance and modifications) and corrective maintenance that restores the production function after equipment and machinery fail or fall behind acceptable conditions, while in operation.

There are several types of maintenance plans in use in various industries:

- Statutory maintenance (required by legislation);
- Preventive maintenance (generally manufacturers' requirements);
- Corrective maintenance (breakdowns); and
- Deferred and backlog maintenance (information is derived through a comprehensive facilities audit).

The functions, objectives, planning and control are explained below under separate headings.

4. THE FUNCTION OF MAINTENANCE WORK

According to Kelly and Harris (1978:4) maintenance can be considered as a combination of actions carried out in order to replace, repair, service (or modify) the components, or some identifiable grouping or components of a manufacturing plant in order to continue to operate to a specified availability for a specified time. Therefore, the function of maintenance is to control plant availability.

The units can be in one of a number of states:

- In production (available working);
- Waiting for repair, undergoing preventive maintenance, undergoing repair (unavailable working).

Preventive or corrective maintenance is to ensure the movement from the unavailable (failure) state to the available (repair) state.

The maintenance department is not always responsible for the causes of low reliability due to poor maintenance of equipment; only the engineering department can remove the problem by a redesigned maintenance plan.

Kelly and Harris (1978:6) define preventive maintenance as that operation which is carried out at predetermined intervals and intended to reduce the likelihood of

equipment's condition falling below a required level of acceptability. This action reduces the effects of equipment unreliability. Preventive maintenance can be time-based and/or condition-based and may, for its implementation, require the equipment to be taken off-line. The development of a preventive maintenance programme is a difficult management problem and will be examined in this Research Study.

Kelly and Harris (1978:6) define corrective maintenance as that operation which is carried out when equipment fails, or falls below acceptable conditions, while in operation. Downtime arising out of failure can consist not only of the time taken to complete the repair (repair time) but also of delays due to lack of resources or information. Repair time is a function of maintainability, management methods and engineering techniques. Therefore, time spent waiting for repairs is a function of the organization of maintenance of resources and information.

5. MAINTENANCE OBJECTIVES, PLANNING AND CONTROL

The maintenance-production situation involves factors related to objectives, strategy and control, which are essential for maintenance work. Failures are due either to poor preventive maintenance, malfunction or poor design.

Kelly and Harris (1978:8) state that there are short periods when the rate of failure exceeds the rate of repair and this results in items queuing for repair. In practice the queuing situation is complicated by the wide variety of corrective maintenance works with different repair priorities.

To ensure that the resources are utilized in the best way possible, it is necessary to establish a maintenance objective, a maintenance plan and a suitable maintenance organization. According to Kelly and Harris (1978:9) in view of the complex and ever-changing nature of the maintenance problem, it is not only necessary to establish a plan and an organization but also to set up a control system to ensure that the plan and the organization are continually updated.

For a more detailed overview of the locomotive maintenance plan refer to Chapter 4 p65 and Annexure A.

6. RESEARCH PROBLEM

The research problem to be addressed has been formulated as follows:

The abnormal increased frequency of wheel change and inter-bogie control repairs on 35-class diesel locomotives impact negatively on service delivery.

7. PURPOSE OF THE RESEARCH

In view of the problem statement formulated above, the following research purpose has been formulated:

- To test the effectiveness of the existing maintenance plan at Spoomet through the identification of the causes for the abnormal increase in wheel changes and inter-bogie control repairs on 35-class diesel locomotives.

To achieve the above purpose, the following two objectives have been defined:

Objective 1

- To determine the effect of incorrect data capturing and record keeping during maintenance repairs on the failure of components and the wastage of material.

Objective 2

- To identify the benefits of an effective application of the maintenance plan.

8. EXPLANATION OF THE CASE STUDY

In order to achieve the research purpose, a case study approach was adopted so as to describe the existing application of the maintenance plan and thereby observe and identify the causes of the problems explained above.

The study has been undertaken at the locomotive depot off Caledon West road in the Bellville yard complex, Cape Town. Traction is a division of Spoornet that maintains diesel and electric locomotives so as to provide a reliable service.

There are ninety-one (91) allocated Diesel locomotives to Bellville locomotive depot, which are hired out to train services for hauling power for their freight and passenger trains. The locomotives haul loads between various shunt yards, as well as branch lines and main line traffic. The section under research is the back shop (heavy-duty road) L&N section, which includes below-deck maintenance, overhaul

and change out, repairs to locomotive bogies, frames, wheels, snubbers, inter-bogie control and traction motors.

Sixteen people are employed in the back shop department and are responsible for all below-deck repairs and service of fifty-two 35-class locomotives.

The composition of the staff is as follows:

1 technical supervisor;

8 diesel electric fitters;

5 trade hands;

1 process worker; and

1 general worker.

9. RESEARCH APPROACH AND METHODOLOGY

The purpose and the objectives will be addressed by means of a case study as explained above.

Unstructured interviews

The case study focused directly on the problem area, where the responses of all the respondents were gathered and recorded for analysis. The information was obtained directly from this selected research group. Direct contact was derived essential for this case study approach.

Questionnaires

The methodology utilised included interviews, discussions and questionnaires as well as focus group discussions with the workers and supervisor in the back shop heavy-duty department section for validation purposes.

The questionnaire utilised for this study included nominal, ordinal and open-end questions that would allow respondents to review their responses.

Questionnaire design

The structure of the questionnaire was designed and divided into four sections.

- Section one: Supervision;
- Section two: Expertise (experience & knowledge);
- Section three: Training; and
- Section four: Reference to Maintenance Manual.

The questionnaire included clear instructions to the respondents that also assured anonymity so as to promote reliable and unbiased answers.

Selection of respondents

The respondents included all sixteen employees located in the back shop (heavy-duty road) L & N section.

10. MANAGEMENT OF THE RESULTS

The historical statistics (records) were analyzed and compared with present statistics (records) regarding the increased failure of the identified 35-class locomotive components. The information was obtained from the maintenance application data-capturing system, known as Sap/R3 (46b version). The recorded failures and the material cost reports were processed for analysis so as to determine trends. Recommendations were made accordingly. The trends were compared with the trends after the recommendations had been implemented so as to determine impact.

The comparison identified significant differences in determining causes for possible errors. Errors may result in incorrect or inaccurate impact data, inappropriate or inaccurate analysis procedures, or unrepresentative validation data.

Other data were gathered by means of information from research literature published and unpublished. Further information was obtained from electronic sources, books, magazines, articles, encyclopaedia and the media.

11. THE SIGNIFICANCE OF THE RESEARCH

The significance of the study is relevant for the following reasons:

- The section employees will be trained and equipped with the right skills, tools, methods and procedures to do the maintenance tasks according to the asset maintenance plan.
- Fewer failures and less material wastage will be experienced, which will result in an increase in revenue due to less downtime as a result of locomotives being out of service.
- Respondents will be able to participate in a survey where they can make a difference to the problem they experience at present.
- There will also be less expenditure on overtime, parts, material and new tools.

12. ASSUMPTIONS

The following assumptions have been factored in:

- The respondents do not understand the concept of budgeting;
- There is no motivation among respondents in the back shop;
- Respondents are very complacent with task execution, and

- The maintenance plan does not seem to be effective for back shop task execution.

12. PLAN OF STUDY

The time allocated for the different stages in the research process will be presented in broad terms and the research document will consist of the following:

- Chapter 2: This chapter will provide an overview of operational management, with special reference to maintenance.
- Chapter 3: An explanation of the case study will be provided in this chapter.
- Chapter 4: An overview of the existing maintenance programme in Spoomet will be provided (“Rolling Stock Environment”).
- Chapter 5: The research analysis will be provided.
- Chapter 6: The findings and conclusions of the research will be presented in this chapter.
- Chapter 7: Recommendations based on the findings and analysis will be made.

CHAPTER TWO

OPERATIONS AND INFORMATION SYSTEM MANAGEMENT WITH REFERENCE TO MAINTENANCE

1. INTRODUCTION

This chapter will explain information processing and operations management from a decision-making perspective. Further discussion for the remainder of this chapter will deal with the provision of information and related data for management, decision-making, and operational activities. In order to stay competitive, modern business organizations (companies) must be productive and effective. Productivity and effectiveness in any organization can be attained through proper management. A brief overview of the nature of management is provided so as to place the discussion in context.

2. THE NATURE OF MANAGEMENT

Management, as we know it today, is essential in all lifestyles. Especially in modern business organizations, a lack of proper management would result in operational losses and such organizations would probably cease to exist. Without proper management, standards of living would drop considerably.

Griffin (1993:5) states that management is a set of activities (including planning and decision making, organizing, leading, and controlling) directed at an organization's resources (human, financial, physical, and information) with the aim of achieving organizational goals in an efficient and effective manner. Efficient

refers to use resources wisely and without unnecessary waste. Effective refers to do things successfully.

Griffin (1993:6) defines a manager as someone whose primary responsibility is to carry out the management process. In particular, a manager is someone who plans and makes decisions, organizes, leads, and controls human, financial, physical and information resources.

Lay, P.M.Q. Eccles, M.G. Julyan, F.W. and Boot, G. (1997:4) stress that since resources are needed to create goods and services, it is clear that the role of management is vital, not only for each organization, but also for the country as a whole. In view of the foregoing, the explanation of management theory is provided so as to place the discussion in context.

3. MANAGEMENT THEORY

Griffin (1993:30) defines management theory as a conceptual framework for organizing knowledge and providing a blueprint for action, and guiding management toward their goals.

Lay et al (1997:4) mentions that in business organizations, management is involved in seeking goals and objectives. It does this by using resources in various ways. This requires managers to get things done.

Chase and Aquilano (1992:5) define operations management (or production decisions that influence other people's behaviour towards management, as it is often called) as the management of the direct resources required to produce the goods and services provided by an organization.

Lay et al (1997:4) identifies six management functions to be performed in an organization, which pursues goals and objectives. These cannot be achieved without managing material and human resources.

The management functions are:

- *Planning*. Selecting goals, objectives, and defining policies, procedures, and programs for achieving them. These activities should guide future decision-making.
- *Organizing*. Grouping the activities to be performed, and establishing organizational structures and relations to carry out these activities.
- *Staffing*. Selecting and training people to work within the organisational structures.
- *Directing*. Leading, guiding, directing, and motivating people in the organization.
- *Co-ordinating*. Scheduling activities in proper sequence and communicating information to and from various levels within the organization.
- *Controlling*. Measuring performance and reporting deviations from planned results. Regulation and correction of activities or adjustments to policies, procedures and programs, where necessary.

All management functions involve decision-making on the part of the manager. Decision-making is, in fact, the most important contribution that a manager can make to an organization.

According to Lay *et al* (1997:5) decision-making by management takes place at three levels: *strategic planning*, *management control* and *operational control*.

- *Strategic planning* develops a strategy with which a business organization will attempt to achieve its objectives. The time range for strategic planning tends to be fairly long and does not necessarily have to occur on a regular basis. Some strategic planning will, however, be scheduled into the annual planning and budgeting cycle.
- *Management control* (which includes tactical planning) involves the measuring of performance, deciding on control actions, formulating new decision rules to be applied by operating personnel, and allocating resources. The time range for management control is shorter than that of strategic planning and decisions have to be made on a more regular basis.
- *Operational control* is the process of ensuring that operational activities are carried out effectively and efficiently. It utilizes predetermined procedures and decision-rules and therefore a large percentage of the decisions can be programmed. The operating decisions and resulting actions generally cover short periods and tend to be very regular. In view of the foregoing, the decision-making process undertaken by managers will be explained.

4. DECISION-MAKING BY MANAGERS

Lay et al (1997:5) states that decision-making should be seen as a process and not as an act that happens in a passing moment. In many cases decision-making can take a considerable amount of time. They recognize a number of steps that managers normally follow systematically when making decisions.

These are:

- *recognizing and defining a particular problem;*
- *determining alternative courses of action for solving the problem;*
- *evaluating the available courses of action and selecting the best one for solving the problem;*
- *using the selected course of action in solving the problem; and*
- *monitoring the activity to ensure that the desired results are obtained.*

In short, decision-making involves:

- *intelligence* (knowledge or information regarding a problem);
- *design* (inventing, developing and analyzing possible courses of action); and
- *choice* (selecting and implementing a particular course of action).

Therefore all steps involved in decision-making require information, and no decisions can be taken without timely, accurate and meaningful information.

Lay et al (1997:6) stresses the importance of looking at the organisational structure of a business enterprise before going into systems and processes for the provision of management information.

A brief overview of organizational theory is provided so as to place the discussion in context.

5. ORGANIZATIONAL THEORY OVERVIEW

A business organization is a collection of decision-making units that exist to pursue certain business objectives. Every business organization operates as a system, which accepts, *inputs* (resources) and transforms them into *outputs* (goods and services). A manufacturing concern, for instance, uses raw material, labour and other scarce resources and transforms them into items such as motor cars and other consumer products that are subsequently sold in order to make a profit.

According to Lay et al (1997:6) any organization is made up of at least three kinds of interrelated elements:

- *First*, there are the resources or productive factors, which have to be controlled. In business organizations, these are normally *people, materials, machines* and *money*.
- *Second*, there are the specific activities that an organization carries out in order to attain required results. In business organizations, these might be *manufacturing, marketing, personnel management* and *financial management*.

- *Finally*, there are management activities, which include *setting objectives, developing and executing plans, and evaluating the results.*

Normally all activities of an organization are carried out under the direction of managers. Therefore organizational theory adopts a broad perspective of how management fits into an organization. The same source identifies numerous properties that an ideal organization should have, including the structural relationships among operational functions (such as the division of work and the hierarchy of authority), personnel management, and processes for communicating information in order to get unified actions from specialist employees.

A formal organizational structure as a hierarchical arrangement of the various functions within the organization is described in this source. It specifies the relationships among these functions as well as the authority delegated to management at the various levels. The principles related to a traditional organizational structure can be described as follows:

- *Division of work.* This refers to the segmentation of tasks or operations and includes the division of managerial tasks. This enables managers and employees to specialize and helps to achieve more effective control over a variety of operations and activities.
- *Authority and responsibility.* This refers to a manager's power to get things done.

- *Authority* is delegated to lower levels of management and the degree of such authority should be related to the manager's assigned responsibility for achieving specific objectives.
- *Unity of command and direction*. This refers to clear lines of authority, with each employee or group that shares the same objectives being directed by one manager.
- *Span of control*. This refers to the number of subordinate managers or supervisors reporting to a superior manager.

According to Lay et al (1997:7) organizational structure can therefore be regarded as the configuration of positions, the allocation of authority and responsibility, as well as the relationships between functions and employees for handling the overall work load. In this context, the operational management process undertaken by managers will be explained.

6. OPERATIONS MANAGEMENT

Thompson, Strickland. (1998:30) defines a company's business as what needs it is trying to satisfy, by which customer groups it is targeting, and by what technology it will use and the functions it will perform in serving the target market.

Management's need for an information system based on the organizational structure of the enterprise is essential for information to be successfully communicated.

According to De Wit and Hamersma (1992:1) operations management was also known as production or industrial management in the past. People believed that only the manufacturing of physical products or goods was referred to when production management was mentioned, therefore it created the wrong perception of the activities involved. The term operations management was implemented to accommodate the wide principle of production management to make provision for a service.

The above mentioned source states that operations management deals with the output of any business, in other words the conversion of input to create certain outputs. The transformation process can result in a physical product, a non-physical service, or a charitable effort. Therefore, operations management plays a role in every market demand that needs to be satisfied.

Operations management are those activities that take place to create products and services, and operations management can also be defined as the management of the direct resources necessary to create the products and services supplied or provided by a business.

De Wit and Hamersma (1992:1) list six factors that relate to direct resources, namely:

- *human resources;*
- *facilities;*
- *processes;*
- *components;*
- *planning; as well as*
- *control systems.*

The source states that operations management is responsible for designing and running manufacturing processes, transporting or supplying goods, and providing services.

According to the above mentioned source the scope of operations management can best be described by means of a model, refer to Figure 1 that reflects the relationship between the following components:

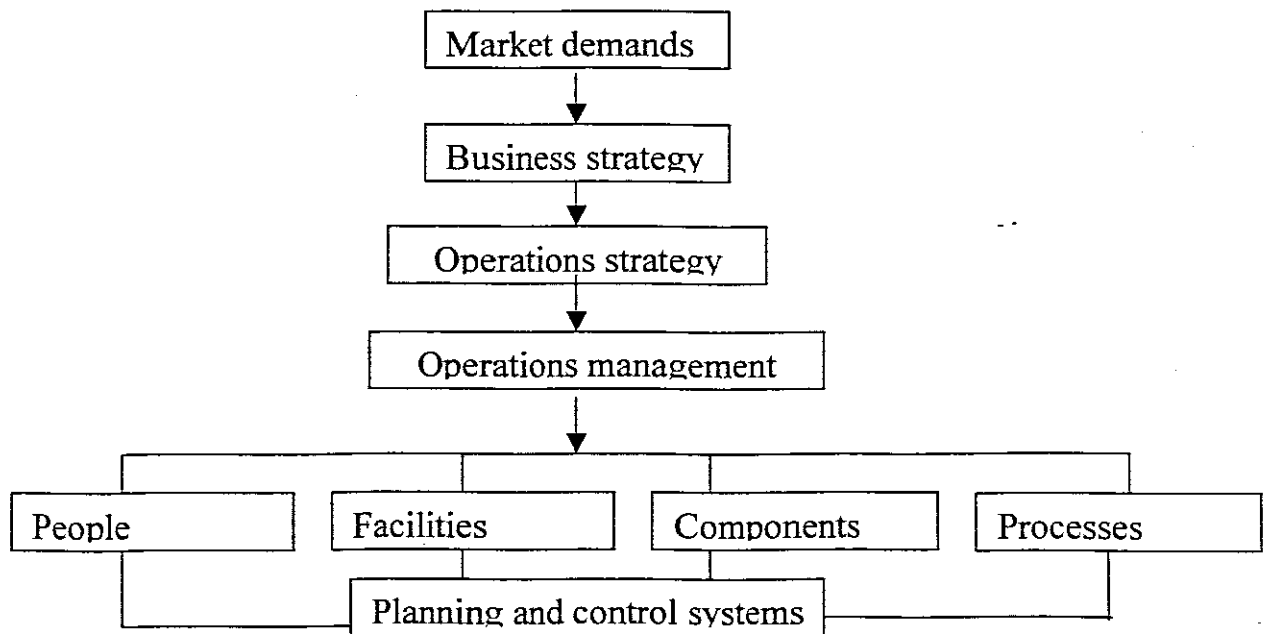
- *market demands;*
- *business strategy;*
- *operations strategy;*
- *operations management; and*

➤ *operations resources.*

De Wit and Hamersma (1992:1) mention that human resources involve direct and indirect labour. Facilities include the plant (a factory or service centre) and equipment involved in the transformation process. The model referred to below includes the following: raw materials, supplies used in manufacturing, the provision of service, planning and control systems and the components and processes.

Management utilizes the planning and control systems to represent the procedures to keep the transformation process on track.

Figure 1: *Operations Management Model.*



(Source: De Wit and Hamersma, 1992.)

According to Chase and Aquilano (1992:6), operations management also deals with the direct production resources of the firm. These resources may be thought of as the five P's of operations management.

The five P's of operations management are listed and explained as:

- *People* – are the direct and indirect work force,
- *Plants* – includes the factories or service branches where production is carried out,
- *Parts* – includes the materials (or in the case of services, the supplies) that go through the system,
- *Processes* – include the equipment and the steps by which production is accomplished, and
- *Planning and Control systems* – are the procedures and information used by management to operate the system.

According to De Wit and Hamersma (1992:2) the environment in which operations management functions consists of:

- *quality* (as measured in terms of product performance);
- *cost-effectiveness* (as measured in terms of low product unit cost);
- *reliability* (as measured in terms of due delivery of orders); and

- *adaptability* (for example reacting quickly to change in output, or new product release).

De Wit and Hamersma (1992:2) is of the opinion that these factors will definitely have an influence on formulating operations management objectives. Furthermore it is also known that a business's strategic focus is determined by its choice of competitive base.

De Wit and Hamersma (1992:5) revealed that the contributions of operations management objectives relate to the creation of a competitive base, and deals with:

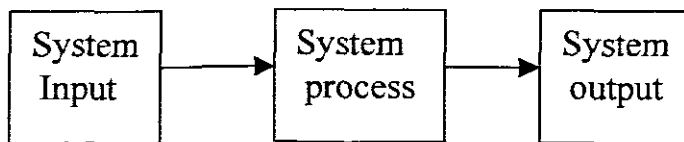
- *product or service characteristics;*
- *the characteristics of the manufacturing process;*
- *the quality of the product or service produced or provided;*
- *efficiency through:*
 - *good employee relations and control over labour costs,*
 - *control over raw material costs; and*
 - *control over the cost of utilising the production facilities.*
- *customer service through:*
 - *producing the correct quantities to meet demand; and*
 - *timely delivery of orders.*
 - *adaptability to ensure future survival.*

The question can now be asked: What is production and operations management?

Stair and Render (1984:2) mention that there are three common textbook titles which reveals different definitions of the three terms: “Production management,” “operations management,” and “ production and operations management.”

In its simplest terms it is implied that “...such a system is one that transforms raw materials and inputs by a certain process or a variety of transformation activities into a desired product”. The product is usually goods or services. The basic nature of a production and operations system can be seen in Figure 2.

Figure 2: A Production and Operations System.

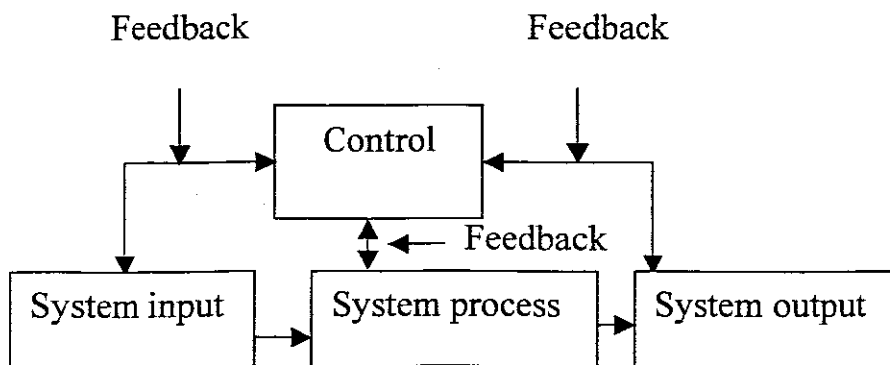


(Source: Stair and Render, 1984.)

Almost all organizations in the private and public sector fit into the category of production and operations systems. Thus, in addition to traditional manufacturing companies, organizations such as hospitals, nursing homes, hotels, and governmental agencies of all types will be considered to be production and operations systems.

The same source states that to obtain the desired goods and services, these organizations have to control production and operations, by monitoring the system and taking corrective action when necessary, as can be seen in Figure 3.

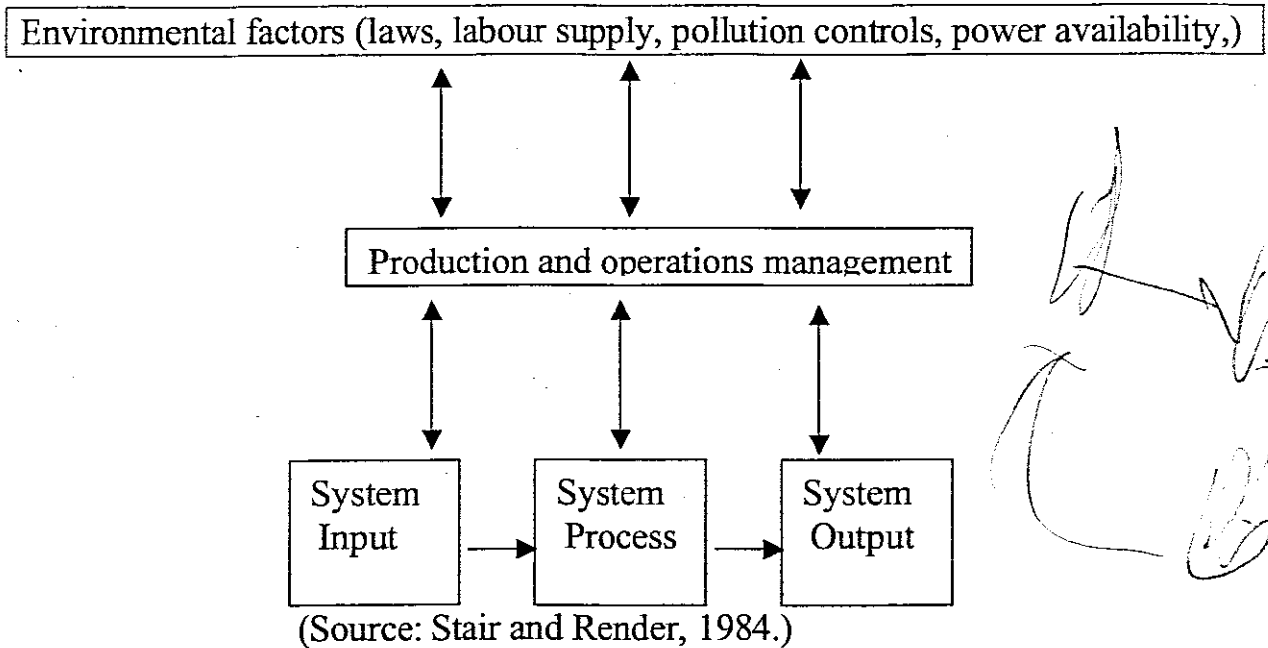
Figure 3: Control System.



(Source: Stair and Render, 1984.)

Figure 4 graphically displays the scope of the field. According to Stair and Render (1984:3) production and operations management deals with problems that directly relate to the design and operation of those resources used in producing goods and services. It is further stated that to manage such a system requires a variety of diverse and sometimes complex analyses. Refer to Figure 4. to understand the context of the system.

Figure 4: Production and Operations Management



Stair and Render (1984:3) reveal that the birth of any operation and production system normally begins with project planning. Management often uses such concepts as:

- *PERT and PERT/Cost;*
- *in addition to computer simulation;*
- *cost-volume analysis;* and
- *financial analysis.*

Stair and Render (1984:3) state that once some of the initial planning has been completed, facility location, transportation methods, layout design, and work measurement are normally analyzed next. It is necessary to explore such problems as inventory control, quality control, and service systems after a production and

operations system has been established.

The same source emphasises that a fully functioning production and operations system requires regular maintenance. Today's most commonly used and discussed tools of production and operations management assist the manager in the design, operation, and control of operations and production systems.

7. NEED FOR MANAGEMENT INFORMATION

As indicated earlier, effective decision-making can only take place with available, accurate information.

Lay *et al* (1997:7) points out that in order to make meaningful decisions, managers need timely, accurate, and meaningful information. The identification of the information requirements for managerial decision-making is one of the most important factors in setting up a modern business enterprise.

The information needs of managers are identified according to their responsibilities, the way in which they are evaluated, the types of problems they face, the means by which they evaluate personal output, and the types of decisions they have to make.

The provision of information is part of the communication function of an organization. Therefore, the information must be in a form the manager can clearly understand and interpret. For communication to be effective, the information

received by managers should have value and stimulate them to make decisions that will assist in achieving the organization's objectives.

As stated by Lay et al (1997:7) management's needs for information can be analysed according to information content, information characteristics, dimensions of information needs, and each manager's individual information needs.

In view of the foregoing, the need for Information Systems is explained, so as to place the discussion in context. Systems that process a business organization's data and provide information to management, are known under various names; for example, data processing systems, management information systems, business information systems, accounting information systems, and others. The objective of an information system is to transform all types of data into information and to provide management with the information they need for decision-making.

Among various definitions of information systems, there is consensus that the purpose of an information system is to provide information that supports management and to add value to the business organization. An information system is therefore an orderly way of providing the information that business organization's needs to operate successfully and make a profit.

Lay et al (1997:7) defines an information system as follows, "...it is an integrated man/machine system for providing information to support the operations, management and decision-making functions in an organization". The system uses computer hardware and software, manual procedures, management and decision models, and a database. As information costs money to create, maintain, and use,

the information system should justify that cost by providing specific, identifiable benefits to the organization.

Information should have some substance, for instance, number of units sold during the previous week, or the number of units expected to be sold the following week. The content of information can be valued relative to its usefulness in making specific decisions.

In view of the foregoing, the information characteristics are explained.

In addition to specific content, information has certain characteristics, which influence the quality of decision-making. Significant information characteristics include the following:

- *The relevance of the information to the decision situation or to the organization's goals and objectives;*
- *The reliability and precision of the information;*
- *The currency of the information;*
- *The scope of the information;*
- *The degree to which numeric values can be assigned to the information; and*
- *The degree to which the information is summarized or aggregated.*

An explanation of Dimensions of information needs is provided so as to place the discussion in context.

According to Lay et al (1997:7) the dimensions of information needs vary considerably in relation to managerial activities, managerial levels, organizational structures and operational functions. By analyzing information needs along these lines, one can obtain a better understanding of the requirements of individual managers. The definitions are:

➤ *Managerial activities*

According to Lay et al (1997:8) planning relates to the comparison of alternative options, whereas control highlights the comparison of actual results against planned results. Because of these differences, the information content necessary for planning decisions will be different from the information content necessary for control decisions.

In addition to information content, the characteristics of information necessary for strategic planning would differ from that needed for tactical planning. Similarly, the characteristics of information needed for making decisions regarding management control would differ from that needed for making decision regarding operational control.

➤ *Managerial levels*

Lay et al (1997:8) concludes that managers at different managerial levels have varying needs for information. Managers at higher levels make decisions regarding strategic planning and therefore they need information that has been summarized or aggregated, with a broad scope and a long-range perspective. Managers need

many different kinds of information, including qualitative, quantitative, internal, and external information.

Lay et al (1997:8) mentions that middle management may need both summarized and detailed information, depending on the situation at hand. For instance, in making decisions regarding management control, a sales manager may need summarized and quantitative weekly reports concerning the performance of branch managers. On the other hand, in making decisions regarding tactical planning, a plant manager may need information concerning the coming week's production workload together with the availability of labour and money.

Managers at the lower levels, make decisions regarding operational planning and control and therefore they need detailed, accurate, timely, and quantitative information.

➤ ***Organizational structures***

Lay et al (1997:8) is of opinion that business organizations are usually structured according to operational functions and product lines. Information needs may vary in accordance with such structures, especially at middle-management levels.

➤ ***Operational functions***

Lay et al (1997:8) mentions that each operational function will need its own distinctive information in accordance with its assigned responsibilities. The financial manager, for instance, needs information regarding cash flow, financial status, and operating results.

The same source states that it can also happen that two or more operating functions share certain information needs and that the sales forecast which contains the basic information for preparing budgets, for instance, can also be used in decision-making concerning production scheduling and the acquisition of materials.

According to Lay *et al* (1997:9) the unique requirements of individual managers will depend largely on the types of decisions to be made, the level on which they operate, and the operational functions they perform. The same source states that a manager's personal background (such as education and experience) will also influence the type of information needed.

In view of the foregoing, it is stated that every business organization needs *information to support its management functions*. In an uncertain and demanding society, the managers of modern business organizations need new and improved ways of managing human and economic resources. It is mentioned that they do not need more data; they need better information, which consists of data that have been filtered, analysed and compared.

Managers face new problems, therefore their information requirements change accordingly. They also have personal differences. It is pointed out that whether managers ask for new information or better access to existing information, the information system should be able to respond quickly to these changing requirements. Different presentations, associations, and summaries of data can sometimes lead to new insights for management.

Three basic information requirements were identified that a business information system must fulfil. Firstly, the system must provide for the internal information needs of management. Secondly, the system must provide management with information for controlling business activity. Finally, the system must provide information for external reporting to various individuals and organizations.

The same source also reveals that management needs an information system that can provide information regarding the past, the present and the future. It is also stated that historical information relates closely to the need to record and process routine business events. The same source confirms that regarding the present, management needs to know who is responsible for the various assets, where each asset is located, what should be on hand and the events that are taking place.

According to Lay et al (1997:9) current information may prove to be especially meaningful when compared with information from previous periods, budgets or standards. It is stated that current and historical information can also be used to project future events or outcomes and to perform meaningful planning.

As indicated earlier by the mentioned source an important aspect of any information system should be its ability to provide management with information for effectively controlling business activities. It is mentioned that although the need for information for control purposes is part of management's internal information requirement, it differs, since control depends on factors such as the assignment of duties and organizational relationships. In order to operate the business effectively on a day-to-day basis, timely, and accurately, and meaningful information must flow from the information system.

An information system that enables management to control performance, and at the same time measures and motivates it, will always be very important for managers. It is stated that most respectable information systems contain a reporting system known as *responsibility accounting* and confirms that this enables expenditure at all levels of management to be controlled and related to the individuals responsible for it.

Furthermore, according to Lay et al (1997:10), the information system should also provide information to individuals outside the organization and confirms that much of the information for external requirements can be derived from data used for internal information needs. A major burden on South African businesses is imposed by the requirements of external users such as stockholders, investors, creditors and government. In view of the foregoing, management information systems will be explained so as to place this content in context.

8. MANAGEMENT INFORMATION SYSTEMS (MIS)

According to Pycraft et al (1997:281) what is important, is the way in which information moves, is changed, is manipulated and presented so it can be used in managing an organization. Although a management information system (MIS) will involve all elements contained in the above statement, and will form part of the comprehensive information system, its main function is to provide information for strategic management and decision-making purposes.

Systems that are concerned with inventory management, the timing and scheduling of activities, demand forecasting, order processing, quality management and many other activities are an integral part of many operations managers working lives.

According to Lay et al (1997:13) a management information system (MIS) is not purely data processing, although it encompasses certain processing activities it is not computer science. Even though database structure and design require knowledge drawn from computer science it is not management science. Although decision and optimization models are used for decision support, it is not management of human behaviour, therefore MIS designers need a background in organization behaviour for a successful system installation.

Management information systems draw from all these areas and, together with information technology, they are changing the shape and behaviour of most organizations.

According to Lay et al (1997:13) a MIS consists of the following: *physical components* (hardware, software, personnel), *managerial components* (strategic planning, tactical planning and management control, and operational control), or *management support for decision-making*.

Providing management information on a higher level requires much more than simple data processing. For this reason, decision support systems (DSS) are introduced to support, but not replace, the decision-making process. Where DSS's are closely related to decision-making, they depend on information management as well as data processing.

Over the years there has been a progression from *data processing* to *information management* to *decision support* to *expert systems*.

Lay et al (1997:14) also mentions another issue associated with management information is the use of knowledge bases. A knowledge base contains facts, rules, inferences and procedures.

Through the use of a knowledge base, it is said that managers are able to make decisions related to a particular domain or expertise; for example authorization of credit card purchases.

To support the above Lay et al (1997:14) identified and listed five basic elements of information systems: *people; machines; procedures; databases* and *control*.

➤ *People*

People, the most important element in an information system, play many roles at various levels within the system. Managers and other personnel should be the prime beneficiaries because information systems are designed to meet their information requirements.

➤ *Machines*

Modern information systems are distinguished by the presence of computers. Although people are still as necessary to computer-based systems as they were

before, their roles have changed from doing routine work to making decisions based on system inputs and outputs.

➤ ***Procedures***

Procedures in the information system use both computer-based and non-computer-based knowledge, models, and personnel to ensure that the correct data are entered into the computer, and that they are then properly transformed, communicated and used. Procedures include all processing and information flow activities, computer programs, and program specifications.

➤ ***Database***

The processes of collecting, storing, processing and transforming data into meaningful information for use in making decisions are central to the information system. In a computer-based system, data must be accessible to, and compatible with the computer system. A formalized database is the foundation upon which such an information system should be built.

➤ ***Control***

Each information system requires an element of control, which relates to the interaction between all the other basic elements (people, machines, procedures and the database). Information systems require measurement, feedback and adjusting mechanisms for cost-effective performance.

An extensive overview of principles for the design of information systems is provided so as to place the discussion in context. According to Lay *et al* (1997:15)

a system principle is the basis for the design of an information system that will produce the required results.

If an information system is to provide management with timely, accurate and meaningful information as well as a means of planning, organizing, directing, coordinating and controlling effectively, the applicable systems principles will serve as a guide to designing, developing and operating such a system.

Lay et al (1997:15) also mentions that systems principles can, in many respects, be compared to accounting principles. Whereas accountants have for many years devoted attention to the statements of accounting principles, systems practitioners have over the years worked on developing systems principles.

Nine principles for the design of an information system are suggested. Each of them has a significant impact on the major aspects of systems analysis, design, development and implementation, and operation.

- *Reasonable cost.* The system should provide information and internal control, consistent with the requirements of management, at a reasonable cost.
- *Effective reporting.* The system should provide for effective and extensive reporting, both internally and externally, since reports are a primary systems product.
- *Human factors.* The system should take into account human factors, requirements, and priorities, since people are responsible for the effectiveness and ultimate success of the system.

- *Organization structure.* The system should function in a specific, clearly defined, organizational structure. It should be developed according to the structure of the business in order to satisfy its particular information and control needs.
- *Reliability.* The system should be able to check the reliability and accuracy of financial and other data, minimise error, safeguard assets, and prevent fraud or other irregularities.
- *Flexibility, uniformity and consistency.* The system should be flexible, yet ensure reasonable uniformity and consistency of application in order to allow business operations to run smoothly.
- *Audibility.* The system should facilitate the tracing of procedural steps in order to permit the analysis and scrutiny of detailed data underlying summarized information.
- *Database.* The system should enable the rapid and efficient recording and classification of data so that they can be transformed into meaningful information for planning, control, and administration.
- *Data processing.* The system should provide for meaningful, continuous and controlled processing of data in order to produce reliable information and facilitate control.

The reasonable cost principle is probably the most important one, because the system provides all the needs required by management.

Furthermore, Lay *et al* (1997:16) states that the database, data processing, and reporting principles govern data and information flow throughout the organization. The proper application of these systems principles should produce an optimum business information system.

The design and development of an information system will also satisfy the needs of all users although it seems to be a complicated task. It is clear that during the design and development processes various disciplines and other issues come into play.

When the different foundations on which a successful comprehensive information system is built is taken into account during the design phase, this task should not be too difficult.

The following factors (foundations) as identified by Lay *et al* (1997:16) should then be considered when designing a comprehensive information system:

- *Management functions;*
- *Quality of information;*
- *Design principles;*
- *Financial accounting principles and practices; (based on generally accepted accounting practices) - (GAAP)*
- *Management accounting practices (which include cost accounting and management accounting models); and*

➤ *Audit and security principles.*

9. CONCLUSION

The relationship between the different foundation factors is very important for information design strategies. All the elements of management information systems play a very important role, as can be seen from all the references from various sources. Operations management cannot be without an information system.

Therefore, managers play a big role in the success of a company by utilizing all the information which was obtained from the data being computed and extracted by an electronic data capture programme system. As indicated effective decision-making can only take place with available accurate information. Managers must obtain correct reliable data to comply with effective decision-making processes.

CHAPTER 3

EXPLANATION OF CASE STUDY

1. INTRODUCTION

This chapter will provide an overview of Transnet Ltd. as well as an explanation of Spoomet, which is a division of Transnet so as to provide an insight into its operations, purpose and functions.

Spoomet also has various sub business divisions. Traction is one of the business divisions where the case study is located. The physical location of the case study is the Bellville Locomotive depot in Cape Town (Western Cape region).

2. OVERVIEW AND HISTORICAL DEVELOPMENT OF TRANSNET

Transnet Limited is a public company of which the South African Government is the sole shareholder. Transnet is the holding company behind South Africa's largest transport businesses and consists of the following eight divisions:

- *Spoornet;*
- *Port Authority;*
- *Port Operations;*
- *Freightdynamics;*
- *Petronet;*
- *Metrorail;*
- *Propnet; and*
- *Transtel and number of related and support businesses.*

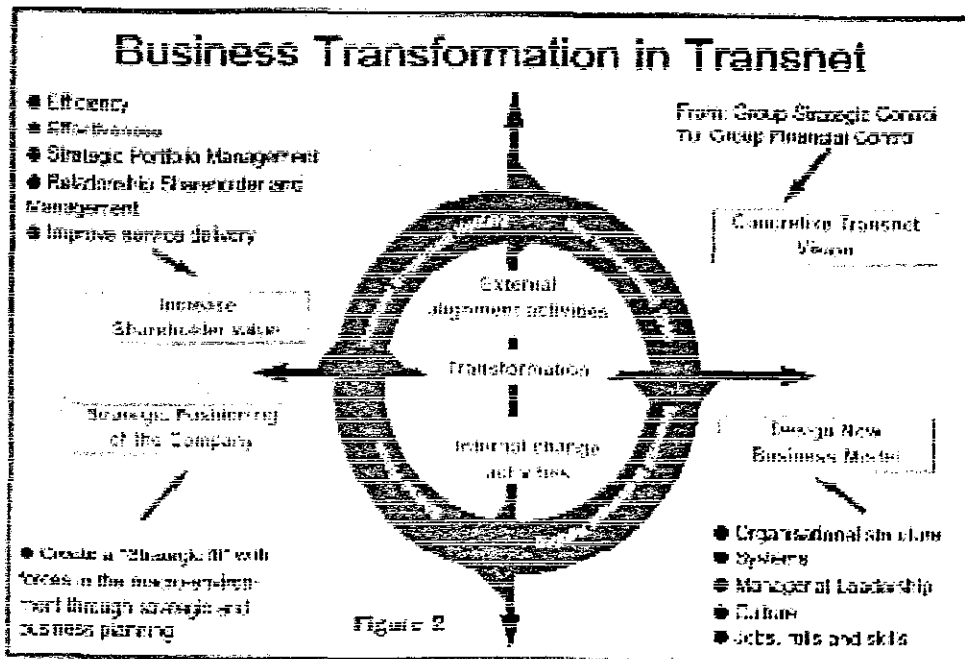
In total Transnet Limited is worth approximately \$7 billion in fixed assets and has a workforce of approximately 90 000 employees.

Transnet has transformed tremendously in the last 110 years commencing in 1891 when the railway from Cape Town to Bulawayo was formally opened. In 1902 the railways of the two republics, Transvaal and Orange Free State, were placed under civil administration known as the Central South African Railways. The South African Railways and Harbours (SAR & H) was founded in 1910. In 1931 Parliament approved the operation of the air transport industry and the South African Airways was established in 1934 as part of the SAR & H. In October, 1981 the name SAR & H was changed to the South African Transport Services, In April 1990 it subsequently changed to Transnet Limited.

A continual cycle of assessment, planning, implementation and evaluation takes place within and across domains. Changes in one domain enable and facilitate changes in other domains, which in turn require new changes.

Transnet also entered a new phase of transformation (refer to [Figure 5](#)) driven by the appointment of new top management in 1996. The new top management gave strategic direction and clarity to the development of Transnet's Vision, Mission and core Values.

Figure 5: Business Transformation.



(Source: Platform One, March 2001.)

The shared vision process followed it in 1997 that resulted in the establishment of the Divisional Boards and new Corporate Architecture. The new Corporate Governance was finalised in 1997/98. A strategic decision was also taken that the strategic end state of Transnet, would be a financial investment holding company to be established in 2004.

To complete the overview of Transnet the mission statement, vision statement and values are provided below.

VISION STATEMENT

Transnet's transformation is aimed at achieving its vision namely:

"Transnet is a transformed world class company that enables its businesses to lead their competitors and positively touches the lives of all South Africans".

MISSION STATEMENT

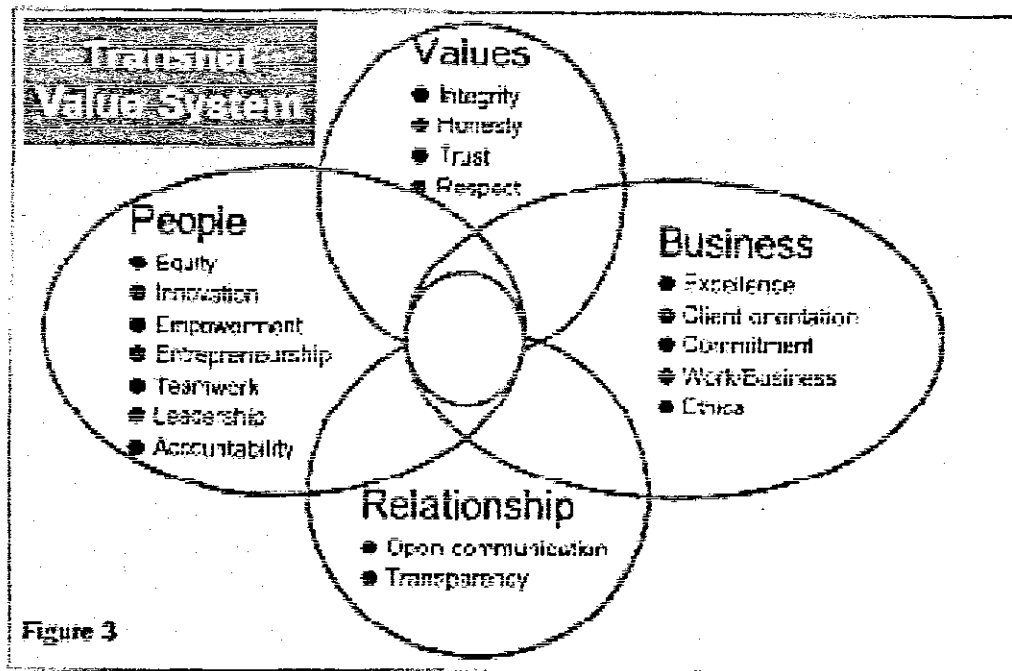
The mission statement results as follows:

"A transport and related services company that focuses on the movement of goods, people and information for customers in the freight, passenger and related services industries".

TRANSNET VALUES

An overview of the value system is explained by means of a diagram below: Refer to Figure 6.

Figure 6: Transnet Value System.



Platform One • March 2001 • 11

(Source: Platform One, March 2001.)

SPOORNET

Spoornet, the largest railroad in Southern Africa, is committed to a vision of being a leader in freight logistics solutions whilst simultaneously contributing to the ideals of South Africa.

In 1997, Spoornet was restructured into a customer driven business. Spoornet is a process-driven business, focused on delivering freight logistics solutions (FLS) to customers. Through FLS, Spoornet can deliver a holistic product, levered from

freight transport - core competency - and from rail - core investment - with the commitment to champion supply chain management. More importantly, through joint ventures, and alliances with customers and other service providers Spoomet strives towards transforming the freight sector into an effective and efficient logistics management industry.

Spoomet's Sales and Marketing division is grouped into 15 industry based freight transport sectors, which form mining, heavy manufacturing and light manufacturing divisions. FLS require absolute predictability, consignment care, responsive customer service, quality commercial processes and enhanced value. Predictable service can only be provided if a system of freight reservation is in place, which makes arrival time management possible when all the role players participate in the system.

Spoomet attempts to be customer driven and the entire planning and execution process is based on a proactive understanding of specific customer service requirements. Spoomet has adopted a service design, an all-encompassing assessment activity, with each customer so as to ensure that customer's requirements will be met with certainty.

Furthermore Spoomet is actively developing tools that will harness customer knowledge and contact. Relationship marketing is utilised, as the basis for all marketing initiatives, which can however only succeed in a culture of service excellence.

Freight protection, one of the core requirements of a customer and a fundamental part of the FLS process, is addressed in the Freight Protection Policy.

Spoornet has invested in information technology and systems that enable proactive changes to train schedules, within a one week window to adapt resource allocation to the customers need for the following week.

Vision

Spoornet, a division of Transnet, is a South African company and has adopted the vision of being a global leader in Freight Logistics Solutions, contributing to the ideals of South Africa, and to be a driving force behind Africa's economic renaissance. Spoornet attempts to achieve this by utilising their knowledge and experience of freight logistics, arrival time management and added value services.

Mission

The business mission of Spoornet is interalia to provide freight logistics solutions in local, regional and world markets so as to create wealth and prosperity for their stakeholders.

3. STATISTICS

A brief overview of Spoornet statistics is provided so as to place the discussion in context. The information will provide the context for the research study as well as

an understanding of the case study in general. The vital statistics for Spoornet are reflected in the subjoined schedule of Figure 7.

Figure 7: Spoornet Vital Statistics.

| Spoornet Vital Statistics January 2000 | |
|--|-----------------------------------|
| Freight Wagons | 123 750 |
| Locomotives | 3 549 |
| Track km | 30 600km |
| Route km | 20 070km |
| Freight Tonnage | 183 million metric tons (1998/99) |
| Net ton km | 102.8 billion (1998/99) |
| Passenger Wagons | 1 848 (March 1999) |
| Mainline Passengers | 4.6 million Blue Train Passengers |
| Blue Train Passengers | 7 540 (1998/99) |
| Turnover | R9.1 billion (Estimate 1999/2000) |

(Source:

http://intra.spoornet.co.za/intranet_changes/bus_philosophyv2/fl_solution2.htm.)

Spoornet operates strictly according to their set annual budget. Material wastage and time management (working overtime) are two of the most critical aspects of

costing (expenditure). These elements are strictly managed to eliminate excessive expenditure.

Other unpredictable elements which are also strictly managed by Spoornet that have a huge impact on the budget expenditure are: fuel price increases and Rand/US Dollar exchange rate deterioration; unforeseen weather conditions; incompetent staff; change management strategies regarding operation activities (maintenance plan-component replacement); and restructuring of business units.

Planning and Technology, a subdivision of Spoornet has eight business sectors within its structure. The locomotive environment within traction maintenance at Bellville locomotive depot is the research area that is addressed in the case study.

The main depot business function is to supply reliable and affordable locomotives for hauling (traction) power to train services. The sub function is to strive for maintaining the allocated fleet locomotives in a working condition so as to be successful as a business unit. The full depot staff strength is approximately 242 people, who represent two division's, namely electric locomotives and diesel locomotives. The diesel division personnel strength is approximately 147 employees.

Spoornet, Traction, Bellville Locomotive depot budgeting was as follow: Review, June 2001. Figure 8 hereunder shows the depot budget for financial year 2001 (12 monthly period). The total budget for the financial year 2001 and various financial accounts are shown in Figure 8. The period concerned is from 1 April 2001 to 30 June 2001.

Total budget expenditure for the first three months amounts to R 4 327 076.95 compared to the total annual budget of R 13 524 822.00. The material budget for the first three months of the financial year amounts to R 85 336.57 compared to the total annual budget of R323 992.00. The material expenditure is also high for the first three months.

The labour cost (71FLR): productive hours expenditure for the first three months of the financial period amounts to R4 047 313.09

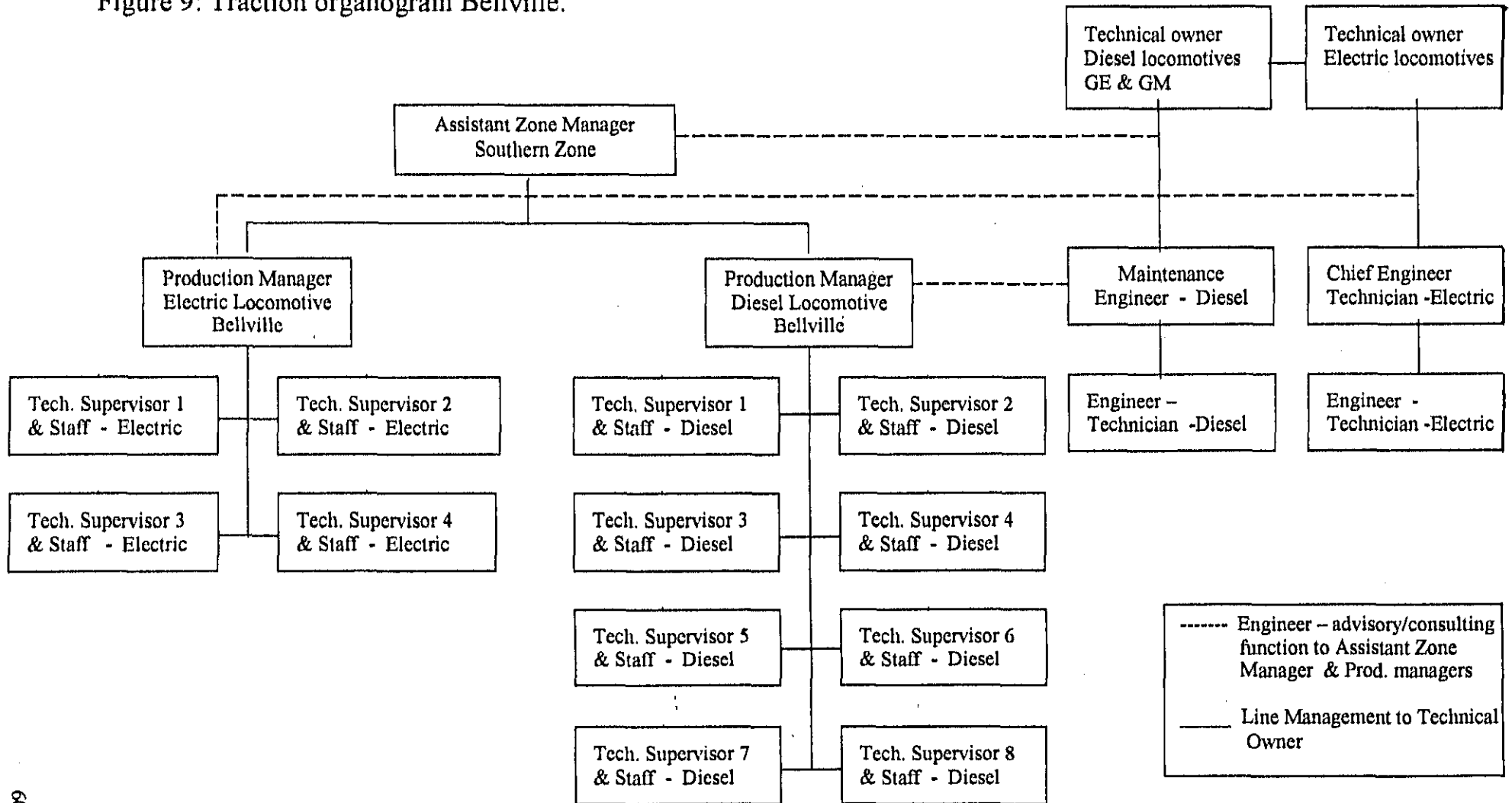
Figure 8: Spoornet Traction, Bellville Audited Results.

| Spoornet Traction, Bellville Audited Results 2000/2001: Figure 8 | | | | |
|--|-------------------------|-------------------------|--|-------------------------|
| | Actual Rm. 1999/2000 | Budget Rm. 1999/2000 | Actual Rm. 01 April 2001 to 30 June 2001 | Budget Rm. 2000/2001 |
| Total Budget | | | 4,327,076.95 | 13,524,822.00 |
| Material Budget | | | 85,336.57 | 323,992.00 |
| Labour Budget: Salaries, Wages & Privileges | | | 3,675,997.20 | 10,967,957.00 |
| Labour cost (71FLR): Productive Hours Worked | | | 4,047,313.09 | 11,207,940.90 |
| Operating Expenditure | | | 4,327,076.95 | 13,524,822.00 |
| Net Profit (loss) | | | 279,763.86 | 2,312,876.10 |

(Source: Sap/R3: 46d)

The Traction organogram at the Bellville Locomotive depot is shown in Figure 9.

Figure 9: Traction organogram Bellville.



(Source: Belville Depot Spoornet Organogram Structure.)

In Figure 9 the line functions of the management is explained hereunder:

Assistant Zone Manager supervises all the functions performed in the locomotive depot.

Production Manager is responsible for keeping expenses within the budget, discipline, safety and that the assets are maintained in perfect condition. He is also responsible to see that the customers are satisfied with the service provided.

Technical supervisors are responsible for discipline and supervising the maintenance of the locomotives in their original condition.

Staff consists of technical, administration and financial personnel. The technical staff services and repairs the locomotives. The administration personnel are responsible for filing and data capturing. The financial personnel is responsible for payment of accounts, purchases and sales.

4. CONCLUSION

The research provided the necessary findings relating to the identified problems. Analysis of the information would facilitate the formulation of recommendation.

The transformation of Spoomet into a customer driven business must be communicated to all workers in the depot. Material wastage and time management need urgent attention to eliminate over expenditure. The production staff must communicate the defects found with locomotives to the engineering staff, so as to create a preventive maintenance plan where there is a need for such a service. Operating expenditure must be addressed to bring cost down, all the roll players must operate as a team in the strive for a zero defect service (less failures overall).

CHAPTER 4

EXISTING MAINTENANCE PROGRAMME AND PROCEDURES WITHIN THE ROLLING STOCK ENVIRONMENT AT SPOORNET.

1. INTRODUCTION

The purpose of this chapter is to explain in detail the existing maintenance management procedures, processes and content of the maintenance plan.

Various procedures and methods have been implemented, including a maintenance plan to keep expenditure within the budget. Yet there is an increase in the failure rate of locomotives due to components not performing to their full manufacturing specifications. The locomotive components were designed to perform a specific task over a certain period of time before they have to be serviced or replaced due to wear and tear.

The failure of diesel components has caused numerous production, maintenance and organisation difficulties, which is reflected in the increased maintenance costs and in the low availability of locomotives. (Refer to Chapter 5, 4. BACKGROUND TO RESEARCH PROBLEM (p80) and Figures 11 – 16)

The engineering management (fleet owners, depot maintenance engineer and engineering staff) are responsible for the formulation of the maintenance processes and procedures for maintaining the diesel locomotive fleet. The system plan includes methods, policies, mapping of work, instructions and the information path for the maintenance and overhaul of diesel locomotive components.

The maintenance plan should minimise production costs and identify problems that may occur during the maintenance availability cycle (time period between services within the cycles).

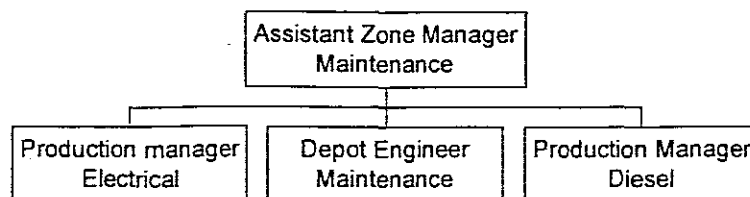
2. DIESEL LOCOMOTIVE MAINTENANCE

The maintenance engineer should analyse and implement a preventative action plan by implementing adjustments to the existing maintenance process and procedure policies where problems arise within the availability cycle.

The maintenance engineer should also discuss the findings with the assistant zone manager and the production managers in order to communicate the recommended improvement to the existing maintenance plan and policies. The production manager also analyses and communicates problems, which cause component failures in locomotives.

In view of the foregoing, a diagram is provided to explain the structure.

Figure 10: Maintenance management staff.



(Source: Depot structure design.)

The unavailability of locomotives results in trains being cancelled or it forces other locomotives to be assigned to freight trains. Arrival times are affected and the customers must be informed of the delay in the planned arrival time of consignments. This hampers the image and mission statement of Spoornet, namely to deliver and supply a reliable logistic freight solutions in local, regional and world markets to all their stakeholders.

A standard costing policy has been set for the minimisation of direct costs (labour, spares, and equipment) for diesel locomotive maintenance as 85% (availability of diesel locomotives per day). In other words, 45 locomotives out of the total fleet of 52 locomotives must be available for train service utilisation (to haul freight and passenger trains).

This is also regarded as the accepted level for maintenance costs. (The sum of the direct maintenance costs and the cost associated with unavailability of locomotives). Since maintenance service dates must be pre planned, it is necessary to have realistic available dates on which to base future service requirements.

The production maintenance sector and train execution services plan their Schedule maintenance work ahead so as to utilise all resources (employees, spares and components).

Maintenance policy

The maintenance policy was formulated and based on the production and operating methods, platform service environment and the location of the situation (for

instance, the demand for diesel locomotive power for train service requirements). The daily (fuel) service and repair policy is to carry out work in the quickest possible way, which entails the direct substitution of assemblies, sub-assemblies (parts) and small component of diesel locomotives.

Due to the difficulty and cost for transporting components and parts between platforms in the workshops and outside warehouses, the local warehouse \$146 [\$ = store] (supported by sub-stores \$153 and \$003) has been located on the locomotive depot premises close to the production area on the locomotive depot.

The preventative maintenance policy is based on servicing and overhauling components of diesel locomotives. All repairs identified as a result of service inspections are carried out immediately, or as soon as possible (provided that there is space on the platform to accommodate locomotives)

Overhauls involve a complete or half strip-down and rebuilding of the diesel locomotive components. The frequency is determined by operating fuel consumption, fixed time-based period and cost trends (failure of components, locomotive out of service). The diesel locomotives status are represented as; in operation (available); or in service repair and overhaul (unavailable) or awaiting maintenance attention (unavailable).

Reconditioning of components form part of the support maintenance system which is necessary to help maintain the diesel locomotive fleet. Storage of overhauled spare parts (components) is necessary to support the maintenance activity. The availability of spare assemblies saves time and keeps costs down due to the direct

exchange of failed components. There are no extra time (overtime) and cost involved for total downtime of defective locomotives, thus avoiding time lost to production.

The maintenance plan covers various types of preventative maintenance service activities. Various services are incorporated into the maintenance system, which consist of categories A-Type, B-Type, C-Type and Major Inspection services.

In view of the foregoing, the categories of the service inspections are explained:

A-Type Service: (Inspection)

The A-Type Service covers the basic service activities required to last until the next cycle (fixed time cycle of 45 days) to execute a basic inspection for worn components

B-Type Service: (Inspection)

The B-Type Service inspection covers (fixed time cycle of 135 days) combines activities from the A-Type and B-Type Service maintenance policy.

C-Type Service: (Inspection)

C-Type Service inspection covers A-Type; B-Type and C-Type (fixed time cycle of 270 days) service activities: Refer to Annexure D for a full explanation.

Major-Type Service: (Inspection)

Major service inspection covers A-Type; B-Type; C-Type and extra tasks (fixed time cycle of 540 days). Tasks are executed as per maintenance policy (major service form) which is formulated and constructed by depot engineer and fleet owner. The service consists of fixed time and conditional maintenance as well as modifications, major component change out and overhaul of components as per form.

Data capture and Schedule systems

Monarcs (Sap/R3-46b) maintenance application electronic system also schedules locomotive service dates. The depot engineer creates all the PM orders for the various major activities as per maintenance plan. (Refer to annexure D.)

The research will be concerned mainly with the maintenance plan problems of the heavy-duty workshop area (back shop). This is confined to the 35-class diesel locomotive fleet, which consists of 52 locomotives.

The Locomotive Service process undertaken in the heavy-duty workshop area is explained in terms of the tasks to be undertaken:

Below-deck section

All of the above-mentioned services cover the below-deck section, which is the responsibility of the heavy-duty workshop supervisor and staff.

Schedule A-Type Service

The A-service personnel do the inspection during the unavailable stage when the locomotive is placed on No. 8 road for its schedule A-Type service inspection.

Planning Office: Locomotive status change process

Planning office staff change the locomotive states on the maintenance application electronic system, (also known as Monarcs Sap/R3-46b) from available status to unavailable status. A production order is created to enable the production employees to execute their tasks. The order is released and issued to workshop employees.

Process for capturing wheel data sizes

The back shop staff takes the wheel readings as per special design maintenance form, to capture the wheel sizes and wear limits.

The fitter uses a special design wheel profile gauge to capture the data on the wheel report form. The gauge reads the wheel angle, radius and height profiles. If the profile tolerance of the wheel sizes is out of specifications, the back shop supervisor will analyse the data recorded on the form and make a decision accordingly.

Supervisor decision taking

The supervisor will take corrective action according to the deviation of the wear pattern. This may require that either the wheel angle must be ground with a machine (angles wrong), wheel interchanges affected (heights) or undertake a complete bogie replacement (change out).

If wheel interchanges or complete bogie changes are required, then the A-Type service will be completed initially, before the locomotive is moved to the back shop workshop area. The supervisor of the back shop will complete and hand in a request form for the non-scheduled work to be undertaken (Mon-01). Planning office personnel will only change the locomotive's status from schedule status to non-schedule status on the Monarcs system, after receipt of the Mon-01 form. The planning office personnel will now create a non-schedule PM Order on the Monarcs electronic data capture system for the back shop personnel to perform the non-schedule work.

Movement of Locomotive

The back shop supervisor will request the planning office to place the defective locomotive in the back shop, either on number 12 or 13 road (position of rail line into shed) to do the repair work. Either the planner or the caretaker will contact the senior shed man to arrange for the locomotive to be moved from platform number 8c position to number 12 (a, b, and c) or 13 (a, b, and c) road. Abbreviations a, b, and c represents the position on the platforms. Position (9a) represents the first space on the service road, 9b, the second, and 9c the last position on the service

road (rail line). After the locomotive is placed on the requested position for repairs, then the back shop staff will start to do the necessary stripping and loosening of various components so as to lift the locomotive off its bogie frames and wheel sets.

Task execution process

Components to be removed are as follows:

- sand pipes and brackets;
- inter-bogie retainer bracket;
- traction motor power cables;
- all safety hook bolts and brackets;
- traction motor air ducts;
- axle alternator cable, unit with retainer bolts;
- odometer unit and retainer bolts; and
- bolster safety brackets.

Locomotive body lifting from bogies (under carriage)

Locomotive lifting requires two x 42ton overhead cranes to lift the body from its bogies, which requires two crane operators as well. The locomotive body is placed on four pedestal stands while work is completed on the two sets of bogies.

Stripping of bogies

The bogies are stripped in accordance with a set procedure as defined by the maintenance policy. When the bogie frames are stripped from the traction motors, they are placed on specially designed iron pedestals (four per bogie frame).

Wheel bay activities

The traction motors are transported to the wheel strip bay by means of the overhead crane and placed in the wheel bay on a special stand to separate the wheels from the motors. The defective wheels are changed out in the wheel bay by a qualified fitter and trade hand staff.

Stripping and assembling of wheels

There is a special procedure for the stripping and assembling of the wheels from the traction motors. Special caution must be taken with the measuring of the precise tolerance sizes between the wheel journal and suspension-bearing cap (gap). The tolerance sizes must be taken before and after tightening of the suspension-bearing caps to ensure the correct fit and free play of bearing to wheel journal surface.

Lubrication of wheel gears

The wheel journals are lubricated by means of special grade oil through capillary action from a specially designed felt wig. The oil prevents the journals from overheating and causing a hot suspension-bearing failure. The wheel gear meshes firmly in the traction motor pinion gear, which drives the wheel during the power excitation process. A special lubrication called crater (compound) is used to lubricate the wheel gear and traction motor pinion during operation. The crater prevents wear on gears as well as overheating of gears due to the high rate of revolutions (wheels turning) per minute during normal operating conditions.

Test run of motors

A test run is performed on traction motors after the wheels have been rebuilt into the traction motors. The motor runs at a certain number of revolutions per minute (r.p.m.) to check for binding and to distribute the crater evenly into the gear-case for correct operation.

Reassembling of bogie and wheels

The complete motor sets are now rebuilt and secured into bogie frames according to set procedures and processes in the maintenance plan. The inter-bogie control mechanism can now be fitted to the bogies according to maintenance procedure and processes.

Re-fitment of locomotive body on bogies

The body can now be lifted with the two overhead cranes and replaced on the bogies and secured according to maintenance procedures and the process plan. The fitting procedure is the reverse of the strip process.

Starting locomotive to perform electric tests

After everything is coupled and secured, the locomotive is started and a block test is performed according to standard procedures and policy in the maintenance manual. If no defects are detected during the various tests, the locomotive is returned to traffic (fit for normal operation).

Communication between back shop supervisor and planning office

The back shop supervisor contacts the planning office staff and advises them that the locomotive is ready to be released for traffic (planner / caretaker). The planner / caretaker contacts the shift technician and senior shed man to have the locomotive placed at the daily pits to be examined and inspected in order to roadworthy the locomotive for traffic.

Document flow process

The back shop staff must record their time on the Mon-03 form provided with the order to capture all the hours worked on the locomotive. The Mon-04 form must also be completed to state the actual defects detected, the date and time started and finished as well as the repair codes captured to help the planning office to complete all data on the non-schedule repair order. The completed form must be signed by staff and supervisor to confirm that the locomotive is fit for traffic (status can change on system).

Planning office activity

The planning office receives the completed forms from the responsible supervisor, who collects the completed order forms after the locomotive is daily (quality check performed) and cleared for traffic.

Responsibility of the shift supervisor and employees

After completion of the daily inspection, the fitter completes and signs the daily form and clears the locomotive on the 24-hour logsheet for traffic. The completed non-schedule order is delivered to his supervisor, who is in charge of all completed

order forms in the sheds. The supervisor scrutinises the locomotive and signs the form for correctness and enters the order number in his order logbook.

Communication between shift supervisor and planning office

He then brings the order logbook to the production planning office (PCO). The caretaker signs the logbook to receive the completed order forms.

Production Planning Office employees functions

The caretaker hands the completed order forms over to the responsible person, who creates all the non-schedule orders so as to capture all the data. After the time has been confirmed and the defects captured, the notification is first completed and only then can the order itself be technically completed (only if all the reserved material has been issued to back shop supervisor or employees). The locomotive's status is now changed back on the Monarcs system from unavailable to normal available. The locomotive is cleared on the sprint system as available (move from ZBL to XBL status).

Process for other service activities

The B-Type, C-Type and Major services are done in the main shed area, road number 9 (a, b, and c), 10 (a, b, and c) and 11 (a, b, and c) respectively.

Process for various maintenance functions as per divisions

The back shop staff does the below-deck service according to the maintenance plan process and procedures. When a defect is detected that requires back shop attention, the staff consults with their supervisor, who in turn decides what action

to take. If a bogie change is required, then the locomotive must be moved to the back shop as soon as the scheduled inspection is completed.

Procedure for inter-bogie bush failures

If the inter-bogie control bushes are defective the same procedure is followed to lift the locomotive as with a bogie change, but the difference is that the motors are not stripped from the bogies.

Removal of inter-bogie control assembly

Only the bogies are separated from the inter-bogie control device. The inter-bogie control (IBC) is now free from the bogies and can be stripped and repaired according to laid-down maintenance plan process and procedures.

Inter-bogie control overhaul procedure

The bearings are pressed out with a 50-ton press. The refitting of new bushes is the reverse of the stripping process.

Reassembling of inter-bogie control

After renewal of the defective parts, the inter-bogie control is coupled to the bogies and must be aligned according to laid-down maintenance plan process and procedures. When all adjustments are done and alignment completed, then the locomotive body can be replaced onto the bogies. The securing process of all the loose components is the reverse of the loosening procedures.

Road worthy quality inspection

When everything is tight and secure, the locomotive is started and tested for correct operation. The locomotive is qualified (inspected for roadworthiness – after faults have been repaired) according to the checklist specially designed in the maintenance plan procedure and process.

Communication between shift employees and production planning office

After everything has been tested and found in order (correct), then the locomotive is given for a daily (inspection to qualify for traffic) and cleared (inspected and signed off for traffic) for service and released. The locomotive is transferred to the planning control office for release. The same procedures and processes are used for an inter-wheel change or bogie change.

All the same documents have to be completed for the bogie change as described above. The increase of breakdown and repair times leads to high cost and loss in the availability of the locomotives (availability of locomotives fluctuates at times.) The maintenance plan (policy) is there to schedule all the locomotives that are available for service at a predetermined date and time, and then released again, as they become available after repairs.

Skills and competencies

The maintenance staff in the back shop rotates, which leads to the production time and quality of work suffering in the long run. New members who are rotated are not equipped and trained to perform repair tasks according to maintenance policy plans.

3. CONCLUSION

If a scheduled maintenance plan (policy) is implemented and executed as required, then the breakdown of diesel locomotive components can be reduced to an acceptable level. This will cut down on costs and loss in production time, and increase the availability of components and locomotives at present. There is no scheduled maintenance plan for wheel changes and inter-bogie control assembly mechanism. The policy states that the components are repaired and changed as and when failures occur, either due to wear and tear or when breakage of components occur (wheels and inter-bogie control bushes being the most common).

CHAPTER 5

RESEARCH APPROACH

1. INTRODUCTION

The study objectives and the methodology used in the case study were to obtain and interpret secondary data and primary source data. It was for the purpose of recommending various options, which Spoornet could implement to improve the shortcomings in the existing maintenance plan as well as propose solutions to reduce future failures.

2. IDENTIFYING AND DEFINING THE RELATIONSHIP BETWEEN VARIABLES

Bless, Claire. Smith, Craig-Higson_(1995:29) states that a research problem is expressed as a general question about the relation between two or more variables. It is stated in the form of a question. Bless et al (1995:30) adds that the formulation of a problem introduces the necessity of defining clearly all the concepts used and of determining the variables and their relationships.

According to Bless et al (1995:31) the independent variable is the factor which is measured, manipulated or selected by the researcher to determine its relationship to an observed phenomenon which constitutes the dependant variable. Bless et al (1995:31) points out that the dependent variable is that factor which is observed and measured to determine the effect on it of the independent variable; that is, it is that factor that appears, disappears, diminishes or amplifies - in short, varies - as the experimenter introduces, removes or varies the independent variable.

In view of the foregoing the reasons for failure and the inability to execute the existing maintenance plan are dependent on the following independent variables:

- The inconsistent attitude of the supervisor towards employees;
- Supervisor not equipped with the necessary expertise (qualification and knowledge) to provide assistance;
- Employees not following supervisor instructions during the execution of tasks;
- Supervisor not enforcing quality standards;
- Employees utilize own methods and tools for data collection;
- Utilizing methods and instructions from co-workers while executing tasks;
- Employees sometime use old notebook sizes to record data;
- Insufficient floor space in back shop;
- Insufficient 40 ton cranes;
- Irregular reference to maintenance manual for prescribes tools (when capturing data;)
- Insufficient utilization of all available resources;
- Lack of experience and skills to execute tasks successful;
- Lack of training programmes; and
- Employees lack motivation to deliver quality work.

In order to facilitate the research study, the research instrument was designed and formulated in accordance with the working terms and concepts (jargon) generally understood by all the respondents.

Bless *et al* (1995:41) states that, before being in a position to search for an explanation a certain amount of background information, namely a description of the "object of research", must be gathered. In such a case, the type of research will be exploratory, which is a particular type of descriptive study.

This study investigates the reasons for component failures. However, exploratory research covering the effectiveness of the existing maintenance plan at Spoornet could assist in providing options that could quantify the benefits and reduce the causes of component failure and material wastage.

Validatory research will establish:

- the actual causes for component failure; and
- the main reasons for component failure and the inability to execute the existing maintenance plan.

Furthermore exploratory and descriptive research will establish:

- beneficial solutions that will reduce component failures;

- whether the implementation and application of an effective maintenance plan will be beneficial.

3. RESEARCH DESIGN

Bless et al (1995:63) states that a research design is a programme to guide the researcher in collecting, analyzing and interpreting observed facts. Very often this process is described as research management or planning.

Bless et al (1995:102) points out that the same method of data gathering can be adapted to different types of research, provided that the research design and the way the collected data will be analysed are directly related to the chosen type of research.

The process followed in this particular research involves primary and secondary research, complemented by a non-scheduled structured interview, based on a list of issues that assisted with the formulation of questions to be included in a questionnaire, judged appropriate for the given situation.

4. BACKGROUND TO RESEARCH PROBLEM

As indicated earlier there are ninety-one (91) allocated locomotives to Bellville locomotive depot, of which fifty-two (52) are 35-class locomotives that are part of the case study.

For a more detailed background to the Research Problem refer to Chapter 1, (2. BACKGROUND (p2) and 8. EXPLANATION OF THE CASE STUDY (p12)).

A summarised breakdown of equipment failures is provided so as to substantiate the abnormal expenditure on material and labour costs.

The total inter-bogie control bushes/spring boxes failure amounted to date twenty for the period 01/11/1999 to 13/09/2001. The fact that out of the twenty failures ten occurred in the first seven months of 2001 was a concern. Six of the ten failed between the third and fourth month compared to ten failures in the previous twelve months.

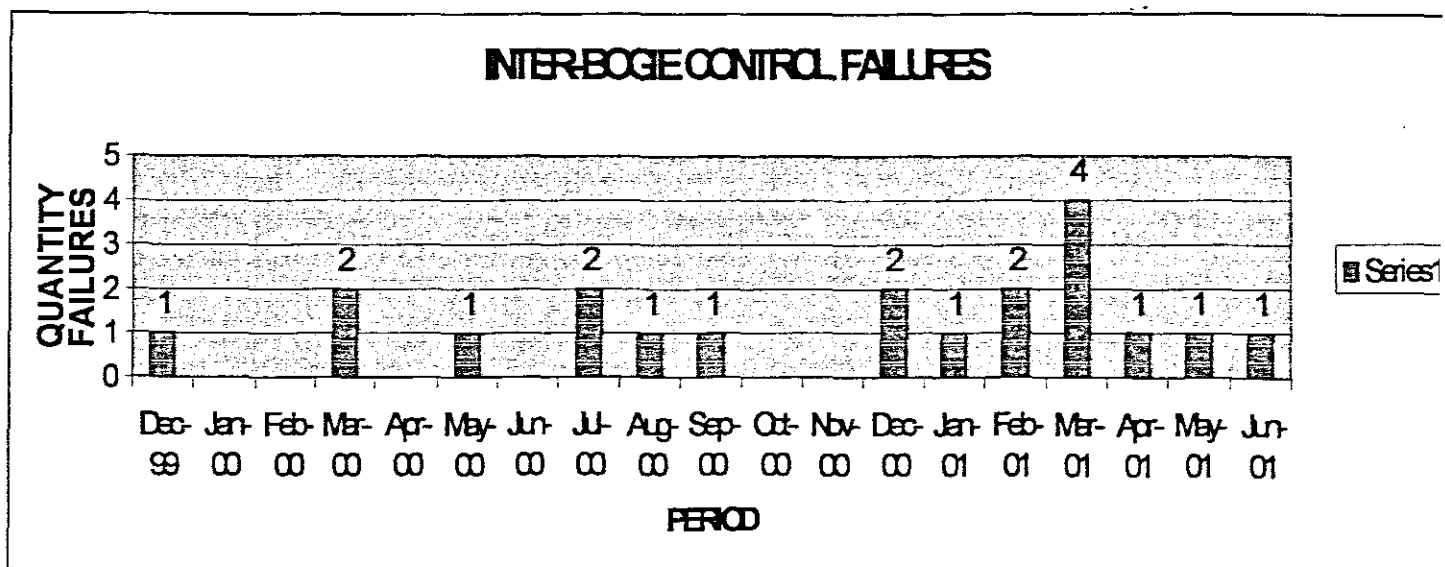
Total wheel wear/high flange failures amounted to twenty-seven for the period 01/11/1999 to 13/09/2001. Fifteen from the twenty-seven failures occurred in the first six months of the year 2001. The remaining twelve failures occurred during the previous eleven months. The fact that ten of the fifteen failed between the fourth and seventh month compared to twelve failures in the previous eleven months was also of great concern.

In view of the background sketched above, the following failure records were obtained and are shown at figures 11 and 12 so as to understand the context of the explanation.

Figure 11: Inter-bogie control failures as per record (Sap/R3: 46d):

| Month | No. of Failures | Month | No. of Failures | Month | No. of Failures |
|--------|-----------------|--------|-----------------|--------|-----------------|
| Dec-99 | 1 | Sep-00 | 1 | Mar-01 | 4 |
| Mar-00 | 2 | Dec-00 | 2 | Apr-01 | 1 |
| May-00 | 1 | Jan-01 | 1 | May-01 | 1 |
| Jul-00 | 2 | Feb-01 | 2 | Jun-01 | 1 |
| Aug-00 | 1 | | | | |

Figure 12: Inter-bogie control failures.



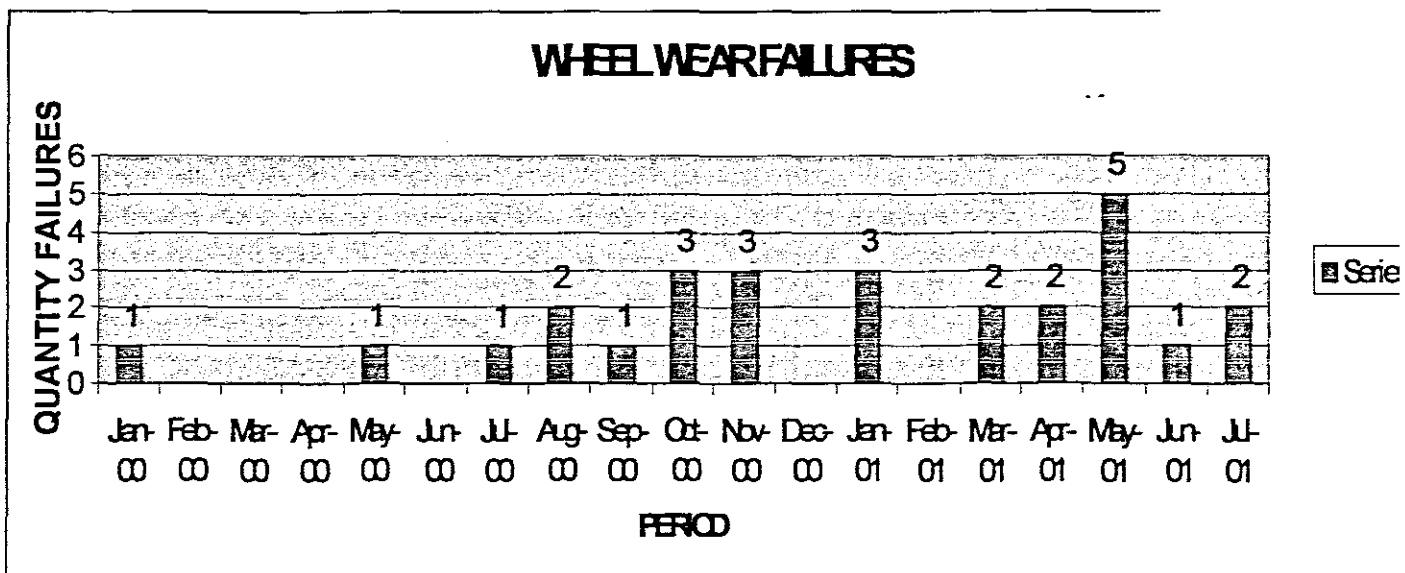
(Source: Analysis of report, Sap/R3: 46d)

The wear failures report obtained from electronic data base system is shown at Figures 13 and 14.

Figure 13 : Wear Failures

| Month | No. of Failures | Month | No. of Failures | Month | No. of Failures |
|--------|-----------------|--------|-----------------|--------|-----------------|
| Jan-00 | 1 | Oct-00 | 3 | May-01 | 5 |
| May-00 | 1 | Nov-00 | 3 | Jun-01 | 1 |
| Jul-00 | 1 | Jan-01 | 3 | Jul-01 | 2 |
| Aug-00 | 2 | Mar-01 | 2 | | |
| Sep-00 | 1 | Apr-01 | 2 | | |

Figure 14: Wheel Wear Failures



(Source: Analysis of report, Sap/R3: 46d)

An overview of Spoornet, Traction, Bellville Locomotive depot Back shop's budget is reviewed as follow: Review, June 2001.

Figure 15: Spoornet Traction, Bellville Audited Results. (back shop)

| Spoornet Traction, Bellville-Back shop Audited Results 2000/2001: Figure 15 | | | | |
|---|------------------------|------------------------|---|------------------------|
| 35-000 & 35-400 class locomotives | Actual R. 1999/2000 | Budget R. 1999/2000 | Actual R. 01/01/2001 to 30/06/2001 | Budget R. 2000/2001 |
| Total Budget Costs | | | 230,888.13 | 350,324.65 |
| 90542: Fuel, oil, and other | | | 1629.69 | |
| 90718: Miscellaneous material | | | 128,637.52 | 204,311.00 |
| 907050: Chemicals | | | 4,703.02 | |
| 90760: Toiletries | | | 70,903.02 | |
| 92032: RS: Maintenance of Assets | | | 70,780.00 | |
| 71FLR: Labour cost | | | 34,014.04 | 259,993.50 |
| Costs | | | 240,151.08 | 464,311.00 |
| 75750:RS-Activity Settled | | | 20,446.82 | |
| 75751:RS-Material Settled | | | 58,491.78 | |
| 75750:RS-Transwerk Settled | | | 63,214.00 | |
| 75750:RS-Fuel & Energy Settled | | | 1619.08 | |
| Settled Costs | | | 143,771.68 | |
| Balance | | | 96,379.40 | 464,304.50 |

(Source: Sap/R3: 46d)

Figure 15 shows the audited budget results for the back shop. The period concerned is from 1 January 2001 to 30 June 2001. The total budget for the financial year 2001 and various consumable accounts are shown in Figure 15. Ledger account 90718: Miscellaneous material is one of the largest expenses for the back shop to date June 2001. When the actual expenditure figures are compared to the budget for the financial year the amount spent on material up till June 2001 is enormously high.

Expenditure amounts to R128 637.52 for the first six months of the financial year 2001. Total budget amounts to R 350 324.65. Expenditure represents 36.72% ($128\ 637.52 / 350\ 324.65$) of the total budget, which was used for 35-class locomotives only.

Figure 16: Inter-bogie control and wheel wear failure costing

| Month | Material & Labour: (R) | | Qty. | Total cost: (R) | Percentage |
|---|---------------------------------------|--------------------------------------|---------------------------------------|-------------------------------|--------------------|
| | Inter-bogie control | | | | |
| Dec-99 to Dec-00 (12 months) | 3,457.64 (Ave.) | | 10 | 34,576.40 | 19.23% (52/10) |
| Jan-01 to July 01 (7 months) | 3,457.64 (Ave.) | | 10 | 34,576.40 | 19.23 % (52/10) |
| Dec-99 to July 01 | 3,457.64 (Ave.) | | 20 | 69, 152.80 | |
| Month | Material & Labour: (R) | | Qty. | Total cost: (R) | Percentage |
| | Wheel Wear Failure | | | | |
| Jan-00 to Dec-00 (12 months) | 3,597.64 (Ave.) | | 12 | 43,171.68 | 23.08 % (52/12) |
| Jan-01 to July 01 (7 months) | 3,597.64 (Ave.) | | 15 | 53,964.60 | 28.85 % (52/15) |
| Jan-00 to July 01 | 3,597.64 (Ave.) | | 27 | 97, 136.28 | |
| Inter-bogie control bush: Total cost (R) | Wheel wear failure: Total cost (R) | Transwerk Wheel rework profiles: (R) | Total cost for component failure: (R) | Actual Budgeted to spend: (R) | |
| 34, 576.40 | 53, 964.60 | 223, 946.00 | 312, 487.00 | 240, 151.08 | |

(Source: Sap/R3: 46d)

The normal expenditure on inter-bogie control is 19.23 % (10 failures) counted for the twelve-month period of the year 2000. But the failure rate over the first seven months for the year 2001 accounted for 10. That is 19.23 % for only seven months.

If this trend continues at this rate, the failure rate will amount to 17 failures at 32.69 %. Total cost will exceed the normal expenditure as follows, $R34\,576.40 \times 17 / 10 = R58\,779.88$. It can clearly be seen from the expenditure above that the cost factor for failure components is very high. The failure of the inter-bogie control bushes/spring boxes has a repercussion effect on the wear pattern of the wheels as was explained in the maintenance chapter. The expenditure has an abnormal impact on the budget for the period recorded.

The normal expenditure on wheel wear failure is 23.08 % (12 failures) counted for the twelve-month period of the year 2000. But the failure rate over the first seven months for the year 2001 accounted for 15. That is 28.85 % for only seven months. If this trend continues at this rate, the failure rate will amount to 26 failures at 57.7 %. Total cost will exceed the normal expenditure as follows, $R53,964.60 \times 26/15 = R93\,538.64$.

It can clearly be seen from the expenditure above that the cost factor for failure components is very high. The expenditure has an abnormal impact on the budget for the period recorded.

Analysis of the financial report reveals a high cost factor caused by the inter-bogie control bushes and wheel wear failures.

The total cost for the first seven months for the two items alone accounted for was R88, 541.00 ($R34, 576.40 + R53, 964.60 = \underline{R88, 541.00}$) The cost includes material and labour hours.

Maintenance of assets for the first seven months accounted for R223, 946.00. Therefore the cost for wheels plus inter-bogie control amounts to R312, 487.00 ($R88, 541.00 + R223, 946.00 = \underline{R312, 487.00}$)

The total budget for the first seven months amounted to R240, 151.08. After deducting the actual expenditure budgeted from the two failure components, there is not sufficient money left for any other components to be replaced or repaired.

$$R240, 151.00 - R312, 487.00 = \underline{(R82, 830.08)}$$

Furthermore, if asset repair cost is added to the total expenditure, then the cost factor becomes a concern. That is ($R69, 152.80 + R 97, 136.28 + R223, 946.00 = \underline{R390, 235.08}$)

In view of the foregoing, it is very clear that the cost for the first seven months exceeds the cost of the previous financial year by 48.08 %

The cost factor has made an impact on the annual budget forecast. Actual cost compared to the budgeted cost figure shows a negative trend. This information was validated by reports drawn from the electronic costing program data bank.

5. PROBLEM STATEMENT

In view of the background sketched above, the research problem to be addressed has been formulated as follows:

The increased frequency of wheel change and inter-bogie control repairs on 35-class diesel locomotives has a negative impact on service provision.

6. EXPLANATION OF RESEARCH POPULATION

The research population consists of sixteen people who are employed in the back shop department and are responsible for all below-deck repairs and service of 52 locomotives.

The composition of the staff is as follows:

- 1 technical supervisor;
- 8 diesel electric fitters;
- 5 trade hands;
- 1 process worker; and
- 1 general worker.

The data collected were obtained from all those participants who were directly related to the problem in the back shop.

The research survey was conducted as follows:

| | Questionnaire Distribution | Returned | Interviewed |
|----------------------------|-------------------------------|----------|-------------|
| 1 technical supervisor: | 1 | 1 | 1 |
| 8 diesel electric fitters: | 8 | 8 | 6 |
| 5 trade hands: | 5 | 5 | 3 |
| 2 process workers: | 2 | 2 | 1 |
| Total return: | 16 | 16 | 11 |

7. INTERVIEWING PROCESS

In order to achieve the research objectives it was necessary to utilize the back shop as a case study to describe the existing application of the maintenance plan and thereby observe and identify the cause of the problems explained above.

The methodology utilized included interviews, discussions and questionnaires with workers and the supervisor in the back shop heavy-duty department section. Interviews were conducted with the employees and the supervisor to clarify some results received from the questionnaire. The data gathered was first-hand and therefore reliable. All events that could provide reasons for the occurrence of the identified problems would be credible and add greater value to the analysis of maintenance plan.

The historical statistics (records) was analysed and compared with present statistics (records) to determine the increased failure trend of the identified 35-class locomotive components. The information was obtained from the maintenance application data-capturing system known as Sap/R3 (46b). The recorded failures and the material cost reports were processed for analysis. Recommendations were made accordingly. The trends were compared with the trends after the recommendations have been implemented so as to determine impact.

The comparison would identify significant differences and determine the causes of possible errors.

Other data has been gathered by means of information from literature published and research. Information available from the Internet, library, books, magazines, articles, encyclopaedia and the media has been collected and integrated with the data obtained and then added as new information to the present study where applicable. A computed Microsoft Excel spreadsheet was used to capture and collate the information and transform it into useful output data.

Purpose of Research

To test the effectiveness of the existing maintenance plan at Spoornet through the identification of the causes for the abnormal increase in wheel changes and inter-bogie control repairs on 35-class diesel locomotives.

Objective 1

To determine the negative effects of incorrect data capturing and records during maintenance repairs on the incidence of failure of components and the wastage of material.

Objective 2

To identify the benefits of an effective application of maintenance plan.

8. QUESTIONNAIRE

Bless et al (1995:105) states that the most frequently used method for gathering information is by directly asking respondents to express their views. Bless et al (1995:107) adds that exploratory research is an excellent technique when no comparison is sought between the responses of different participants, but when each participant is considered as a specific case, such as in this case-study.

Bless et al (1995:117) emphasizes that great attention must be devoted to the wording of questions. The following list was identified as important:

- Questions should be simple and short;
- Questions should be unambiguous. Words which are too general, vague or give different interpretation should not be used;
- Questions should be understandable (vocabulary);
- Questions should not be double-barreled (contain two questions in one); and

- Leading questions should be avoided. (favour one type of answer over another type).

The questionnaire developed for this study was divided into three types of questions:

Nominal type questions. (Dichotomous) yes/no;

Ordinal type questions. (Multiple-questions) always/ sometimes/ never;

Open ended type questions.

The questionnaire format included the following four sections:

- Section one: Supervision;
- Section two: Expertise; (experience and knowledge);
- Section three: Training; and
- Section four: Maintenance manual.

The questionnaire was designed to provide the following results:

- Section one: Supervision – five questions were included to validate the role of the supervisor in task execution.
- Section two: Expertise (experience and knowledge) – nine questions were included to determine the level of efficiency.

- Section three: Training – two questions were included to determine the level of competency and to develop a training plan.
- Section four: Reference to Maintenance manual – four questions were included to ascertain whether the respondents adhered to the maintenance plan (policy) and to ascertain the awareness for quality.
- The respondents were kindly requested to identify possible causes (reasons) for inter-bogie control bush and wheel wear. Responses were recorded based on interviews, and then recorded on paper.

The questionnaire provided clear instructions to the respondents and provided an overview of the need for the research. The respondents were also assured of anonymity in order to promote reliable and unbiased opinions.

A sample of the questionnaire is attached at Annexure B for ease of reference.

9. CONCLUSION

The explanation of the background to the research case study identified the need for management to revise the existing maintenance plan to eliminate the abnormal component failure rate. The abnormal cost factor reveals that the maintenance plan is not executed efficiently and it is definitely not effective. Intervention should be identified and implemented to improve the situation.

The need to examine the high abnormal expenditure and the effectiveness of the existing maintenance plan should be included in this investigation.

CHAPTER 6

THE FINDINGS AND CONCLUSIONS

1. INTRODUCTION

This chapter presents the findings based on the analysis of the completed questionnaires by the respondents who participated in the case study. It is clearly noticeable from the respondents that there are problems in the back shop (heavy-duty) department. The raw data was captured, collated and recorded onto an Excel spreadsheet and computed for analysis. The results of the analysis, on which the conclusions are based, are discussed in detail.

2. ANALYSIS OF RESULTS

Based on the questionnaire the following results were computed.

Section One: Supervision.

Question 1: Attitude of supervisor (consistency)

| | Y | N | Missing | Total |
|------------------|-------------------------------------|---------|---------|-------|
| Raw Score | 3 | 13 | 0 | 16 |
| | Raw Score presented as a percentage | | | |
| Standard Score % | 18,75% | 81,25 % | 0 % | 100 % |

Question 2: Supervisor equipped with the expertise (qualification and knowledge)

to assist.

| | Y | N | Missing | Total |
|------------------|-------------------------------------|---------|---------|-------|
| Raw Score | 7 | 9 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 43,75% | 56,25 % | 0 % | 100 % |

Question 3: Supervisor experienced with Inter-bogie control alignment.

| | Y | N | Missing | Total |
|------------------|-------------------------------------|---------|---------|-------|
| Raw Score | 9 | 7 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 56,25 % | 43,75 % | 0 % | 100 % |

Question 4: Adhering to Supervisors instructions during task execution.

| | Y | N | Missing | Total |
|------------------|-------------------------------------|--------|---------|-------|
| Raw Score | 2 | 14 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 12,5 % | 87,5 % | 0 % | 100 % |

Question 5: Supervisor quality enforcement.

| | Y | N | Missing | Total |
|------------------|-------------------------------------|---------|---------|-------|
| Raw Score | 5 | 11 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 31,25 % | 68,75 % | 0 % | 100 % |

Section Two: Expertise (experience & knowledge)

Question 1: Task execution based on own experience.

| | Y | N | Missing | Total |
|------------------|-------------------------------------|--------|---------|-------|
| Raw Score | 10 | 6 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 62,5% | 37,5 % | 0 % | 100 % |

Question 2: Draw correct material quantity for defective components.

| Raw Score | Y | N | Missing | Total |
|------------------|-------------------------------------|--------|---------|-------|
| | 14 | 2 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 87,5% | 12,5 % | 0 % | 100 % |

Question 3: Use own method and tools for data collection.

| Raw Score | Y | N | Missing | Total |
|------------------|-------------------------------------|--------|---------|-------|
| | 2 | 14 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 12,5 % | 87,5 % | 0 % | 100 % |

Question 4: Draw additional material quantity in event of damage.

| Raw Score | Y | N | Missing | Total |
|------------------|-------------------------------------|------|---------|-------|
| | 8 | 8 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 50 % | 50 % | 0 % | 100 % |

Question 5: Utilisation of co-worker methods and instructions when executing tasks.

| Raw Score | Y | N | Missing | Total |
|------------------|-------------------------------------|--------|---------|-------|
| | 10 | 6 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 62,5% | 37,5 % | 0 % | 100 % |

Question 6: Capture notebook sizes.

| Raw Score | Always | S Times | Never | Missing | Total |
|------------------|-------------------------------------|---------|--------|---------|-------|
| | 2 | 7 | 7 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | | |
| | 12,5% | 43,75% | 43,75% | 0% | 100% |

Question 7: Check parts (identify) to specification.

| Raw Score | Always | S Times | Never | Missing | Total |
|------------------|-------------------------------------|---------|-------|---------|-------|
| | 12 | 4 | 0 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | | |
| | 75% | 25% | 0% | 0% | 100% |

Question 8: Sufficient floor space in Bakeshop.

| Raw Score | Always | S Times | Never | Missing | Total |
|------------------|-------------------------------------|---------|-------|---------|-------|
| | 0 | 6 | 10 | 0 | 16 |
| | Raw Score presented as a percentage | | | | |
| Standard Score % | 0% | 37,5% | 62,5% | 0% | 100% |

Question 9: Reasons provided for unavailability of all resources (overhead cranes, spares and personnel)

| Reasons: | Frequency: |
|---|------------|
| - Bad Planning of work schedule. | (3) |
| - Floor space constraints. | (4) |
| - Staff shortage due to absenteeism. | (3) |
| - None-availability of cranes. | (14) |
| - Excessive workload. | (3) |
| - Weak attitude. | (3) |
| - Crane overload – tripped. | (1) |
| - Supervisor not always fair to affirmative candidates. | (3) |
| - Trade hands not available when required. | (1) |
| - Crane remote control failure. | (1) |
| - Different jobs requiring crane at same time. (sections) | (5) |
| - Insufficient 40-ton cranes. | (4) |

- Document delays at planning control office. (5)
- Delays regarding spares at store (5)
- Racism. (1)
- Weak time management not utilizing 100% (early tea, delayed return from lunch). (2)
- Locomotive schedule, late arrival (planning and train services) (3)
- Management not eager to assist with drop-pits for certain jobs. (1)
- Staff not drawing spares for task execution. (1)
- Spares shortage (unavailable). (8)
- Poor quality of spares. (1)
- Locomotives are old and many parts worn, causing more failures. (2)
- New people on section, take time to learn tasks. (1)
- Unavailability of tools in tool store. (1)
- Components not available. (2)
- Excessive paper work. (1)
- Gas bottles and suspension oil always empty. Not replenished. (1)
- Flog jobs, bad workmanship regarding bogie and wheel repairs (1)

Section Three: Training.

Question 1: Undergone sufficient training.

| Raw Score | Y | N | Missing | Total |
|------------------|-------------------------------------|------|---------|-------|
| | 8 | 8 | 0 | 16 |
| | Raw Score presented as a percentage | | | |
| Standard Score % | 50% | 50 % | 0 % | 100 % |

Question 2: Identification of Training

| Need for task execution. | Frequency |
|---|-----------|
| - The Occupational Health & Safety Act, 1993. | (1) |
| - Tool Skills. | (2) |
| - Training out of manual specifically for back shop tasks. | (1) |
| - Training so as to obtain Crane License. | -- (6) |
| - Bogie overhauls on all classes. | (1) |
| - Wheel sets in general. (assessments, causes and actions and solutions to be taken in special conditions for re-occurrence.) | (4) |
| - Training in digital alignment instruments. | (1) |
| - Training in wheel reading gauges. | (1) |
| - Training in advanced wheel wear conditions. | (1) |
| - Training for trade hands. | (3) |

- Training so as to obtain Forklift license. (5)
- Adult training in good house keeping. (1)
- Training so as to facilitate the conversion from trade hand to artisan. (1)
- Computer training. (ms-office package) (5)
- Supervisor duty training. (1)
- Gas cutting (torch, plasma) training. (6)
- Welding training (6)
- Apprentice training. (1)
- Training to standardise the concept of modules. (1)
- Extensive apprentice competency tests. (1)
- Staff rotations so as to gain other skills. (1)

Section Four: Reference to maintenance manual.

Question 1: Reference to Maintenance Manual for prescribing tools when capturing data.

| Raw Score | Always | S Times | Never | Missing | Total |
|------------------|-------------------------------------|---------|--------|---------|-------|
| | 5 | 8 | 3 | 0 | 16 |
| | Raw Score presented as a percentage | | | | |
| Standard Score % | 31,25% | 50% | 18,75% | 0% | 100% |

Question 2: Use of item number from maintenance manual when replacing component.

| | | | | | |
|------------------|-------------------------------------|---------|-------|---------|-------|
| Raw Score | Always | S Times | Never | Missing | Total |
| | 12 | 2 | 2 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | | |
| | 75% | 12,5% | 12,5% | 0% | 100% |

Question 3: Utilisation of all available resources.

| | | | | | |
|------------------|-------------------------------------|---------|-------|---------|-------|
| Raw Score | Always | S Times | Never | Missing | Total |
| | 6 | 9 | 1 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | | |
| | 37,5% | 56,25% | 6,25% | 0% | 100% |

Question 4: Capturing of actual sizes according to form (inspection).

| | | | | | |
|------------------|-------------------------------------|---------|--------|---------|-------|
| Raw Score | Always | S Times | Never | Missing | Total |
| | 10 | 1 | 5 | 0 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | | |
| | 62,5% | 6,25% | 31,25% | 0% | 100% |

Possible causes of inter-bogie control bush and wheel wear.

Question 1: Maintenance plan not adhered to.

| | | | | |
|------------------|-------------------------------------|---------|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 2 | 9 | 5 | 11 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 12,5 % | 56,25 % | 31,25 % | 100 % |

Question 2: Poor workmanship.

| | | | | |
|------------------|-------------------------------------|------|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 7 | 4 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 43,75 % | 25 % | 31,25 % | 100 % |

Question 3: Inter-bogie control bushes not performing to requirements. (inferior material)

| | | | | |
|------------------|-------------------------------------|------|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 3 | 8 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 18,75 % | 50 % | 31,25 % | 100 % |

Question 4: Spring box worn.

| | | | | |
|------------------|-------------------------------------|-----|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 11 | 0 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 68,75% | 0 % | 31,25 % | 100 % |

Question 5: Alignment measurements not 100% accurate.

| | | | | |
|------------------|-------------------------------------|--------|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 1 | 10 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 6,25 % | 62,5 % | 31,25 % | 100 % |

Question 6: Repairs not done on minor inspections (a, b, c and majors)

| | | | | |
|------------------|-------------------------------------|---------|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 2 | 9 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 12,50 % | 56,25 % | 31,25 % | 100 % |

Question 7: Supervisor not enforcing quality principles.

| | | | | |
|------------------|-------------------------------------|--------|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 1 | 10 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 6,25 % | 62,5 % | 31,25 % | 100 % |

Question 8: Supervisor lack technical ability.

| | | | | |
|------------------|-------------------------------------|---------|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 2 | 9 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 12,5 % | 56,25 % | 31,25 % | 100 % |

Question 9: Workers lacking motivation to deliver quality work.

| | | | | |
|------------------|-------------------------------------|--------|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 10 | 1 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 62,5 % | 6,25 % | 31,25 % | 100 % |

Question 10: Workers lacking technical ability.

| | | | | |
|------------------|-------------------------------------|---------|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 0 | 11 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 0 % | 76,85 % | 31,25 % | 100 % |

Question 11: High Workload: Quality and accuracy suffers.

| | | | | |
|------------------|-------------------------------------|-----|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 11 | 0 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 68,75 % | 0 % | 31,25 % | 100 % |

Question 12: Condition of the rail tracks.

| | | | | |
|------------------|-------------------------------------|--------|---------|-------|
| Raw Score | Y | N | Missing | Total |
| | 9 | 2 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 56,25 % | 12,5 % | 31,25 % | 100 % |

Question 13: Bogie frames twisted and out of alignment.

| Raw Score | Y | N | Missing | Total |
|------------------|-------------------------------------|---------|---------|-------|
| | 8 | 3 | 4 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 50 % | 18,75 % | 31,25 % | 100 % |

Question 14: Wheel sizes not recorded properly. Sizes taken from notebook not measured.

| Raw Score | Y | N | Missing | Total |
|------------------|-------------------------------------|------|---------|-------|
| | 7 | 4 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 43,75 % | 25 % | 31,25 % | 100 % |

Question 15: Complacency with regard to task execution.

| Raw Score | Y | N | Missing | Total |
|------------------|-------------------------------------|--------|---------|-------|
| | 9 | 2 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 56,25 % | 12,5 % | 31,25 % | 100 % |

Question 16: Defective bushes not recorded due to wheel wear sizes at limits.

| Raw Score | Y | N | Missing | Total |
|------------------|-------------------------------------|-----|---------|-------|
| | 11 | 0 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 68,75 % | 0 % | 31,25 % | 100 % |

Question 17: Defective inter-bogie control bushes not recorded due to extra workload to renew defective bushes.

| Raw Score | Y | N | Missing | Total |
|------------------|-------------------------------------|--------|---------|-------|
| | 10 | 1 | 5 | 16 |
| Standard Score % | Raw Score presented as a percentage | | | |
| | 62,5 % | 6,25 % | 31,25 % | 100 % |

3. FINDINGS

The following results were obtained from Section one: Supervision; Section two: Expertise (experience and knowledge); and possible causes of inter-bogie control bush and wheel wear from the questionnaires.

- 18,75% do not make use of the maintenance manual to perform their tasks.
- 50% sometimes make use of the maintenance manual to perform their tasks.
- 62,5% perform their duty and complete daily tasks by means of using own experience and methods.
- 56,25% feel that the Acting Technical Supervisor lacks experience and is not qualified to help them.
- 43,75% feel that the Acting Technical Supervisor lacks knowledge to help them.
- 62,5% obey their co-workers instructions.
- 56,25% became too complacent with task execution. Not worried about inter-bogie control bushes – small defect.
- 38,75% neglect to record defective bushes due to wheel wear sizes at limits due for bogie change.
- 62,5% neglect to record defective bushes due to extra workload imposed upon them to renew defective inter-bogie control bushes.

Objective 1

The following results were obtained from Section two: Expertise (experience and knowledge); and possible causes of inter-bogie control bush and wheel wear from the questionnaires.

- 12,5% use their own methods and tools to capture data;
- 43,75% revealed that poor workmanship is the cause for failure of components and material wastage;
- 62,5% lacked the motivation to deliver quality work;
- 12,5% use their notebook to capture sizes (data to be recorded);
- 43,75% sometimes use their notebook to capture sizes (data to be recorded);
- 6,25% sometimes capture actual sizes (data to be recorded);
- 31,25% never capture actual sizes (data to be recorded);
- 43,75% do not use the correct tools to perform their tasks;
- 12,5% do not follow the proper maintenance plan to perform their tasks;
- 12,5% do not draw the correct quantity material for defective components;
- 50% draw extra quantity material in the event of damage;
- 25% sometimes check the specification of the parts (identity) that must be replaced;
- 18,5% feel that the inter-bogie control bushes are not performing according to requirements (inferior material) and are also to blame for the increase in component failure;
- 68,75% state that the neglected worn spring box contributes greatly to the increase in inter-bogie control bush failure;

- 68,75% state that the excessive workload contributes greatly to the poor workmanship (quality) and accuracy data capturing suffers;
- 56,25% state that the condition of the rail tracks also contributes to the increase in inter-bogie control bush failure; and
- 50% state that the bogie frames could be twisted and could be out of alignment, and therefore contributes to the increase in inter-bogie control bush failure.

Objectives 2

The following results were obtained from Section one: Supervision; Section two: Expertise (experience and knowledge); and possible causes of inter-bogie control bush and wheel wear from the questionnaires.

- 43,75% felt that the supervisor lacks experience with regards to inter-bogie control alignment to help them;
- 62,5% felt that there is never sufficient space in the back shop. They have to wait on other staff for the crane. This leads to time wastage – i.e. poor time management;
- 56,25% admitted that they only sometimes utilize all available resources;
- 87,5% admitted that they never follow the instructions of their supervisor;
- 81,25% felt that the attitude of their supervisor is not the same towards everybody;
- 68,75% felt that the supervisor does not enforce quality during task executions;
- 62,5% sometimes utilize co-workers methods;

- 25% sometimes utilize the correct methods to execute task and data capturing;
- 12,5% using own methods and tools for data capturing;
- 12,5% always use their black notebook to capture sizes;
- 43,75% sometimes use their black notebook to capture sizes; and
- 31,25% never capture actual sizes to be recorded.

4. CONCLUSIONS

The following conclusions were drawn from the analysis of the findings:

- No adherence to rules and processes;
- No utilization of the prescribed maintenance manual to perform their daily tasks;
- No utilization of the right tools and methods to capture correct sizes for data recording;
- No sense of vision or mission nor of the objectives and goals to be achieved, these must be communicated to them;
- The acting Technical Supervisor, does not have all the skills, knowledge and experience to help the subjects with their problems;
- Management skills are non-existent;
- Poor planning of job execution and bad time management;
- Not obeying the instructions of the supervisor and rather follow co-workers methods and means of executing tasks;
- Negative results, failure of components Wheel Slips; and

- All require some form of training to be able to perform their daily tasks according to the business rules.

Employees lack skills, knowledge and experience in task execution. The main areas of concern are:

- Bogie overhaul knowledge. (reliability);
- Wheel sets in general. (sizes & methods);
- Cable collection. (wheel slips);
- Basic tool skills – usage (methods);
- Crane license – operation (safety);
- Planning of work execution (prioritise cost effectiveness);
- Time management (result of non-conformance is lost time);
- Quality work performance (failure of locomotives); and
- Cost management (wastage of material).

The research has also revealed the following problems, which requires attention:

- Occupation of overhead cranes;
- Breakage of overhead cranes;
- Absenteeism from work;
- Excessive workload due to no maintenance schedule plan for inter-bogie control and wheel changes;
- Lack of enough 40-ton cranes;
- No multi-skilled subjects to work anywhere;

- Confined to certain jobs;
- Lack experience and training in technical and practical knowledge;
- Lack of space in back shop to execute tasks;
- Various departments using the overhead cranes at the same time. (Engine Bay, Electric repair shop, back shop staff, Traction Motor bay and Back shop Diesel); and
- Task execution performed based on their own experience and not according to standard process and procedures (Business Rules).

The research also revealed the following positive results:

- 83% make use of the correct item numbers for drawing material and components from Promat to repair locomotives;
- 83% draw the correct quantity of material required to perform repair task;
- 75% use the correct method for data capture and taking sizes; and
- 67% check the parts to see that they are the correct types according to specification.

CHAPTER 7

RECOMMENDATIONS

1. INTRODUCTION

The research study proved that there are many factors, which contributed to the abnormal failure rate of components in the back shop section. In the light of the findings, management must attend to the problems that require immediate attention and ensure that preventive measures are put in place.

2. RECOMMENDATIONS

According to the results of the empirical study there are problems in the back shop environment. Based on the analyses and conclusions drawn the following recommendations have been formulated:

- That the lack of leadership, vision, mission, objectives for the back shop must be rectified.
- That all employees be trained and be exposed to the company objectives, vision and mission statement;
- That the acting supervisor be trained in managerial skills – leadership, control, motivation, delegation, budgeting and trust (ethical issues);
- That all employees be trained how to use basic tools for various tasks;

- That all employees get training in technical knowledge and mechanical experience in various task executions;
- That a special training schedule (module) be drawn up for all employees in the back shop;
- That the maintenance engineers have a look at the possibility of implementing a maintenance schedule for inter-bogie control overhaul and wheel changes – bogie overhauls;
- That the problem with the occupation of overhead cranes be addressed;
- That an in-depth study of the overhead crane maintenance schedule plan be implemented;
- That reaction time on call-out for crane failures should be addressed. Too much time is wasted on waiting for maintenance staff to respond to repair defective cranes;
- That management should consider an extra 40-ton overhead crane for the back shop area to meet requirements;
- That the possibility of implement shift work should be considered for sections that clash the most by occupying the overhead cranes; (those sections that require the crane all the time for task execution)
- That communication between various sections requires serious consideration;

- That grey communication area where people spend the least time on being addressed (communication from top management down to floor staff- up down method, and from floor staff to top management- down up method);
- That communication and feedback be addressed, no one can be successful in performing their task properly without being disturbed and upset by other section employees;
- That the technical supervisors of the various sections must urgently make an effort to communicate with one another to be able to perform their daily tasks in harmony without ill feelings or discrimination against each other;
- That quarrel amongst employees, bad tempered and unmotivated employees be addressed. These are results of poor integration of business rules, space and tool usage in back shop area (resources);
- That all employees be coached about what zero budget means to company and sections; and
- That employee lives by the business rules and obeys and understands company objectives, vision and mission.

3. CONCLUSION

A possible area for future research will be to find a solution for the integration of the various tasks to be executed in the back shop (more fluent workflow).

This section also needs an in-depth study to rectify the problem with regard to the lack of floor space.

Productivity is influenced adversely due to the failure to comply with set business rules, such as maintenance policy, standing depot instructions and reference to maintenance manual. The study further proved that there is a lack in skills among the employees.

Tasks cannot be performed to set standards if the employees do not know how to use measuring instruments. The use of tools is critical for data capturing.

There is a lot of scope for improvement in the back shop division. With everybody participating in training and communicating with each other, a good future lies ahead for this section to succeed in reducing costs and failures.

Quality improvement needs to be address in all tasks as well.

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9/13/01
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(ANNEXURE A)

THE MAINTENANCE PLAN COVERS THE FOLLOWING PROCESSES, SYSTEMS AND INSPECTIONS:

1. Brake system: multiple brake application valves. (condition and fixed time)
2. Cooling systems: water and oil samples. (laboratory analysis reports from samples taken daily)
3. Power system: engine, turbo, traction motors and main generator. (conditional and fixed time)
4. Control systems: electrical components, governor, power contractors and relays. (conditional and fixed time)
5. Fuel system: electric fuel-pump motor, injectors, piping, filters, fuel transfer mechanical pump. (conditional and fixed time)
6. Safety systems: low oil pressure trips (L.O:P.T.), low water pressure trip (L.W.P.T.), low water level trip indicator (L.W.L.), ground relay trip device (GR Relay), overspeed trip device. (O/S trip) (conditional and fixed time maintenance)

Types of service scheduled for fixed time, conditional = preventive maintenance periods are as follows:

A Service Type Inspection: (fixed time cycle of 45 days),

- check brush wear limits (conditional maintenance),
- change out if short (conditional maintenance).

B Service Type Inspection: (A+B = fixed time cycle of 135 days),

- change out oil filters (fixed time maintenance),
- check brush wear limits on auxiliary generator (conditional maintenance).

C Type Service Inspection: (A+B+C = fixed time cycle of 270 days),

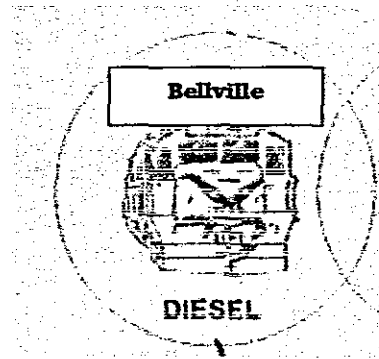
- change out oil filters (preventive maintenance),
- check brush wear limits on main generator (conditional maintenance).

Major-Type Service Inspection: (A + B + C + Extra = fixed time cycle of 540 days),

- change out fuel filters (fixed time maintenance),
- check brush wear limits on all types of generators (conditional maintenance),
- change out engine and compressor (fixed time work).

ANNEXURE B

SPECIMEN QUESTIONNAIRE



BACKGROUND

The study will be undertaken at the locomotive depot off Caledon West road in the Bellville yard complex, Cape Town.

The section under research is the back shop (heavy duty road) L & N section, which includes below deck maintenance, overhaul, and change out repairs to locomotive bogies, frames, wheels, snubbers, Inter Bogie Control, and Traction motors.

Sixteen people are employed in the back shop department and are responsible for all below deck repairs and service of 52 locomotives.

PURPOSE OF THE QUESTIONNAIRE

The purpose of the questionnaire are to test the effectiveness of the existing Maintenance plan at Spoornet through the identification of the causes for the

abnormal increase in wheel changes and Inter Bogie Control repairs on 35-class Diesel Locomotives.

The structure of the questionnaire is divided into four sections. It consist of the following:

- Section one: Supervision;
- Section two: Expertise (Experience & Knowledge);
- Section three: Training; and
- Section four: Refer to Maintenance Manual.

Instructions to the respondent: Please just follow the instructions below, it will only take up fifteen minutes of your time.

- Please answer all the questions as honestly and correct as possible.
- Just make a cross (x) in one of the blocks, which you choose.
- Do not mark more than one block at a time.
- If you are unsure of the meaning of any questions, feel free to ask for more clarification.
- Your privacy will be respected.
- Your identification will remain anonymity and confidential.

The benefit of answering these questions will reduce material wastage and reduce extra workload. Responder will be able to participate in a survey where they can make a difference in the problems they experience at present. (Give positive direct information to help solve their problems with task execution and to utilize the resources to full capacity).

The questionnaire consists of four sections, which you have to complete by yourself.

| | | |
|--------------------------|-----|----|
| Section one: Supervision | Yes | No |
|--------------------------|-----|----|

| | | | |
|---|---|-----|----|
| 1 | Does the Supervisor always reflect the same attitude toward the back shop employees? (staff) | Yes | No |
| 2 | Is the supervisor equipped with the expertise (qualification and knowledge) to assist his staff with task execution in the back shop? | Yes | No |
| 3 | Is the supervisor experienced enough to give guidance with I.B.C alignment so as to capture data correctly? | Yes | No |
| 4 | Do you always follow the supervisor's instructions with task execution? | Yes | No |
| 5 | Do the supervisor practicing quality awareness when you execute your daily tasks? | Yes | No |

| | | |
|---|-----|----|
| Section two: Expertise (experience & knowledge) | Yes | No |
|---|-----|----|

| | | | |
|---|--|-----|----|
| 1 | When executing task, do you use your own expertise to perform a bogie alignment after overhaul of equipment? | Yes | No |
| 2 | Do you only draw the correct quantity of material for defective components to be replaced? | Yes | No |
| 3 | Do you utilise your own method and tools to perform I.B.C. alignment & Bogie streamline so as to capture the sizes for data collection on form? | Yes | No |
| 4 | When replacing defective components do you just draw the quantity material required or do you get extra for incase of damage during the fitting process? | Yes | No |
| 5 | Do you make use of your co-workers methods and instructions as how to execute the task in the back shop? | Yes | No |

| | | | | |
|---|--|--------|----------|-------|
| 6 | Do you make use of your own notebook sizes to capture the sizes for I.B.C. alignment on data sheets? (forms) | Always | Sometime | Never |
| 7 | When fitting new parts do you check that it is the correct type and size according to specifications? (compare with old one) | Always | Sometime | Never |
| 8 | Is there sufficient space in the back shop to execute your task accordingly to the business rules properly and correct? | Always | Sometime | Never |

| | | |
|---|--|--|
| 9 | What are the reasons for all the resources not being available for executing daily tasks in the back shop? (cranes, spares, and personnel) | |
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| Section three: Training | Yes | No |
|-------------------------|-----|----|

| | | | |
|---|---|-----|----|
| 1 | Do you think that the training you received to assist and equipped you to execute your task in back shop was enough? | Yes | No |
| 2 | What training is required to enable you to use the tools and measuring instruments required in the back shop to execute the task? | | |
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| Section four : Refer to maintenance manual | | Always | Sometime | Never |
|--|--|--------|----------|-------|
| 1 | When capturing data, do you refer to the maintenance manual for prescribe tools to use for I.B.C. alignment and bogie streamline? | Always | Sometime | Never |
| 2 | When replacing worn or broken components, do you refer to the maintenance manual to look-up the correct material item number? | Always | Sometime | Never |
| 3 | While replacing new components or material, do you utilise all the available resources to assist you with the task? (manual, tools, procedures) | Always | Sometime | Never |
| 4 | When executing I.B.C. alignment, do you write the real sizes down as measured on the forms, referring to the maintenance manual instruction methods? | Always | Sometime | Never |

Possible causes of inter-bogie control bush and wheel wear.

| Possible causes | | Yes | No |
|-----------------|--|-----|----|
| 1 | Not following proper maintenance plan. | | |
| 2 | Poor workmanship. | | |
| 3 | Inter-bogie control bushes not performing to requirements. (inferior material) | | |
| 4 | Spring box worn. | | |
| 5 | Alignment measurements not 100% accurate. | | |
| 6 | Repairs not done on minor inspections. (a, b, c and majors) | | |
| 7 | Supervisor not enforcing applicable quality principles. | | |
| 8 | Supervisor lacking technical ability. | | |
| 9 | Workers lacking motivation to deliver quality work. | | |
| 10 | Workers lacking technical ability. | | |
| 11 | Too much work. Quality and accuracy suffers. | | |
| 12 | Condition of the rail tracks. | | |
| 13 | Bogie frames could be twisted and out of alignment. | | |
| 14 | Wheel sizes not recorded properly. Sizes taken from notebook not measured. | | |
| 15 | Too complacent with task execution. Not worried about inter-bogie control bushes - small defect. | | |
| 16 | Defective bushes not recorded due to wheel wear sizes at limits, due for bogie change. | | |
| 17 | Defective inter – bogie control bushes not recorded due to extra workload to renew defective bushes. | | |

ANNEXURE C

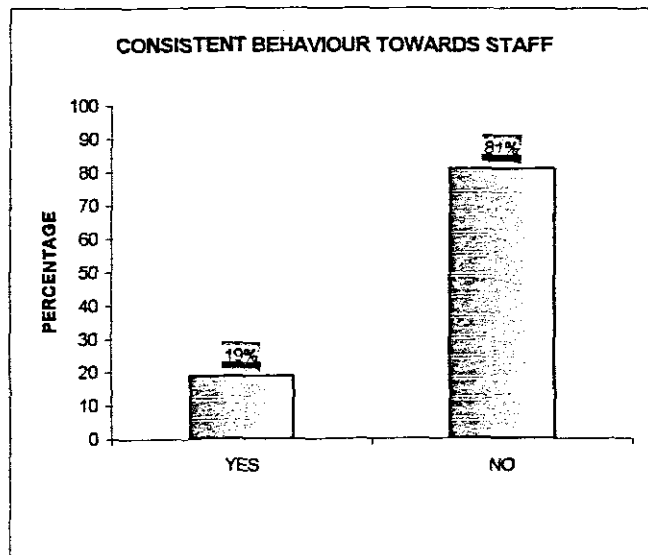
QUESTIONNAIRE ANALYSIS [CHAPTER 5]

Section one: Supervision.

Responses to each question contained in the questionnaire is graphically presented hereunder

Question. 5.1.1. Does the Supervisor always reflect the same attitude toward the back shop employees? (staff)

Figure 18: Attitude of supervisor (consistency)

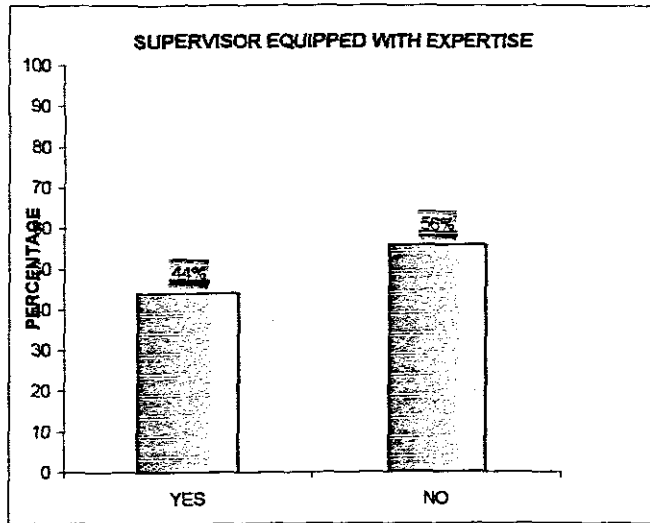


SUMMARY OF RESULTS

| | |
|-----|------|
| YES | 19 % |
| NO | 81 % |

Question. 5.1.2. Is the supervisor equipped with the expertise (qualification and knowledge) to assist his staff with task execution in the back shop?

Figure19: Supervisor equipped with the expertise (qualification)

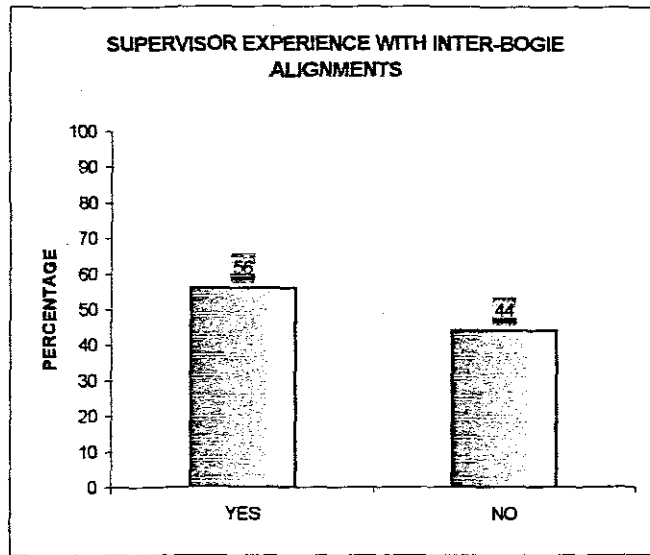


SUMMARY OF RESULTS

YES 44 %
NO 56 %

Question. 5.1.3. Is the supervisor experienced enough to give guidance with I.B.C alignment so as to capture data correctly?

Figure 20: Supervisor experience with Inter-bogie control alignments?

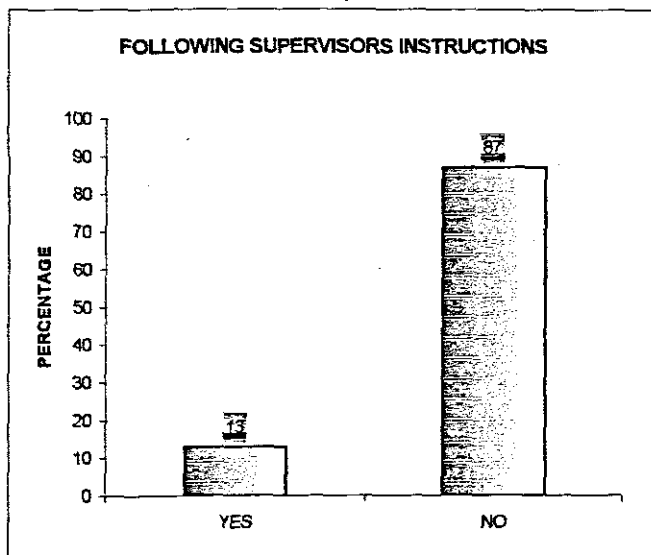


SUMMARY OF RESULTS

YES 56 %
NO 44 %

Question. 5.1.4. Do you always follow the supervisors instructions with task execution?

Figure 21: Adhering supervisor instructions during task execution.

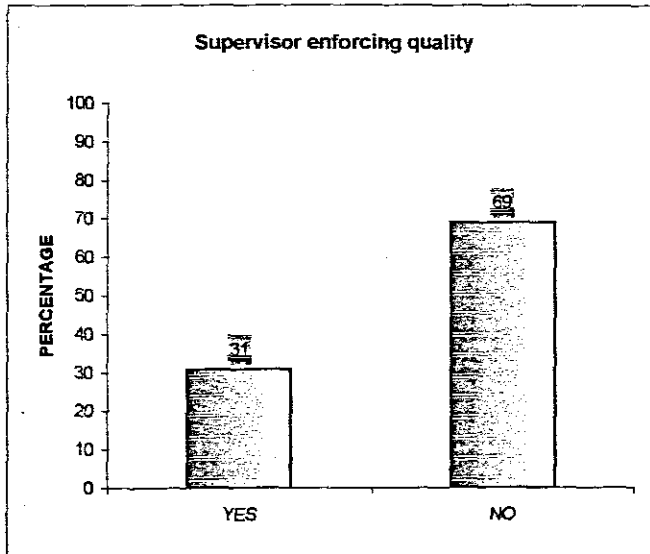


SUMMARY OF RESULTS

YES 13 %
NO 87 %

Question. 5.1.5. Do the supervisor practicing quality awareness when you execute your daily tasks?

Figure 22: Supervisor quality enforcement.



SUMMARY OF RESULTS

YES 31 %

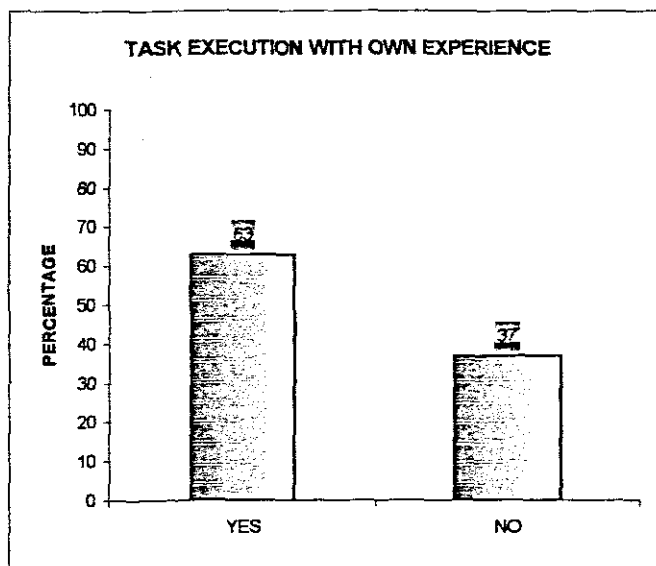
NO 69 %

Section Two: Expertise (experience and knowledge)

Y N as Percentage %

Question. 5.2.1. When executing task, do you use your own expertise to perform a bogie alignment after overhaul of equipment?

Figure 23: Task execution based on own experience.

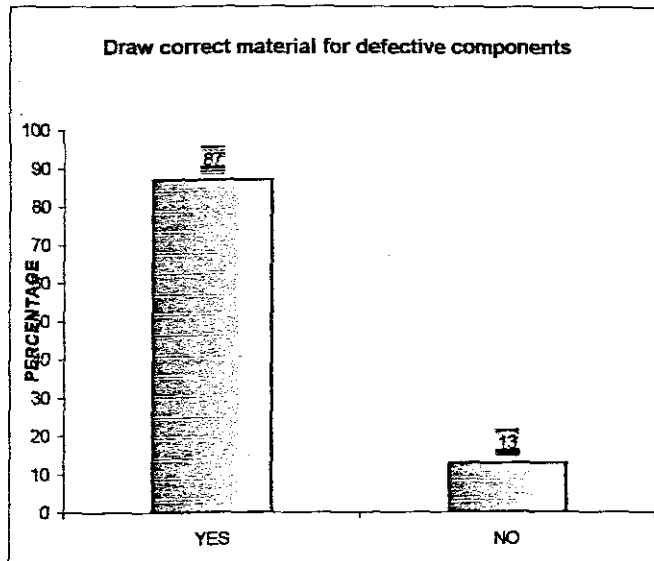


SUMMARY OF RESULTS

YES 63 %
NO 37 %

Question. 5.2.1. Do you only draw the correct quantity of material for defective components to be replaced?

Figure 24: Draw correct material quantity for defective components.

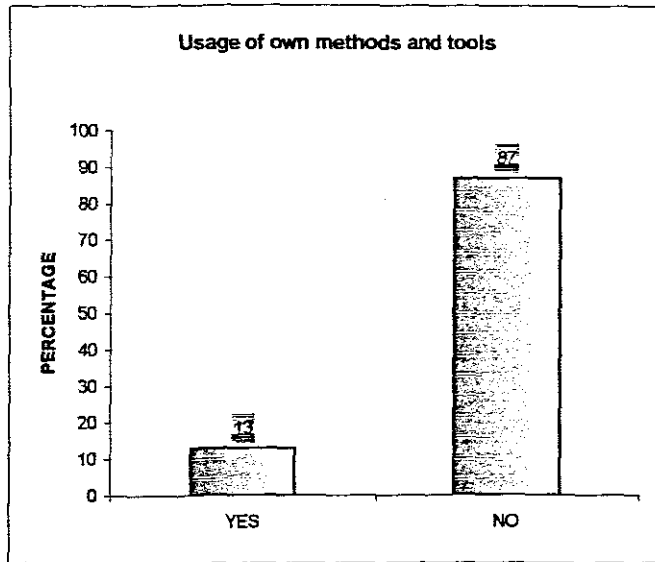


SUMMARY OF RESULTS

YES 87 %
NO 13 %

Question. 5.2.3. Do you utilise your own method and tools to perform I.B.C. alignment & Bogie streamline so as to capture the sizes for data collection on form?

Figure 25: Use own method and tools for data collection.



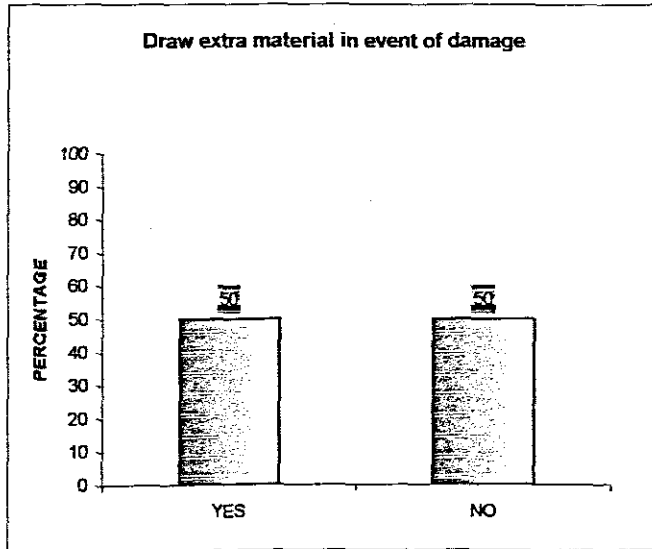
SUMMARY OF RESULTS

YES 13 %

NO 87 %

Question. 5.2.4. When replacing defective components do you just draw the quantity material required or do you get extra for incase of damage during the fitting process?

Figure 26: Draw additional material quantity in the event of damage

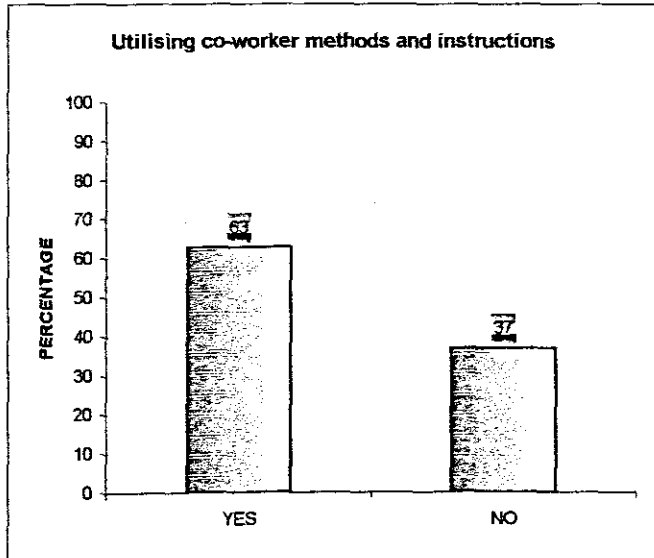


SUMMARY OF RESULTS

YES 50 %
NO 50 %

Question. 5.2.5. Do you make use of your co-workers methods and instructions as how to execute the task in the back shop?

Figure 27: Utilisation of co-worker methods and instructions when executing tasks

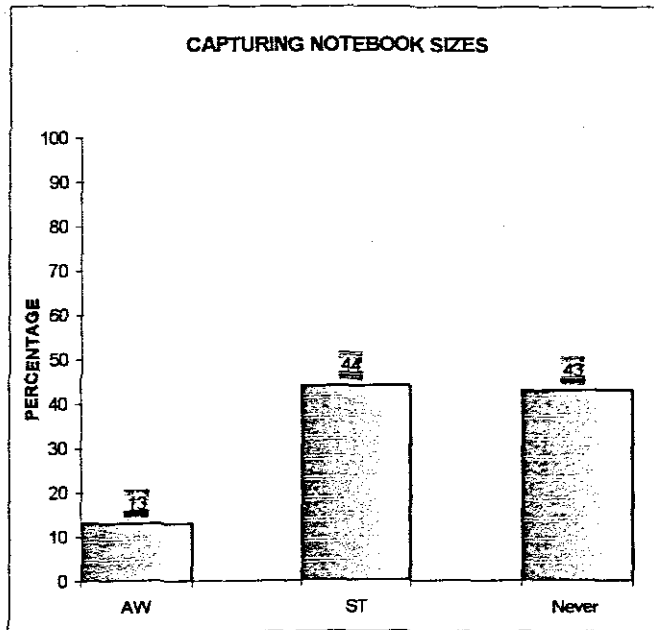


SUMMARY OF RESULTS

YES 63 %
NO 37 %

Question. 5.2.6. Do you make use of your own notebook sizes to capture the sizes for I.B.C. alignment on data sheets? (forms)

Figure 28: Capturing notebook sizes

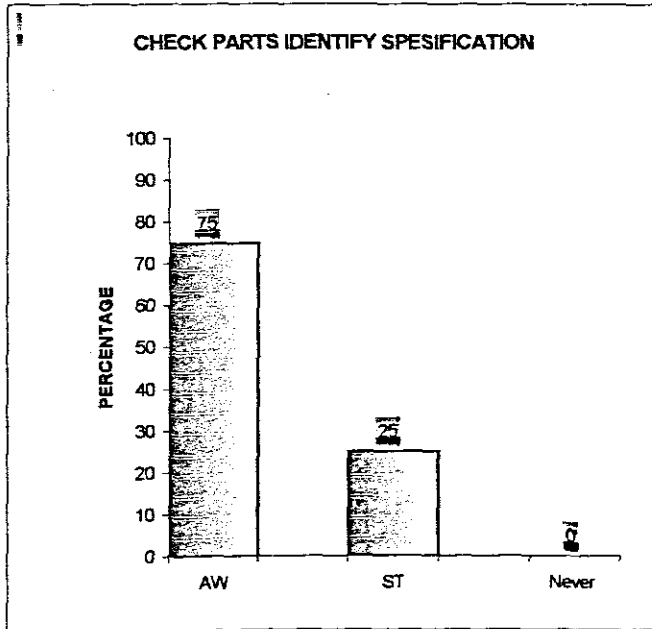


SUMMARY OF RESULTS

| | | |
|-------|------|------------|
| AW | 13 % | FREQUENT |
| ST | 44 % | INFREQUENT |
| Never | 43 % | |

Question. 5.2.7. When fitting new parts do you check that it is the correct type and size according to specifications? (compare with old one)

Figure 29: Check parts (identify) to specification

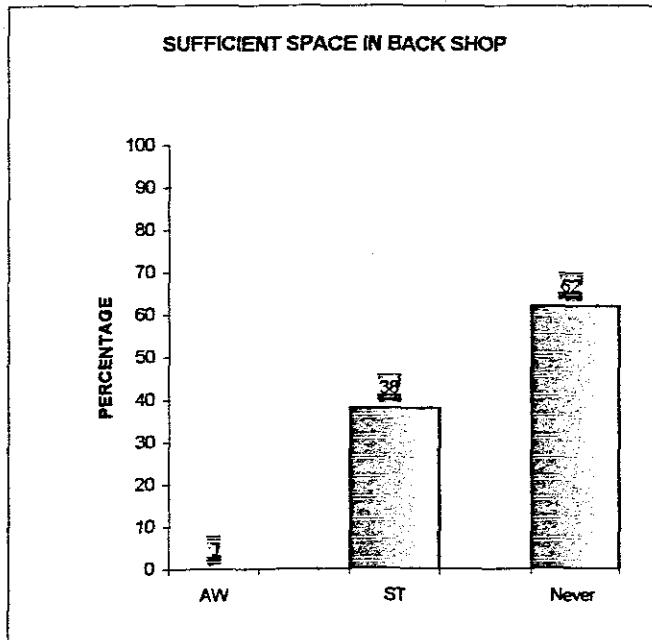


SUMMARY OF RESULTS

| | | |
|-------|------|------------|
| AW | 75 % | FREQUENT |
| ST | 25 % | INFREQUENT |
| Never | 0 % | |

Question. 5.2.8. Is there sufficient space in the back shop to execute your task accordingly to the business rules properly and correct?

Figure 30: Sufficient floor space in back shop



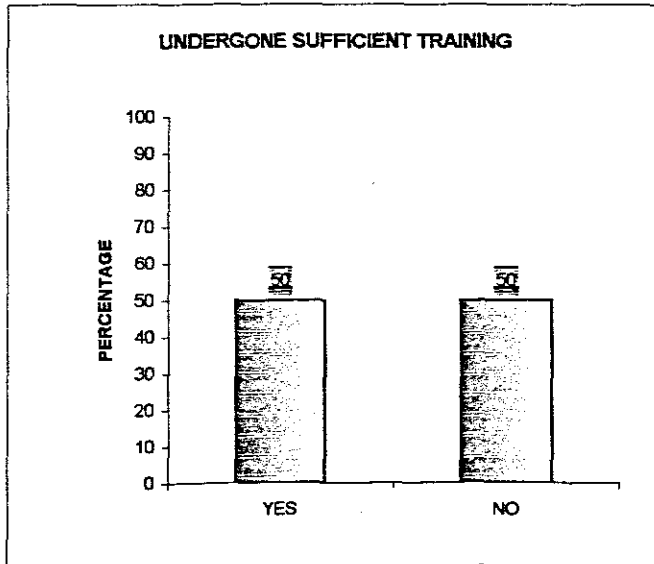
SUMMARY OF RESULTS

| | | | |
|-------|----|---|------------|
| AW | 0 | % | FREQUENT |
| ST | 38 | % | INFREQUENT |
| Never | 62 | % | |

Section Three: Training

Question. 5.3.1. Do you think that the training you received to assist and equipped you to execute your task in back shop was enough?

Figure 31: Undergone sufficient training.



SUMMARY OF RESULTS

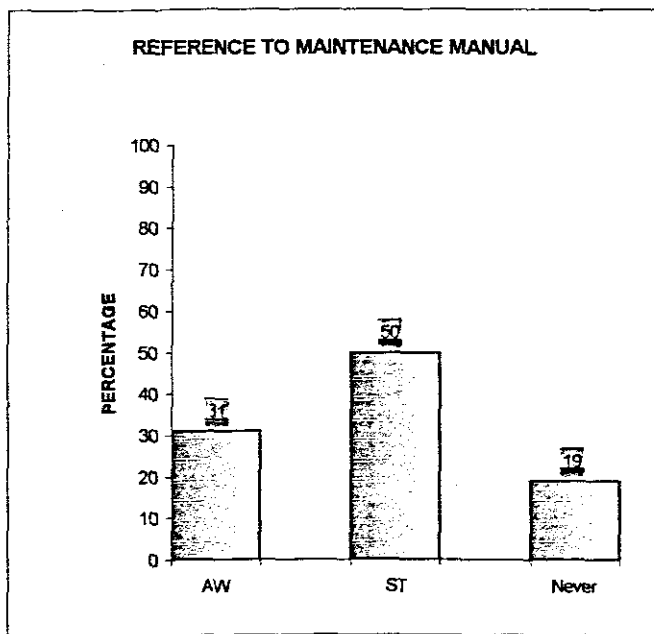
YES 50 %
NO 50 %

Section Four: Reference to maintenance manual

AW (FREQUENT) ST (INFREQUENT) Never as Percentage %

Question. 5.4.1. When capturing data, do you refer to the maintenance manual for prescribe tools to use for I.B.C. alignment and bogie streamline?

Figure 32: Reference to maintenance manual for prescribing tools when capturing data

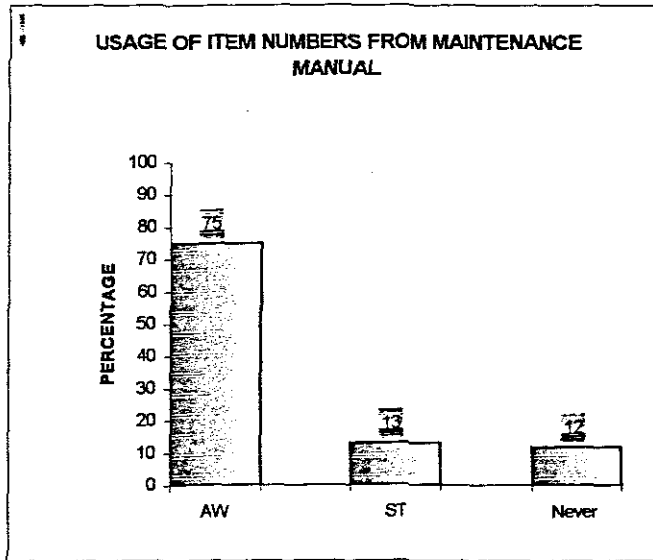


SUMMARY OF RESULTS

| | | |
|-------|------|------------|
| AW | 31 % | FREQUENT |
| ST | 50 % | INFREQUENT |
| Never | 19 % | |

Question. 5.4.2. When replacing worn or broken components, do you refer to the maintenance manual to look-up the correct material item number?

Figure 33: Use of item number from maintenance manual when replacing component

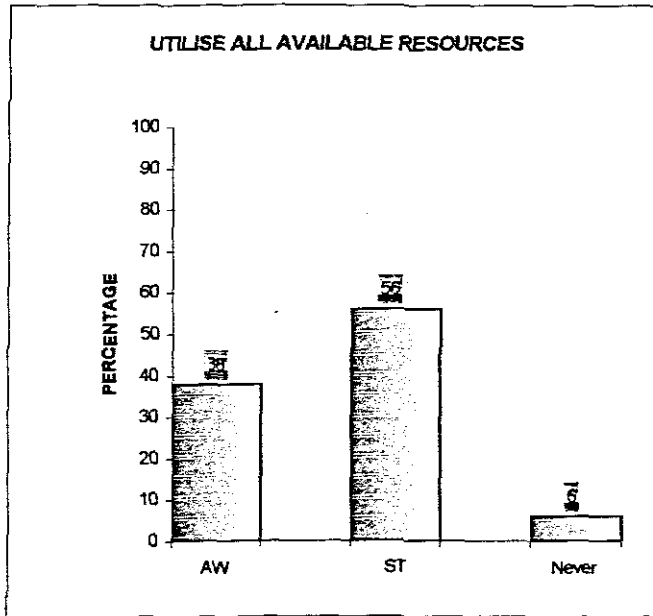


SUMMARY OF RESULTS

| | | |
|-------|------|------------|
| AW | 75 % | FREQUENT |
| ST | 13 % | INFREQUENT |
| Never | 12 % | |

Question. 5.4.3. While replacing new components or material, do you utilise all the available resources to assist you with the task?
(manual, tools, procedures)

Figure 34: Utilisation of all available resources

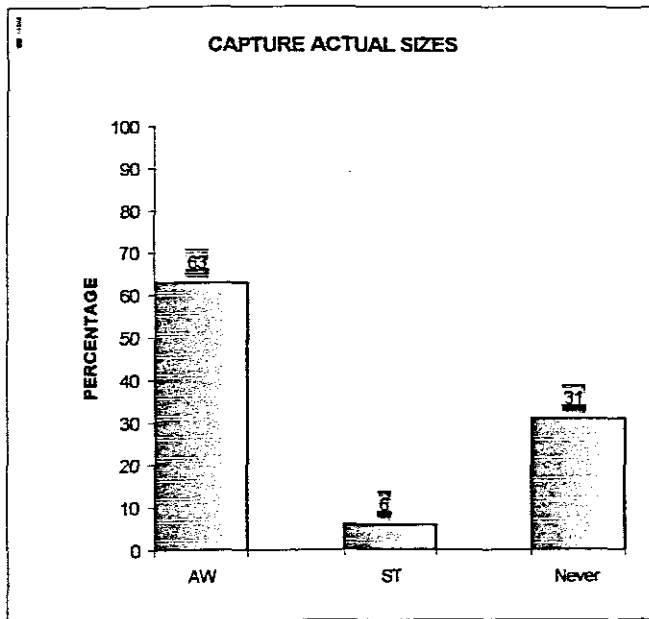


SUMMARY OF RESULTS

| | | |
|-------|------|------------|
| AW | 38 % | FREQUENT |
| ST | 56 % | INFREQUENT |
| Never | 6 % | |

Question. 5.4.4. When executing I.B.C. alignment, do you write the real sizes down as measured on the forms, referring to the maintenance manual instruction methods?

Figure 35: Capturing of actual sizes according to form (Inspection)



SUMMARY OF RESULTS

| | | |
|-------|------|------------|
| AW | 63 % | FREQUENT |
| ST | 6 % | INFREQUENT |
| Never | 31 % | |