

**THE APPLICATION OF WORK STUDY METHODOLOGIES:
TOWARDS THE DEVELOPMENT OF AN EFFICIENCY
REPORTING SYSTEM FOR MANUFACTURING
ORGANISATIONS IN SOUTH AFRICA**

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DECLARATION

I, **Barnes Sookdeo**, hereby declare that this dissertation submitted for degree purposes at the North-West University, has not previously been submitted for degree purposes at any other institution of higher learning and that, except for sources acknowledged, the work is entirely that of the researcher.

.....

22 August 2015

DEDICATION

I dedicate this study to the fond memory of the following four people that had a significant impact on my life:

- My beloved father and mother, who gave me the ultimate gift of life;
- The late Devanand Ramlall, who instilled in me the need to study further, and
- My late “brother” Roger Narain for his continuous encouragement to pursue my dreams.

I sincerely wish they could be here to celebrate this achievement with me.

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“Be the change you wish to see in the world”

Mohandas Karamchand Gandhi

ABSTRACT

The aim of this study is to demonstrate that work study techniques must be used to determine realistic and achievable standard times for operations and the subsequent development of efficiency reporting systems towards the improvement of performance. Carcasses of organisations that foundered without the ability to time their operations cover the manufacturing landscape in South Africa as many new business ventures fail to sustain themselves. Many organisations do not measure their efficiencies and do not have reporting systems in place. This study presents an efficiency reporting system designed and based on work study techniques which organisations can use to measure their performance. The necessity for the system was supported by the empirical results of the research instrument. It is recommended that organisations utilise this system and adapt it to their specific needs in order to measure their efficiencies. The existence of a dedicated efficiency reporting system ensures that employee performance and production outputs as per set targets are monitored, measured and sustained. Findings of this study may be extended to the service sector.

Keywords: work study, efficiency, method study, work measurement, standard time, basic time, rating, time study, rest allowance, contingency allowance.

ABBREVIATIONS AND ACRONYMS

ERS	-	Efficiency reporting systems
CSS	-	Central Statistic Services
OR	-	Operational research
IV	-	Internal validity
JIT	-	Just in time
BPR	-	Business process engineering
BMR	-	Bureau of market research
URL	-	Uniform reference locator
WMSD	-	Work-related musculoskeletal disorders
TQM	-	Total quality management
RTC	-	Resistance to change
PMTS	-	Predetermined motion time systems
PPE	-	Personal protective equipment
BOK	-	Body of knowledge
TEAS	-	Time elapsed after study
TEBS	-	Time elapsed before study
AT	-	Actual time
SBT	-	Selected basic time
CA	-	Contingency allowance
RA	-	Rest allowance
BT	-	Basic time
ANNOVA	-	Analysis of variance

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION AND BACKGROUND

A major cause of companies getting into trouble with manufacturing is the tendency for many managers to accept simplistic notions in evaluating performance of their manufacturing facilities. The general tendency in many companies is to evaluate manufacturing primarily on the basis of cost and efficiency. There are many more criteria to judge performance (Neely, 2000:1119). All high-performance organisations – whether public or private – are and must be interested in developing and deploying effective performance measurement and performance management systems, since it is only through such systems that they can remain high-performance organisations. Nowadays, companies have a great demand for measuring the standard time of the products that they produce to compete effectively (Dagdevirena, Eraslanb & Celebic, 2011:563).

As the above statements suggest, one of the main weaknesses of current performance measurement systems used by organisations is that those organisations normally adopt a narrow, unidimensional focus (Neely, 2000). Karatepe and Ekiz (2004:476) state that increasing global competition, understanding customers' expectations, and meeting customer needs are critical if superior service quality is to be delivered.

Kennerley and Neely (2003:213) state that increasingly the environment in which organisations compete for market share is dynamic and rapidly changing, constantly requiring organisations to modify their strategies and even their operations to reflect the changing circumstances. Despite these pressures, few organisations appear to have systematic processes in place to ensure that their performance measurement systems continue to reflect their environment and strategies. This places organisations under tremendous pressure to reduce their costs, increase their service levels and supply goods of superior quality in order to be sustainable. In order to meet these goals and remain competitive, organisations embark on the use of many different tools, techniques and strategies to make their production processes more efficient. In addition, organisations are always searching for ways to optimise business processes so that they can reduce manufacturing costs. However, developing efficiency reporting systems ERSs without the

use of work study techniques simply compounds the confusion and inaccuracy of the system and adds to the cost of performance measurement (Paranjape, Rossiter & Pantane, 2006).

When standard hours are not realistic, production schedules fail. Setting standard hours is not just a major challenge for today's industrial engineer, it is critical. Some operations require high-cost, high-tech, traditional work measurement, but one can often employ a low-cost, low-tech method. Many organisations have unrealistic, few or no standard hours. Carcasses of firms that foundered without the ability to time their operations cover the manufacturing landscape (Thomas, 2006:35). In South Africa, about 40% of new business ventures fail in their first year, 60% in their second year, and 90% in their first 10 years of existence and most businesses do not survive past the first year (Central Statistic Services, 2002; ETV News Bulletin, 2014).

The above information begs the question: "Why measure?" This question was pivotal in the researcher's decision to conduct an investigation using work study methodologies towards the development of an ERS) for manufacturing organisations in South Africa. If organisations are to be competitive, they must understand that invisible value exists all around awaiting their discovery, and measurement systems and controls allow them to 'see' this value. It must be understood that if you cannot measure, you cannot control and "If you cannot measure, you cannot manage" (Rollins & Lanza, 2005). In addition, there are old adages such as "What gets measured, gets done" and "You get what you measure" (Kennerley & Neely, 2003). In order to measure, an organisation must have a dedicated ERS to measure its outputs and subsequently its productivity. Riddle (2010:01) states that increasing employee productivity should be at the forefront of any managerial mind. In simple terms, the owner or manager of the organisation must develop a statistical and measurable way to measure each employee's actual production and then balance those numbers against the cost of each employee.

For the purpose of this study, the researcher conducted a work study investigation in a selected manufacturing organisation, and outlined the work study methodologies that were used to improve the methods of working, determine standard times and develop an ERS as the output of this study. The study was conducted in the field of operational research (OR). OR is an analytical method of problem solving and decision-making that is useful in the management of organisations. In operations research, problems are broken down into basic components and then solved in defined steps by mathematical analysis (www.whatis.techtarget.com).

Neely (2000:1141) states that little work has been done on the process of actually designing

measurement systems. The present study aimed to make an essential contribution in ensuring that manufacturing organisations in South Africa have, at their disposal, a dedicated ERS developed using the universally accepted techniques of work study to measure their performance. Furthermore, it outlines the benefits of a work study investigation towards productivity improvement and overall organisational effectiveness. The measurement of performance allows organisations to determine whether they are profitable and sustainable as the sustainability of organisations is considered to be the panacea for South Africa's unemployment problems and a stagnating economy (Van Scheers & Radipere, 2007).

1.1.1 The researcher

The researcher is presently employed as a senior lecturer at the University of South Africa (Unisa) and is in charge of the qualification National Diploma in Management Services. He lectures five subjects with approximately two thousand registered students. He spent sixteen years practicing work study in industry and fifteen years in academia. He has a passion for work study and an avid interest in his personal efficiency. He approached a large manufacturing organisation for the purposes of conducting this study. After liaisons with the management of the organisation and Unisa, permission was granted to the researcher to conduct the investigation. The researcher was required to sign a letter of confidentiality.

1.1.2 The organisation

This section contains a brief of the organisation where this research was conducted.

1.1.2.1 Origins of the organisation

The organisation represented in this study is based in Krugersdorp, Gauteng, South Africa. It was established more than 50 years ago to manufacture taps and plumbing fittings specifically designed to suit local market needs. Today, the organisation employs approximately 1 500 people. For the purposes of this study, the organisation will be referred to as Company A.

The company is best known for its popular range of stylish taps and mixers, showers, accessories and reticulation design systems for the domestic market. The product range is comprehensive and extensive, often incorporating technology initiated and developed within the company itself. Systems and techniques pioneered by Company A have become benchmarks for the industry. Every component manufactured meets stringent quality and performance standards that not only comply with the company's internal quality specifications, but also with internationally respected and independent quality assurance

standards. Many changes have followed, and yet the strengths and qualities, which allowed a small 'family business' to grow in Africa's leading supplier of plumbing fittings remain the same. Company A is committed to the kind of inventive thinking which solves problems, no matter how intricate they may be.

1.1.2.2 Main product lines produced and sold

Company A's main product line consists of a variety of water taps and mixers as well as bath and shower accessories. It also specialises in the manufacture of a wide range of pressure relief and control valves as well as a variety of toilet and urinal flush valves. Together with this, the company manufactures gate valves, ball valves and capillary fittings.

1.1.2.3 Major markets, customers and competitors

Company A's main sales market is Southern Africa, including Botswana, Zimbabwe, Mozambique and Namibia. The exports of products are also becoming another major market. Products are currently being exported to Australia, Malaysia, Chile and the United States of America, to name but a few. The company does not sell its product directly to the customer, but makes use of merchants to sell it for them. Their competition comes in the form of imports from other countries. Local competition comes from two companies, namely Pro-brass and Isca. International competition comes from companies like Gröhe, SOS and KWC.

1.1.3 The field of study

This study was conducted in the field of operational research with the emphasis on the concept of work study and productivity. Work study is the systematic examination of the methods of carrying out activities so as to improve the effective use of resources and to set up standards of performance for the activities being carried out (Kanawaty, 1995:09), whilst productivity is a measure of the effective use of resources, usually expressed as a ratio of output to input (Stevenson, 2009:53). Productivity is generally defined as the ratio of an extent of output to the unit of all of the resources used to produce this output (Kulkarni et al., 2014:429).

The present study was limited to the assembly department of Company A. At the time of this study, this department consisted of four assembly lines and u-cells. For the purposes of this study, the study was limited to the assembly of taps only. At the time of the research, the assembly department employed an average of one hundred and twenty employees. Supervision came in the form of a production manager, three foremen and a line leader for each of the four lines.

Initial visits to Company A revealed that the organisation did not have properly set standard times for their operational processes, some of which were highly labour-intensive. Standard times were determined via work measurement, which is a universally accepted technique of work study (Pycraft, Singh, Philela, Slack, Chambers & Johnston, 2010:247). Daily production reports on performance to management were inconclusive due to the absence of proper standard times and hence hindered decision-making towards the achievement of predetermined goals. A standard time is the amount of time it should take a qualified worker to complete a specified task, working at a sustainable rate, using given methods, tools and equipment, raw materials and workplace arrangement (Stevenson, 2007:328). Kanawaty (1995:336) defines work measurement as the application of techniques designed to establish the time for a qualified worker to carry out a task at a defined rate of working.

The above information justifies the necessity for this study, and the justification is enhanced by the following statements:

- If an organisation does not measure its production on an ongoing basis, it will not be able to sustain itself.
- Non-measurement of production leads to poor employee performance.
- Management requires continuous feedback and reports regarding production.
- Employees need to know that they are utilising the best methods and that the set time standards are realistic and achievable.
- Accurate time standards are imperative for control and for costing purposes.
- An effective ERS is vital to ensure set targets are achieved.

Preliminary observations revealed that the present standard times for the operations were not set by experienced work study officers. Employees carried out work without set targets. At the time of the research, there was no established method of measuring employee outputs, i.e. no recording system and no standards. Management had a set daily target of R1.2 million for the assembly department. The department lacked adequate supervision. The production manager did not work at all on the shop floor. The three foremen did not have designated areas of responsibility. The line leaders did not fulfil their core responsibility but work merely as 'fillers' in the event of an operator leaving the assembly line. The researcher had to utilise work study techniques and methodologies to:

- carry out an intensive method study investigation using the universally accepted procedure of method study;

- carry out work measurement on selected popular taps and other related operations in order to set realistic and achievable standards;
- develop and implement an ERS; and
- overall, enhance productivity and add to the body of knowledge in the field of work study.

1.2 PROBLEM STATEMENT

In South Africa, about 40% of new business ventures fail in their first year, 60% in their second year, and 90% in their first 10 years of existence (CSS, 2002). In addition to this, about 75% of small, micro and medium enterprises do not become established businesses (Fatoki & Garwe, 2010:71) and as much as 80% fail in the first 10 years after inception. This is supported by Niemand and Nieuwenhuizen (2009:35) who state that an unacceptable and disappointingly high number of business ventures fail during the first few years of operation in South Africa. This trend cannot be allowed to continue as the South African economy will suffer as a result of the non-sustainability of organisations and subsequent job losses.

A review of literature showed that few organisations appear to have systematic processes in place. Many organisations are getting into trouble without ERSs and many managers use simple methods to evaluate performance. Organisations normally adopt a narrow focus with regard to ERS, and have unrealistic, unachievable, few or no standard times. Organisations consequently cannot time their operations and little work is completed on designing measurement systems (Neely, 2000:375; Riddle, 2010:01; Rollins & Lanza, 2005; Thomas, 2006:35). This statement is supported by Paranjape et al. (2006) who argue that little research has been done on performance measurement within global organisations operating in dynamic business environments.

During regular visits (industry liaison) to manufacturing organisations, the researcher found that many organisations lacked dedicated methodologies to effect improvements in their workplaces. They did not have ERSs in place and many did not measure their efficiencies on a regular basis. This view was supported by the literature review. Hence, the formulated problem statement of this study was that organisations do not use work study methodologies to determine the standard times for their operations in order to measure their efficiencies and monitor outputs.

1.3 THE RESEARCH QUESTION

The above problem statement gave rise to the following research question:

Which framework can organisations use to determine their efficiencies using work study methodologies?

1.4 AIM AND OBJECTIVES OF THE STUDY

The aim and objectives of the study are explained below:

1.4.1 Aim of the study

Paranjape et al. (2006) state that a performance measurement framework, with a primary focus of being adaptive, and a secondary focus of operating within a process-driven framework, which acknowledges the team and individual structures of global organisations, needs to be designed. Therefore, the aim of the present study was to develop an ERS using work study methodologies and to make it available to organisations.

1.4.2 Objectives of the study

In the present study, the researcher aimed to:

- carry out a detailed literature survey with the goal of identifying the different techniques that would be necessary for the execution and success of this study;
- conduct a complete work study investigation using the universally accepted work study techniques and methodologies;
- carry out an intensive method study investigation using the universally accepted procedure of method study in order to ensure that the most efficient methods of work are being used;
- carry out a work measurement investigation on a selected popular tap in order to set realistic and achievable time standards;
- develop and utilise research instruments to elicit responses of employee experiences in the assembly department of Company A, in order to identify factors that constitute stumbling blocks to improved productivity and to elicit responses from those in manufacturing organisations regarding the availability of an ERS at their place of work;
- develop an ERS using work study methodologies; and
- present the ERS to four organisations to elicit their responses on its suitability.

1.5 KEY THEORETICAL CONCEPTS

The following shows the key theoretical concepts:

Work study

Kanawaty (1995:09) defines work study as the systematic examination of the methods of carrying out activities so as to improve the effective use of resources and to set up standards of performance for the activities being carried out.

Efficiency

Efficiency implies that the right technique or method has been used for doing a job or achieving a goal.

Inputs

This includes human labour, materials and capital. Capital also means the availability of vehicles and equipment such as buildings, plant, tools, instruments, work equipment, furniture and other equipment. Input can also be expressed in terms of money, hours or physical units.

Outputs

This includes all goods and services, which satisfy human needs. Output therefore not only implies the production of industrial and agricultural products, but also the provision of services by doctors, teachers, people in the retail trade, office workers, people in municipal services and tertiary organisations and attorneys. Output can be expressed in terms of money, hours or physical units.

Process charts

This is one of the most commonly used recording techniques used during a method study investigation.

Process symbols

These are symbols that are used in the compilation of process charts. In order to carry out a method study effectively, process chart symbols are absolutely essential and all management services practitioners must understand the meanings of the symbols and must be able to use them in practice.

Work content

The amount of work 'contained in' a given product or process, measured in 'work hours' or 'machine hours'.

Standard

A standard can be defined as a stated rule, model or criterion against which comparisons can be made. A standard is therefore some kind of pre-determined norm.

Standard time

The total time, in which a job should be completed at standard performance, i.e. work content, contingency allowance for delay, unoccupied time and interference allowance, where applicable.

Standard pace (rating)

The assessment of the worker's rate of working, relative to the observer's concept of the rate, corresponding to standard pace.

Work cycle

A work cycle is the sequence of elements which are required to perform a job or yield a unit of production. The sequence may sometimes include occasional elements.

Element

An element is a distinct part of a specified job selected for convenience of observation, measurement and analysis.

Breakpoint

Breakpoint refers to the instant at which one element in a work cycle ends and another begins.

Time study

A work measurement technique for recording the times of performing a specific job or its elements carried out under specified conditions, and for analysing the data so as to obtain the time necessary for an operator to carry the job out at a defined rate of performance.

1.6 RESEARCH METHODOLOGY

The research methodology of this study consisted of the following:

1.6.1 Research design

The research design of this study was a mixed-methods approach, i.e. a mixture of both qualitative and quantitative research. Cresswell and Plano Clark (2011:04) state that mixed-methods research is a type of research in which the researcher combines elements of qualitative and quantitative research approaches for the purposes of breadth and depth of understanding. Research in the present study took the form of systematic data collection relating to the requirements for the development of the ERS. Cooper and Schindler (2006:198) articulate that quantitative research is often used for testing a theory and is focused on describing, explaining and predicting data with the use of statistical and mathematical methods.

The theoretical concepts and the subsequent integration of theory into practice with regard to the two techniques of work study represented the qualitative research of this study. The method study investigation entails the use of process charts to record the activities of the present method of working and thereafter proposed or improved methods are developed and implemented. In the present study, the work measurement investigation involved the use of time study to measure the durations of all activities and thereafter the development of standard times.

Due to the processes being highly labour-intensive, the research instrument took the form of questionnaires. This survey method was deemed appropriate as employees in the organisation could be accessed easily, as also reported by Alam, Hoque, Rout and Priyadarshani (2010:775). These are used to gain insight into the availability of ERS's in organisations and the problems experienced by employees of the assembly department and possible reasons for poor performance.

In order to achieve the above-mentioned objectives, the following research methodology was envisaged:

1.6.1.1 *Carry out a detailed literature survey to identify techniques necessary for the execution and success of this study*

- survey literature on the concept of productivity as the study revolved around the enhancement of productivity at Company A;

- survey literature on related methodologies such as ergonomics, work sampling, lean manufacturing, value analysis and business process engineering to create an awareness of the different management aids that are or should be available to management; and
- examine the current work study literature critically to determine the methodologies necessary for the development of the ERS.

1.6.1.2 Conduct a complete work study investigation using universally accepted work study techniques and methodologies

- follow the universally accepted procedure of work study to conduct a thorough investigation of the assembly department at Company A;
- carry out a method study investigation to chart the activities of the present method of working and thereafter to develop and implement improved methods of working; and
- carry out a work measurement investigation using time studies to determine standard times in order to develop the ERS.

1.6.1.3 Develop an efficiency reporting system

- use the standards compiled using time studies, to develop the ERS;
- present the ERS to four organisations to elicit their responses on its suitability and report on this in the conclusions and recommendations; and
- offer the new system to organisations so that they can utilise ERS to record and monitor their efficiencies.

1.6.2 Population and sampling procedures

“A population is a totality of persons, events, organisation units, case records or other sampling units with which our research problem is concerned” (De Vos, 2002:199). The population for the present study consisted of all employees of the assembly department of Company A and selected manufacturing organisations in South Africa.

1.6.3 Data collection

Data was collected via the method study and work measurement techniques of work study. Work sampling was also used to determine the percentage occurrences of employee and related activities. Process charts were used to document the present method of all operations and thereafter to analyse the recorded data, them critically, in order to develop

alternate and improved methods. Time studies were used to collate data for the calculation of standard times towards the development of the ERS.

Questionnaires were used to gain insights into the availability of ERSs in organisations and to elicit responses from employees regarding the problems experienced and possible reasons for poor performance.

Pilot studies were carried out for the clarity and comprehension of the formulated questions. A pilot study allows the researcher to correct possible errors before the final questionnaires are printed and copies made. It also allows the researcher to redesign problematic areas of the questionnaires before they are actually used. Pilot testing also predicts difficulties that may arise during the data collection that may otherwise go unnoticed. It also provides useful information about how the questionnaire will actually perform in the field. According to De Jager (2003:92), the pilot test is a critical step in assessing the practical application of the survey instrument although it requires extra time and energy.

1.6.4 Data analysis

During the present study, data collected from the method study and work measurement investigation was analysed using the set procedures of these two techniques. New and improved processes were developed using process charting. Time studies were analysed using the procedure for time study. Relaxation and contingency allowances were allocated in order to develop standard times for the selected processes.

Work sampling was carried out to determine the percentage occurrences of three basic activities, namely working, idle and absent from workplace. This was done to determine the average percentage of time that employees of the assembly department spent on the above three activities.

Two questionnaires were used during the present study to collect data.

Questionnaire 1: This was compiled by the researcher based on indicators from the literature review, and completed questionnaires were sent to an independent statistician for data capturing and processing. Due to the literacy levels of the employees, the questions had to be designed in such a way that the operators were able to understand the terminology used (Rathilall, 2010). The data gained through the questionnaires was imported in SAS/JMP version 9.0. Variable labels and value labels were allocated and a frequency analysis was performed upon each of the variables.

Questionnaire 2: This questionnaire was compiled using the LimeSurvey program. Data capturing and processing was an automatic process and the researcher was assisted by a statistician based at Unisa in the Bureau of Market Research.

1.7 VALIDITY AND RELIABILITY

1.7.1 The concept: validity

The idea behind validity is that it encompasses the entire experimental concept and establishes whether the results obtained from a study meet the requirements of a scientific research method (Shuttleworth, 2008). Price (2000:01) states that when we conduct experiments, our goal is to demonstrate cause-and-effect relationships between the independent and dependent variables. We often try to do it in a way that enables us to make statements about people at large. How well we can do this is referred to as the study of generalisability. A study that readily allows its findings to generalise to the population at large has high external validity. The degree, to which we are successful in eliminating confounding variables within the study itself, is referred to as internal validity. The validity of a measuring instrument refers to how well that instrument measures what it is intended to. A study is valid if it measures what it claims to measure. Internal and external validity are discussed below.

1.7.1.1 Internal validity

Leedy and Ormrod (2005:97) state that the internal validity of a research study is the extent to which the design of the study and the data it yields allow the researcher to draw accurate conclusions about cause-and-effect and other relationships within the data. The questions asked in this instrument were formulated from the literature study. Huitt, Hummel and Kaeck (1999:01) state that one of the keys to understanding internal validity is the recognition that when it is associated with experimental research, it refers both to how well the study was run (research design, operational definitions used, how variables were measured, what was/was not measured, etc.), and how confidently one can conclude that the change in the dependent variable was produced solely by the independent variable and not by extraneous ones.

A pilot study was conducted with selected employees of the assembly department at Company A. The persons involved in the pilot study had to verify whether the questionnaire was measuring exactly what it was intended to measure. The feedback received from these persons was used to finalise the questionnaire. The completed questionnaire was then sent to a senior researcher at the research department of Unisa for final inputs.

1.7.1.2 External validity

External validity refers to the generalisation of the findings and conclusions of the study. Further to this, external validity is preceded by internal validity. If a study can be referred to be valid internally, it is possible to claim external validity. Leedy and Ormrod (2005:99) state that the external validity of a research study is the extent to which the results of the study apply to the situations beyond the study itself – in other words, the extent to which the conclusions drawn can be generalised to other contexts. Based on Huitt et al. (1999:01), it can be stated that, although it was assumed that insights gained in the present research might be found useful by academic peers, this was not the major concern of the study. The extent to which the results of a study (regardless of whether the study is descriptive or experimental) can be generalised or applied to other people or settings reflects the external validity.

1.7.2 The concept: reliability

Babbie (2008:157) states that reliability is that quality of the measurement method that suggests that the same data would be collected each time in repeated observations of the same phenomenon. The idea of reliability in this study entailed that any significant results had to be more than just a once-off finding and had to be repeatable. Others should be able to perform exactly the same study and generate the same results. Leedy and Ormrod (2005:99) state that reliability is the consistency with which a measuring instrument yields a certain result when the entity being measured has not changed. A research instrument is reliable to the extent that it measures whatever it is measuring consistently. The results of this study are applicable to all manufacturing organisations as the work study techniques utilised for this study are universally accepted and can be generalised to all organisations.

In conclusion, validity is the extent to which the research findings accurately represent what is happening in a specific situation, and reliability involves the credibility of the findings (Welman, Kruger & Mitchell, 2005:142).

1.8 ETHICAL CONSIDERATIONS

Since this study required the participation of human subjects, it was necessary to consider the ethics of research design (Babbie, 2008). The most important ethical agreements which Babbie (2008:67) summarises as applicable to this study included voluntary participation, informed consent, anonymity and confidentiality.

All employees were advised of the presence of the researcher and the purpose of the study. Work study clearly dictates that no work should be carried out without the person being studied having knowledge of it. Consent from employees had been obtained before the questionnaires were issued. Compared to observation, questionnaires have fewer ethical problems as they afford the participants more control in that they can refuse to answer troublesome questions.

In this regard, all respondents were handed the same questionnaire and the questions allowed the respondents opportunities to share their own experiences, problems and ideas. Participation of employees was voluntary and confidentiality and anonymity were ensured.

1.9 VALUE OF THE STUDY

In order for organisations to ensure sustainability, it is necessary to measure its productivity. Organisations are failing to do this and this inevitably leads to low outputs. Low outputs lead to low sales revenue and subsequent low profits. The value of this study will ensure that:

- organisations have, at their disposal, a developed ERS which they will be able to adapt to suit their needs;
- organisations are able to measure efficiencies on an hourly basis; hence, that they will be able to detect inefficiencies early;
- organisations are able to set realistic and achievable standard times for their production processes;
- the value of this study will ensure it improves the researcher's knowledge in the subject area; and
- the work study investigation and the ERS will add to the body of knowledge in the fields of work study, management services, quality and operations management.

1.10 LIMITATIONS OF THE STUDY

The following were limitations of this study:

- The study was limited to the assembly of taps only.
- Resistance to change: humans do not accept change readily. Organisations will need to monitor the new system to ensure that employees do not revert to the old/inefficient method of operation.

- Literature on work study was found to be limited, and the researcher therefore had to make significant references to Kanawaty (1995), which is considered to be the 'bible' of work study.

1.11 LAYOUT OF THE RESEARCH REPORT

In this section, a summary of the study report is given.

CHAPTER 1: INTRODUCTION

This chapter outlines the essence of the study and is indicative of the proposal of this study.

CHAPTER 2: RESEARCH DESIGN AND METHODOLOGY

In this chapter, the emphasis is placed on the research design and the research methods employed and the data collection process.

The research design of this study comprised a mixture of both qualitative and quantitative research. Research in this study took the form of systematic data collection relating to the requirements for the development of the ERS. The two main techniques of work study, namely method study and work measurement, were utilised to gather information of the situation at the time of this research with the aim of effecting improvements.

The data collection instrument took the form of two questionnaires. The researcher applied the data collection instrument in the assembly department of Company A and a convenience sample was used. Respondents were all employees of the assembly department.

This chapter explains the rationale behind the methodology employed and the way in which the research was conducted. This includes a discussion of the study in terms of design and the data collection instrument used. The construction of the questions for the questionnaire emanated from the indicators of the literature survey.

CHAPTER 3: LITERATURE SURVEY

Productivity and related methodologies

In this chapter, the concept of productivity is discussed in detail, as the study revolved around the enhancement of productivity at Company A. This is followed by a look at various management aids that were developed through the years to assist managers in their daily

functions to ensure the efficiency and effectiveness of their organisations. Some of the management aids are motion study, value analysis, variety reduction and line balancing.

A literature survey was also conducted into other related methodologies such as ergonomics, work sampling (activity sampling), just in time (JIT) and lean manufacturing and business process engineering (BPR). These are discussed with the aim of identifying the different techniques that are necessary to improve productivity. A literature survey regarding the u-cell assembly method versus the traditional line assembly method was also conducted.

CHAPTER 4: LITERATURE SURVEY

Work study

In this chapter, the value of work study for an organisation is discussed. A comprehensive literature survey was undertaken to examine the current work study literature critically to determine the methodologies necessary for the success of the present study. The literature survey comprised data regarding the objectives, financial implications, procedure, structure, importance and value of work study. Furthermore, the literature survey covered the human factor in work study, the reaction of groups to work study, and work study officers and their relationships with others in the workplace. One of the main obstacles in the application of work study in an organisation is obtaining the co-operation of supervisors and workers. The two principal techniques of work study, namely method study and work measurement, are discussed in detail in Chapter 6.

CHAPTER 5: LITERATURE SURVEY

Work study techniques

In this chapter, the literature survey relates to the two principal techniques of work study, namely method study and work measurement, which are discussed in detail. The discussion covers the objectives, scope, structure and procedures of these two techniques. Since method study is considered to be a systematic investigation (Slack, Chambers & Johnston, 2010:259), the researcher defines a systematic investigation and shows the value of such a systematic approach to a problem in this chapter. The definition, principles, objectives, advantages and procedures of systematic investigations are discussed.

CHAPTER 6: DATA COLLECTION AND ANALYSIS PROCEDURES

This chapter comprises a discussion of the collection of the data for this study and the analysis of the data.

CHAPTER 7: RESULTS AND DISCUSSION OF FINDINGS: PART 1

The contents of this chapter relate to the findings and discussion of the results and the analysis of the work study investigation, i.e. the main issues that emanated from the data that was collected, analysed and presented. Part 1 presents the results and discussions of the method study and the work measurement investigation. The researcher revisits the literature review and selects the literature relating to the main issues that were identified and base the findings and discussion on these. The departmental layouts are examined and the present and proposed (improved) layouts are presented.

CHAPTER 8: RESULTS AND DISCUSSION OF FINDINGS: PART 2

The contents of this chapter relate to the findings and discussion of the two questionnaires, i.e. the main issues that emanated from the data that was collected, analysed and presented. Part 2 presents the results and discussions of the interpretations of the questionnaires. The ERS that was developed as the output of this study is also presented and discussed.

CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS

This chapter contains a summary of Chapters 1 to 8 in the form of a concise synopsis. In the conclusions, the research objectives set in Chapter 1 are revisited and reviewed to determine the exact extent to which these objectives had been achieved. The shortcomings of the research are also reviewed. In the recommendations, the researcher charts the way forward and makes considerations for further research.

Figure 1.1 below reflects a graphic representation of the layout of the thesis.

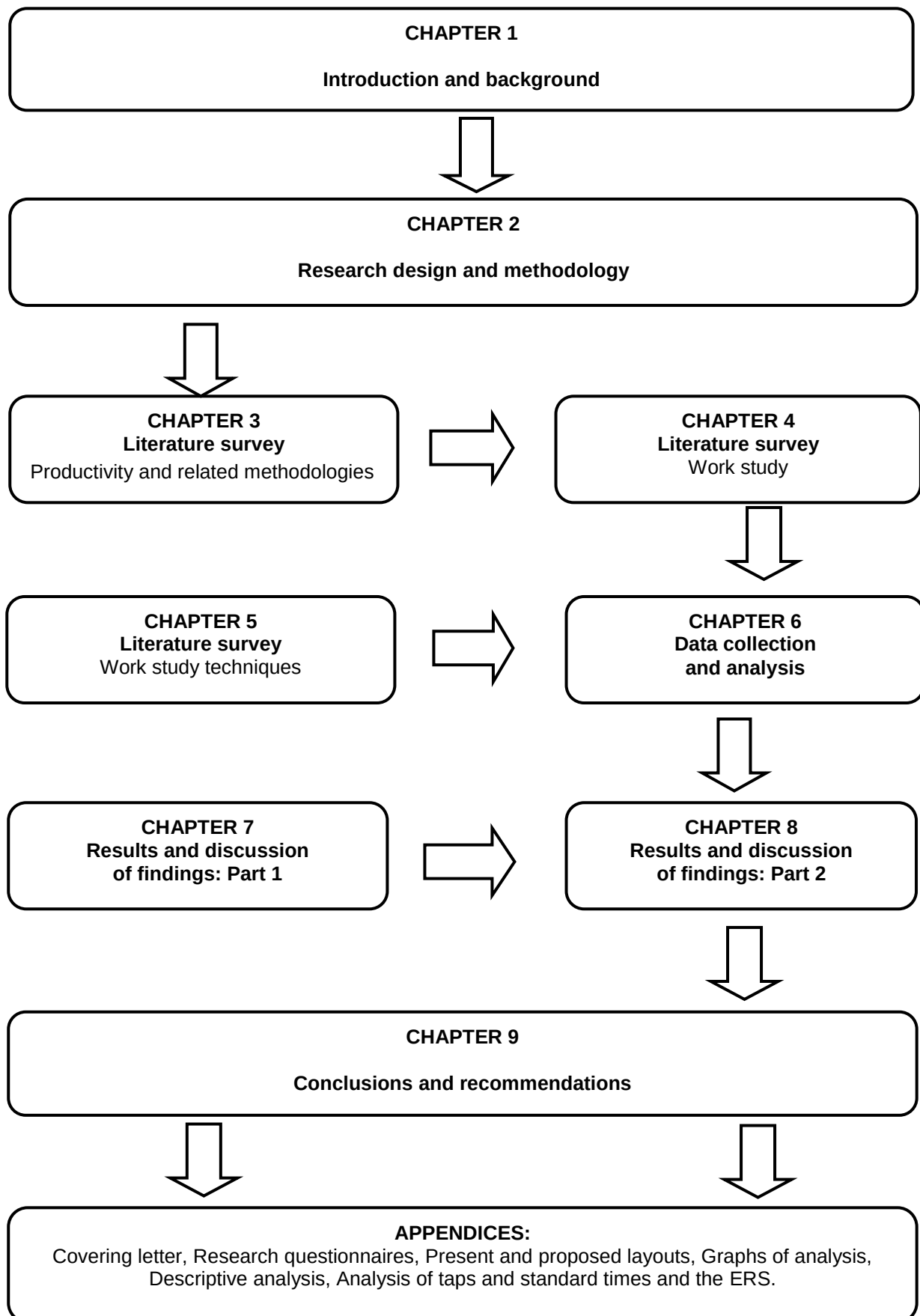


Figure 1.1: Layout of study

CHAPTER 2

RESEARCH DESIGN AND METHODOLOGY

2.1 INTRODUCTION

The previous chapter offered an introduction and background of the study.

The information gathered and discussed in the literature survey, formed the basis for the development of the research instruments. In this chapter, the emphasis is placed on the research design and the data gathering methodology employed. The researcher again shows the aim of the present study for purposes of clarity and to maintain the focus of the study. The primary sources for data gathering were the method study investigation, the work measurement investigation and two sets of questionnaires. The method study and work measurement investigations were conducted in the assembly department of Company A. The first set of questionnaires was applied in the assembly department. Respondents were one hundred and fourteen (114) employees of the assembly department and a “one hundred percent” sample will be used as this study was restricted to the assembly department of Company A. The second set of questionnaires was forwarded to eight hundred (800) respondents in manufacturing organisations in South Africa.

This chapter explains the rationale behind the methodology employed and the way the research was conducted. This comprises a discussion of the study in terms of design and the data gathering methodology, including the research instruments used and the sampling. The construction of the research instruments are also discussed.

2.2 RESEARCH DESIGN

The research design of the study is explained below:

2.2.1 Introduction

Research design provides the glue that holds the research project together. A design is used to structure the research, to show how all of the major parts of the research project, the samples or groups, measures, treatments or programmes, and methods of assignment work together to try to address the central research questions (Trochim, 2006:01). He further

states that research design provides the glue that holds the research together and it is also a plan outlining how information is to be gathered for an assessment or evaluation that includes identifying the data gathering method(s), the instruments to be used or created, how the instruments will be administered, and how the information will be organised and analysed. Zikmund (2000:65) states that a research design is a master plan that specifies the methods and procedures for collecting and analysing the needed information, in other words, it is a framework for the research plan of action. The objectives of the study, determined during the early stages of the research, are included in the design to ensure that the information collected is appropriate for resolving the research problem.

The present study followed a mixture of both qualitative and quantitative researches, which can hence be termed a mixed-methods approach. There can be little doubt that research that involves the integration of quantitative and qualitative research has become increasingly common in recent years. It conveys a sense of rigour of the research and provides guidance to others about what the researcher intends to do or have done. To that extent, the researcher found that the typologies of mixed-methods or multi-strategy research can be helpful to clarify the nature of his intentions with regard to this study (Bryman, 2006:97–98).

2.2.2 Problem statement

In South Africa, about 40% of new business ventures fail within their first year, 60% in their second year, and 90% in their first 10 years of existence (CSS, 2002). In addition, about 75% of small, micro and medium enterprises do not become established businesses (Fatoki & Garwe, 2010:71) and as much as 80% fail in the first 10 years after inception. This is supported by Niemand and Nieuwenhuizen (2009:35) who state that an unacceptable and disappointingly high number of business ventures in South Africa fail during the first few years of operation. This trend cannot be allowed to continue as the South African economy will suffer due to the non-sustainability of organisations and subsequent job losses.

A review of the literature shows that few organisations appear to have systematic processes in place. Many organisations are getting into trouble without ERSs. Many managers use simple methods to evaluate performance and organisations normally adopt a narrow focus with regard to ERS. Organisations thus have unrealistic, unachievable, few or no standard times. Organisations consequently cannot time their operations and little work has been completed on designing measurement systems (Neely, 2000; Riddle, 2010:01; Rollins & Lanza, 2005; Thomas, 2006:35). This statement is supported by Paranjape et al. (2006), who argue that little research has been done on performance measurement within global organisations operating in dynamic business environments.

During regular visits (industry liaison) to manufacturing organisations, the researcher found that many organisations lacked dedicated methodologies to effect improvement in their workplaces. They did not have ERSs in place, and many did not measure their efficiencies on a regular basis. This view is supported by the literature review. Hence, the formulated problem statement of this study was that organisations do not use work study methodologies to determine the standard times for their operations in order to measure their efficiencies and monitor outputs.

2.2.3 General aim of the study

Paranjape et al. (2006) further state that a performance measurement framework, with the primary focus of being adaptive and the secondary focus of operating within a process-driven framework, which acknowledges the team and individual structures of global organisations, needs to be designed. Therefore, the aim of the present study was to develop an ERS using work study methodologies and to make the ERS available to organisations.

2.2.4 Qualitative and quantitative research

The simplest way to distinguish between qualitative and quantitative research may be to say that qualitative methods involve a researcher describing kinds of characteristics of people and events without comparing events in terms of measurements or amounts. Quantitative methods, on the other hand, focus attention on measurements and amounts (more and less, larger and smaller, often and seldom, similar and different) of the characteristics displayed by the people and events that the researcher studies (Thomas, 2003:01). Denscombe (2005:232) reiterates this by saying:

- qualitative research tends to be associated with words as the unit of analysis; and
- quantitative research tends to be associated with numbers as the unit of analysis.

2.2.4.1 Qualitative research

The comprehensive literature survey (Chapter 2) makes up the qualitative research part of this study. Qualitative research is multi-method in focus, involving an interpretative, naturalistic approach to its subject matter. This means that qualitative researchers study things in their natural settings, attempting to make sense of it, or interpret it, and phenomena in terms of the meanings people bring to them. The qualitative approach is inductive, with the purpose of describing multiple realities, developing deep understanding and capturing everyday life and human perspectives (Taylor, 2005:101).

Leedy and Ormrod (2005:133) state that the term “qualitative research” encompasses several approaches to research that are, in some respects, quite different from each other. Yet, all qualitative approaches have two things in common. First, they focus on the phenomena that occur in natural settings, that is, in the ‘real world’, and secondly, they involve studying those phenomena in all their complexity. Qualitative researchers rarely try to simplify what they observe. Instead, they recognise that the issue they are studying has many dimensions and layers, and so they try to portray the issue in its multi-faceted form. According to Wilson (2006: 37), qualitative research uses an unstructured research approach with a small number of carefully selected individuals to produce non-quantifiable insights into behaviour, motivations and attitudes. Qualitative data is usually analysed by subjecting it to some form of coding process. This does not imply that quantitative work cannot be done within a qualitative research project. The essential difference is the fact that the quantification is not used to generalise beyond the research context.

In summary, qualitative research can be defined as a form of research in which the findings are based on personal, first-hand interaction and observation, in order to understand the feelings and experiences of people and give a valid and true report thereof.

2.2.4.2 Quantitative research

The method study investigation, the work measurement investigation and the research instruments made up the quantitative part of this study. Leedy and Ormrod (2005:179) state that this type of research involves either identifying the characteristics of an observed phenomenon or exploring possible correlations between two or more phenomena. Wilson (2006:37) states that quantitative research uses a structured approach with a sample of the population to produce quantifiable insights into behaviour, motivations and attitudes. Wilkinson and Kitzinger (2000) state that in essence, analysis of data can occur in one of two ways. It can either be a descriptive analysis, which describes the data, or it can be an analysis that questions the data or tests hypothesis. Wilkinson and Kitzinger (2000) further state that quantitative data is that type of data that can usually be reduced to numerical form. The analysis of such data types involves manipulating the data in some way and/or applying some form of statistical test. Denscombe (2005:236) states that the use of quantitative data in social research has its attractions. For one thing, it carries with it an aura of scientific respectability because it uses numbers and can present findings in the form of graphs and tables. It further conveys a sense of solid, objective research.

The present study, using quantification, applied the following in the assembly department of Company A in order to realise the aim of this study:

- the method study investigation to chart the present method of activities in order to look at potential improvements in the method of working;
- the work measurement investigation to determine the duration of selected product lines in order to develop the ERS; and
- questionnaires as the measuring instruments to determine the perceptions of employees and possible suggestions towards an improvement in productivity.

It was envisaged that the findings and conclusions of this study would have a positive effect particularly on the improvement of productivity in the assembly department.

2.2.5 Descriptive and exploratory research

2.2.5.1 *Descriptive research*

According to Malhotra and Birks (2000), descriptive research is a type of conclusive research that has as its major objective the description of something. Mouton (2001) states that descriptive research emphasises the in-depth description of a specific individual, situation, group, organisation, tribe, sub-culture, interaction or social object. The present study can be considered descriptive in the light of the formulated aim, namely, to develop an ERS using work study methodologies and to make the ERS available to organisations. The assembly department of Company A was under review. The researcher aimed at using the questionnaires with a view to obtaining perceptions of employees, any problems encountered in the department, and possible suggestions towards an improvement in productivity.

2.2.5.2 *Exploratory research*

Malhotra and Birks (2000) state that exploratory research has as its primary objective the provision of insights into and the comprehension of the problem situation confronting the researcher. Exploratory research investigates a problem, which is relatively unknown. The purpose of this kind of research is to investigate one or more cases to see what is going on and to describe the observations. One of the main purposes of qualitative research is exploration. For the purposes of this investigation, the researcher endeavoured to explore the two techniques of work study and the various other concepts in operations management. Insights gained contributed to the development of the questionnaire and a clearer understanding of the various concepts.

2.3 RESEARCH METHODS EMPLOYED

2.3.1 Literature survey

The purpose of the literature survey is to identify the different techniques that will be necessary for the execution and success of the study. It also identifies the competencies needed by the researcher to conduct the work study investigation. However, very little literature has been published with regard to the use of work study methodologies for the development of an ERS. This limited availability of literature gives further credence to the present study and justifies the need and urgency for the study. Manufacturing organisations will now have an exemplar study upon which to start an attack on the inefficiency in their organisations. The researcher utilised the method study technique to ensure that the most efficient methods of work were being used and the work measurement technique to set realistic and achievable time standards on selected popular taps. These are universally accepted work study techniques (Kanawaty, 1995). The main aim of selecting one type of tap was due to the large variety of products that currently exist at Company A.

The literature survey also served as an indicator for the construction of the research instrument.

2.3.2 Empirical study

For the purposes of this study, the quantitative research comprised the analysis of the method study and work measurement investigations as well as the research instruments. The nature of the three segments of the quantitative research is discussed in point 2.2.4.2 above. The recorded information of the first two segments of this study was analysed by the researcher. The analysis of the Questionnaire 1 was conducted by an independent statistician. The analysis of the Questionnaire 2 was conducted by a statistician based at the Bureau of Market Research (BMR) of Unisa.

2.4 THE RESEARCH APPROACH

The research approach to this study is explained below:

2.4.1 The questionnaire

A questionnaire consists of a set of questions designed to generate the data necessary for accomplishing the objectives of the research project (De Jager, 2003:85). Questionnaires are usually paper-and-pencil instruments that the respondent completes (Trochim, 2006:108).

When most people think of questionnaires, they think of a mail survey. Mail surveys have many advantages. They are relatively inexpensive to administer, as you can send the exact same instrument to a wide number of people. Mail surveys allow the respondents to fill it in at their own convenience. Leedy and Ormrod (2005:185) state that this type of questionnaire can be sent to a large number of people, including those who live a thousand kilometres away. Thus, mail surveys may save the researcher travel expenses, and postage is typically cheaper than a lengthy long-distance telephone calls. From the perspective of survey respondents, this distance becomes an additional advantage, i.e. participants can respond to questions with the assurance that their responses will be anonymous, so they may be more truthful than they would be in a personal interview, particularly when they are talking about sensitive or controversial issues.

Self-administered questionnaires, whether disseminated by hand (i.e. delivered at a person's home or office), by post, via e-mail or the Web, have the following distinct advantages:

- they are more cost-effective to administer than personal (face-to-face) interviews;
- they are relatively easy to administer and to analyse;
- most people are familiar with the concept of a questionnaire;
- they reduce the possibility of interviewer bias;
- they are perceived to be less intrusive than telephone or face-to-face surveys and hence, respondents will more readily respond truthfully to sensitive questions; and
- they are convenient since respondents can complete it at a time and place that are convenient for them.

The greatest advantage of the questionnaire is its versatility. It is a fast method of attaining information and it is cheap. Thomas (2003:69) states that an important strength of questionnaires is that they enable a researcher to collect a large quantity of data in a relatively short period of time. In addition, the researcher does need not be present at the time the information is provided, and the data can be collected from people in distant places if the questionnaires are sent by regular mail or over the Internet. Yet questionnaires have their drawbacks as well. Typically, the majority of people who receive questionnaires do not return them. Furthermore, by specifying in advance all of the questions that will be asked and thereby eliminating other questions that could be asked about the issue in question, the researcher is apt to gain only limited and possibly distorted information. The disadvantages of questionnaires include the unwillingness of respondents to provide information and the inability of the respondent to provide information.

The most important disadvantage of self-administered structured questionnaires that are disseminated by hand, post, e-mail or the Web is that the response rate tends to be low, especially when the questionnaire is too long or is complicated to complete, the subject matter is either not interesting to the respondent or is perceived as being of a sensitive nature. Another disadvantage is that the researcher does not have control over who fills in the questionnaire even though it may be addressed or delivered to the intended respondent.

2.4.2 Questionnaire process

2.4.2.1 Questionnaire 1

A structured questionnaire consisting of mostly Likert-type scale questions, which called for responses to the questions and statements was utilised for this study (Barac, 2009:61). The questionnaire was compiled using certain indicators identified in the literature survey. It was designed using MS Word format and was applied in the assembly department of Company A. The purpose of the questionnaire was to elicit employee experiences in order to identify factors that constitute stumbling blocks to improved productivity. Almost ninety percent of these questions were single-answer questions, which allowed the respondent to pick only one answer from the list of choices (Kent, 1993:65). The questionnaire consisted of a total of forty questions. In order to pursue this objective, the following main aspects relating to the questionnaire were formulated:

- ***Category A: Personal data***

The purpose of this category was to determine the personal information of the employee. Information included his/her age, gender, duration of employment and type of job.

- ***Category B: Psychological issues***

Under this category, the researcher attempted to obtain information that affected the worker at his/her workplace. Information such as employees' feelings of working at Company A, problems that they encounter at work, their relationship with their manager and supervisory staff, was requested.

- ***Category C: Management and supervisory issues***

Here, the idea was to elicit responses from employees regarding their relationships with management and supervisory staff. Issues included whether they had a job description, their relationship with their supervisor and the quality of supervision in the department.

- ***Category D: Operational issues***

By questions in this category, the researcher aimed at determining whether the employee encountered any problems with the work being carried out. Questions included questions such as whether Company A was good organisation to work for, whether respondents understood the meaning of the term **productivity** and some of the problems encountered with production in the department.

- ***Category E: Support mechanisms***

In this category, the researcher attempted to obtain responses regarding the support and benefits that are offered by the organisation. Issues referred to include a clinic, canteen facilities, HIV counselling, study assistance schemes and on the job training.

- ***Category F: Health and safety***

It is a moral responsibility of organisations to ensure a safe and healthy working environment for its employees. In this category, the researcher attempted to obtain responses from employees regarding the perceptions of health and safety at Company A. Questions included whether they felt that they were working in a safe environment, the provision of personal protective equipment and the safety policy. A safe and healthy working environment boosts employee morale and inevitably improves productivity.

- ***Category G: Suggestions for improvement***

The researcher added this category because employees have a lot to contribute regarding suggestions for improvement, as they work full-time on the shop floor and are aware of the problems and potential improvements. This was an open-ended question. Since the questionnaire contained information that could be sensitive to certain respondents, it was decided that the questionnaire would be anonymous, so that the rights of those respondents in the survey would be protected. This allowed the respondents to answer all the questions in an honest and free manner.

See Annexure B for a copy of Questionnaire 1.

2.4.2.2 Questionnaire 2

Questionnaire 2 was also compiled using certain indicators identified in the literature survey. It was also designed using the Lime Survey program. This questionnaire also used mostly Likert-type scale questions. A self-administered approach was followed, utilising a computer-

aided Web-based questionnaire. A dedicated uniform reference locator (URL) had been established on the website of the BMR at Unisa. An e-mail message explaining the procedure to follow in order to complete the questionnaire was sent to eight hundred (800) respondents in manufacturing organisations in South Africa. The e-mail message included a hyperlink to the URL where the questionnaire had been hosted. The respondents were invited by-mail to go to the URL and complete the questionnaire online.

The purpose of the questionnaire was to gather critical responses to determine whether manufacturing organisations have performance standards and measurement criteria for their manufacturing processes. The questionnaire consisted of fifteen questions. In order to pursue this objective, the main questions described below were formulated.

Q01. Would you identify your organisation as?

Respondents were requested to state into which category their organisation fell, i.e. large, medium, small or micro, with the large organisations being 'greater than 200 employees' and micro being "less than 5 employees". There were four options.

Q02. The annual turnover of your organisation is:

Respondents had to choose whether their organisation's turnover was 'less than R100 000' to 'greater than R50 million'. There were six options.

Q03. How long has your organisation been in existence?

Respondents had to indicate the duration of the functioning of their organisation. Choices ranged from '0–1 year' to 'greater than 5 years'. There were five options.

Q04. Which of the following sectors does your organisation fit into?

This question required respondents to indicate the sector into which their organisation fell. Choices ranged from sectors such as 'Food and beverages' to 'Furniture'. There were eleven options with the eleventh being 'Other'.

Q05. Your company supplies products to:

Here, respondents had to indicate whether their organisation supplied products to domestic markets, international markets or both markets.

Q06. Does your company currently have a:

This question requested participants to indicate whether their organisation presently had a work study, industrial engineering or productivity department. The fourth choice was 'None of the above'.

Q07. Which of the following process types is applicable to your organisation?

The choices here ranged from 'Job shop production' to 'Project type'. There were five choices with the fifth being 'Other'. Respondents were required to state which specific process type was applicable to their organisation.

Q08. How do you monitor your production outputs?

Respondents were asked to indicate how their production outputs were monitored. Responses included 'Daily production reporting' and 'Rand value of outputs'. There were nine choices, with the ninth choice being 'Other'.

Q09. When do you analyse your finished product's production?

This question merely requested respondents to indicate whether they analysed their production hourly, daily, weekly or monthly.

Q10. How were production targets developed?

Respondents were requested to indicate the methodology used to develop their production targets. Options ranged from 'Work measurement' to 'Work study department'. There were ten options.

Q11. Does your organisation currently have time standards for processes developed by work study or industrial engineering?

Time standards are critical for measuring production. Here, respondents were requested to indicate whether their time standards were set by either work study or industrial engineering. The questions required a simple 'Yes' or 'No' response from the participants.

Q12. Does your organisation currently have an efficiency reporting system?

This was probably the most important question as this formed the basis of the study. Similar to question 11, a simple 'Yes' or 'No' response was required from the respondents.

Q13. *The time standards were set by which of the following?*

This question required the respondents to indicate whether the time standards were set by a work study department, an industrial engineering department or whether they were set by consultants. There were four options, with the fourth option being 'Other'.

Q14. *Who is responsible for recording and calculating the efficiency in your organisation?*

The aim of this question was to determine who in the organisation recorded and calculated the efficiency. The options ranged from the clerk, the supervisor or the manager, while the fourth option was 'Other'.

Q15. *What does your organisation do with the results?*

Respondents were requested to indicate for which purposes the calculated efficiencies were utilised. Options differed from 'Discussed at production meetings' to 'Staff are notified of the results'. There were five options and respondents had to indicate their choice with (1) representing 'Agree strongly' to (5) representing 'Disagree strongly'.

See Annexure C for a copy of Questionnaire 2.

2.4.3 The covering letter

It is important to provide a well-written cover letter that provides the following information:

- Why is the study being conducted?
- Who is doing the study?
- Why is it important to respond?
- How long will it take to complete the questionnaire?
- How and when should the questionnaire be returned?
- What are the contact details of the researcher?
- Will responses be treated confidentially, i.e. is the respondent assured of anonymity?

De Jager (2003:88) states that the covering letter to the questionnaire needs to inform the respondents about the nature of the research and the importance thereof, and should encourage respondents to respond freely. A copy of the covering letter for Questionnaire 1 is attached as Annexure A, while the covering letter for Questionnaire 2 can be found at the start of Questionnaire 2 (Annexure C). The covering letter presented the purpose of the

survey, including assurance of confidentiality, as recommended by Alam and Hoque (2010:537).

2.4.4 The pilot study

Litwin (1995:60) is of the opinion that the pilot study allows the researcher to correct possible errors before the questionnaire is printed and copies made. It also allows the researcher to correct possible errors and to redesign problematic areas of the questionnaire before it is actually used. Pilot testing also predicts difficulties that may arise during the data collection that may have gone unnoticed. At this early stage, the researcher is still able to correct any problems that may occur. The pilot study also provides useful information about how the questionnaire will actually perform in the field. According to De Jager (2003:92), a pilot study is a necessary and important part of the development of the research instrument and although it requires extra time and energy, the pilot test is a critical step in assessing the practical application of the research instrument.

Questionnaire 1: A pilot study was carried out using a sample of four supervisory staff (i.e. foremen and line leaders and a sample of 10 assembly department employees. The respondents were asked to determine the clarity and comprehension of the formulated questions, and whether the questions were readable, visible and unambiguous. The pilot study respondents (14 in total) were asked to complete the questionnaire and to indicate whether any of the questions were ambiguous to them. They were also asked to comment on any questions that they felt needed improvement. Comments of the respondents were implemented and a final questionnaire was compiled.

Questionnaire 2: In this case, the researcher sought the assistance of a statistician at Unisa to finalise Questionnaire 2. This was then peer-reviewed by colleagues from the researcher's department. The aim was to get academic inputs into the contents and quality of Questionnaire 2, based on the researcher's aim. Further to this, Questionnaire 2 was pilot tested at two manufacturing organisations. Similar to Questionnaire 1, the respondents were asked to complete the questionnaire and to indicate whether any of the questions were ambiguous to them. The respondents were also asked to comment on any questions that they felt needed improvement. Comments of the respondents were implemented and a final questionnaire was compiled.

Comments from all the respondents were taken into consideration and allowed the researcher to correct the problematic sections before they were distributed.

2.4.5 The target population and the sample

A sample is the actual group that the researcher has to select and contact in some way. The process of selecting the particular entities is called **sampling** (Leedy & Ormrod, 2005:144; Trochim, 2006:110). McDaniel and Gates (1998:301) state that the target population is the total group of people from whom the researcher needs to obtain information and whose opinions are needed to achieve the objectives of the research. The target population is based on the characteristics of current and targeted customers. Hague and Jackson (1999:99) state that a sample is a sub-set of the population. Confidence to use samples in research applications is based on a branch of statistical theory that allows the accuracy levels to be estimated within ranges of probabilities. The most important reason for using sampling is that it is the only possible way to collect information about large population groups (Dodge, Fullerton & Rink, 1982:148).

The target population for Questionnaire 1 consisted of all employees of the assembly department at Company A. This was made up of operators, supervisory staff and management. A total of 114 questionnaires were distributed.

The target population for Questionnaire 2 consisted of 800 selected students registered in the Department of Quality and Operations Management of Unisa and who were also employees of organisations in South Africa. Their positions ranged from operators and supervisory staff to management.

2.4.6 Special ethical considerations

Saunders, Lewis and Thornhill (2009:183) state that **ethics** refers to the appropriateness of behaviour in relation to the rights of those who become the subject of your work. Good ethics provide a solid foundation for professionalism, and striving for a lofty level of professionalism necessitates proper ethics on the part of the researcher. When designing a new survey instrument, or applying established ones in populations of different ethnicity, creed or nationality, the researcher must make sure that his/her items translate well into both the language and the culture of the target audience. Failure to be attentive to multicultural issues may result in significant bias when collecting data (Litwin, 1995:70). Ethics is a branch of philosophy that deals with morale. It is simply the philosophy of what is right and wrong. Research is the attainment of new knowledge, and this new knowledge is supposed to represent the current truth of our state of knowledge. Therefore, truthfulness is one of the pillars when conducting research (Shamoo & Dunigan, 2000:205).

The design of the research instruments took into consideration the different ethnicity, creed and nationality (De Jager, 2003:91) of the target audience. Due to the literacy levels of the employees of the assembly department of Company A, Questionnaire 1 was designed with certain straight-forward questions, for example *Does management regularly motivate you to perform well?*

At all times during this research, respondents were assured of anonymity. Consent from was obtained respondents before the questionnaires were distributed. The questionnaires were completed anonymously with each respondent having the opportunity to answer the questions in his or her own time. Participation was voluntary and confidentiality and anonymity were ensured.

2.4.7 Validity and reliability of the study

2.4.7.1 Methods to ensure validity

Shuttleworth (2008:01) states that validity encompasses the entire experimental concept and establishes whether the results obtained meet all of the requirements of the scientific research method. Joppe (2000:01) and Zikmund (2003:301) are of the opinion that the purpose of measurement is to measure what we intend to measure and to establish how truthful the research results are. In other words, does the research instrument allow you to achieve the aim and objective of your research object? Researchers generally determine validity by asking a series of questions, and will often look for the answers in the research of others. Validity is concerned with whether the findings are really about what they appear to be about. It is also about truthfulness, in other words “Does the test measure what it purports to measure to the extent in which certain inferences can be made from test scores or other measurement (Saunders et al., 2009:157).

Internal validity dictates how an experimental design is structured and encompasses all of the steps of the scientific research method. External validity is the process of examining the results and questioning whether there are any other possible causal relationships.

The Glossary of Education (2015) defines content validity as the extent to which a test adequately represents the subject-matter content or behaviour to be measured, and is commonly used in evaluating achievement or proficiency tests. The content validity of the present study was established when the performance of the research instrument (Questionnaire 2) was determined. Content validity is a subjective evaluation as a number of knowledgeable reviewers determine the appropriateness of the items. In the case of the present research, this was done by the researcher’s academic peers.

The following methods were implemented in the present study in order to ensure content validity:

- Questionnaire 1: The questionnaire was designed using indicators from the literature survey and with the aim of the study in mind, namely to determine the profile of the assembly department employees and their knowledge of productivity and production outputs.
- Questionnaire 2: The respondents who formed the sample represented a diversity of manufacturing organisations and came from all around South Africa. The main reason why the sample may be said to be fairly representative of manufacturing organisations in South Africa is that the population was representative of the entire country, both geographically and demographically.
- Both questionnaires were descriptive and aimed to provide a list of the most important questions in relation to the aim of the study.

2.4.7.2 *Methods to ensure reliability*

Reliability is the degree to which measures are free from error and therefore yield consistent results over time and display an accurate representation of the total population. If these conditions are satisfied, then the research instrument is considered to be reliable. In simple terms, reliability is the measure of how stable, dependable, trustworthy, and consistent a test is in measuring the same thing each time. In other words, other researchers must be able to perform exactly the same experiment, under the same conditions and generate the same results (Joppe, 2000:01; Zikmund, 2003:301).

Saunders et al. (2009:157) state that reliability refers to the extent to which the data collection techniques or analysis procedures will yield consistent findings. A questionnaire has to be consistent in order to be accurate. The reliability testing of items provide a quantitative measurement of how well an instrument performs when used in a given population. When developing a new survey instrument, it is imperative to test it for reliability before using it to collect data from which inferences will be drawn (Litwin, 1995:27).

2.5 CHAPTER OVERVIEW

In this chapter, the research design and the research methods employed were outlined. The rationale behind the methodology employed and the way the research was conducted were explained. This included a discussion of the study in terms of the research design, the research instruments, target population and sampling. It was agreed that the study would use

a mixed-methods approach. Qualitative and quantitative research was defined to justify the use of a mixed-methods approach to this study. A brief explanation of both questionnaires and the questionnaire process was provided. The special ethical considerations were discussed, referring to respondents being assured of anonymity at all times.

The pilot studies that were conducted were also discussed, and the usefulness of this exercise in assisting in the compilation of the final questionnaires was indicated. This allowed the researcher to correct possible errors before the final questionnaire was printed. The chapter concluded with a discussion of the validity and reliability of the study.

In the next chapter, the data collection process and presentation are discussed.

CHAPTER 3

LITERATURE SURVEY: PRODUCTIVITY AND RELATED METHODOLOGIES

3.1 INTRODUCTION

In the previous chapter, the research design, the rationale behind the methodology employed and the way the research was conducted were described. This included a discussion of the study in terms of the design, the research instruments used, the target population and the sample.

The purpose of the literature survey was to gain insight into the requirements for this study. It must be highlighted at the outset that certain references were made to textbooks that are rather old; however, they are neither out-dated nor obsolete as the techniques of work study are universally accepted. References are for instance made to textbooks by Kanawaty (1995), Prokopenko (1987) and Currie (1981). The main reason for using these old references is that these authors are authorities in the field of work study and furthermore, the limited availability of literature on this topic. This statement also justifies the need for and the value of the present study. Continuous references are made to the textbook by Kanawaty as this is regarded as the 'bible' of work study. Further to this, the researcher has used literature from five books that he has written on work study.

In this chapter, the concept of productivity is discussed in detail, as the theme of the study revolves around the enhancement of productivity at Company A. Jacobs and Chase (2011:66) state that productivity is a common measure of how well a country, industry or business unit is using its resources (or factors of production). This is followed by a look at various management aids that were developed through the years to assist managers in their daily functions and to ensure the efficiency and effectiveness of their organisations. Some of the management aids are motion study, value analysis, variety reduction and line balancing.

A literature survey was also conducted into related methodologies, such as ergonomics, work sampling (activity sampling), just in time (JIT) and lean manufacturing and business process engineering (BPR). These are discussed with the aim of identifying the different techniques that are necessary to improve productivity. References to literature regarding the

u-cell assembly method versus the traditional line assembly method surveys are also conducted.

3.2 THE CONCEPT OF PRODUCTIVITY

Kulkarni et al. (2014:429) state that productivity is generally defined as the ratio of an extent of output to the unit of all of the resources used to produce this output. Stevenson (2012:56) states that productivity is an index that measures output (goods and services) relative to the input (labour, materials, energy and other resources) used to produce them. Productivity is usually expressed as the ratio of output to input. Slack, Chambers and Johnston (2007:704) define productivity as the ratio of what is produced by an operation or process to what is required to produce it, that is, the output from the operation divide by the input to the operation. Jacobs and Chase (2011:66) state that productivity measurement is fundamental to understanding operations-related performance and in its broadest sense, productivity can be defined as:

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

Higher productivity means that there is better management of inputs and processes, so that outputs of better quality and lower costs are produced (Kruger & Ramphal, 2009:361). A productivity ratio can be computed for a single operation, a department, an organisation or an entire country. In business organisations, productivity ratios are used for planning workforce requirements, scheduling equipment, financial analysis, and other important tasks. The two commonly asked questions about productivity will be answered in sections 3.2.1 and 3.2.2 respectively:

- How can productivity be improved?
- How is productivity measured?

Since productivity is the ratio of output over input, we should clarify exactly what is meant by the terms **output** and **input**.

Output comprises all goods and services, which satisfy human needs. Output therefore not only implies the production of industrial and agricultural products but also the supplying of services by doctors, teachers, persons in the retail trade, office workers, municipal services, attorneys and tertiary organisations. Output can be expressed in terms of money, hours or physical units.

Input refers to human labour, materials and capital. Capital also means the availability of vehicles and equipment like buildings, plant, tools, instruments, work equipment, furniture and other equipment. Input can also be expressed in terms of money, hours or physical units.

It can be stated that productivity measurement is an important means to an end. It provides valuable information on how an organisation is performing, where it is, where it would like to be, and how it can go about achieving its goals. Productivity measures are only useful if they take into consideration the goals and objectives of an organisation, and if it is used to bring about productivity improvements. This requires commitment from all concerned, from senior management and teamwork to participation from all employees (Spring, 2011:22)

3.2.1 Ways to improve productivity

Stevenson (2012:56) states that one of the primary responsibilities of a manager is to achieve productive use of the organisation's resources. It is very important to ensure employees work not only effectively but also efficiently because it influences the organisation's productivity levels. To improve productivity, the aim would be to make the ratio of outputs to inputs as large as practical (Chase, Jacobs & Aquilano, 2006:39). One might well ask: How can an organisation ensure that its productivity levels are improved? Productivity could be improved by:

- increasing input and increasing output;
- keeping input constant but increasing output;
- decreasing input and keeping output constant; and
- decreasing input and increasing output.

These sound like easy solutions, but it must be understood that a lot of strategic thinking and actions must first take place before the productivity levels are increased and maintained. Sookdeo (2005:58) states that further to this, an organisation can take the following steps to improve productivity:

- Develop standards for all operations in the organisation. This is an initial step in managing and controlling an operation. Having a standard allows the organisation to gauge its performance against the standard. In Chapter 1 (Introduction), the investigator stated that work measurement was carried out on selected popular taps in order to set realistic and achievable standards;

- Select the most critical operation from the organisation in order to carry out a productivity improvement investigation. The investigation for the present study was carried out in the assembly department of Company A.
- Develop different methods for achieving productivity improvements, e.g. suggestion schemes (seek ideas from workers), and organise teams of workers, managers and technicians.
- Establish reasonable goals for improvement. Do not set unachievable goals.
- Obtain management's support and inform all employees that management encourages productivity improvement. Furthermore, look at incentives as rewards to workers.
- All improvements should be measured and publicised.

Productivity increases add value to the economy of a country whilst simultaneously keeping inflation in check (Stevenson, 2007:51) and are therefore a criterion of efficiency where the output/input ratios of an economy, a sector of the economy, an organisation, a department or a resource are compared to its performance during a previous period, or to the performance of another organisation, or to predetermined standards.

3.2.2 How is productivity measured?

Managers need to understand that productivity should be measured for the organisation as a whole (Kruger & Ramphal, 2009:361). Before managers can consider improving an organisation's productivity, it is crucial to measure the levels of productivity in the organisation first. Productivity is the measure that is most frequently used to indicate how successful an operation is doing as all operations have an interest in keeping their costs as low as possible (Pycraft et al., 2010:48). The unit of output used in productivity measurement depends entirely on the type of operation or process being performed in the organisation, Stevenson (2012:28). The following shows the type of productivity calculation and the unit of measure:

TYPE	OUTPUT MEASURE
Material productivity	Unit cost of the material or the number of units used
Labour productivity	Units of output per labour hour
Capital productivity	Cost of equipment or if a machine's productivity is measured, machine hour can be used as measure unit.

Productivity can be used to measure output in terms of products (**units**) and/or in terms of money (**monetary units**). The following shows an example using units followed by an example using money.

Example 1: Using the measuring element as units:

Appliance SA is a manufacturer of electrical appliance and household fans. The assembly operation uses three workers. Worker A attaches the rotating mechanism, worker B attaches the motor, and worker C fits the fan blades and guards assembly. The complete fan is then sent to the inspection department. The work is monotonous, labour turnover is high and the reject percentage is high.

The factory manager then attends a course on improvement of work content and on returning, decides to try out some of the things that he had learned. He selects two workers and makes each responsible for all the assembly operations, i.e. each worker does the complete assembly of fans. He also makes them inspect their own work and sign the guarantee label. After a brief learning period, the workers begin to compete with each other and to take pride in the quality of the work they turn out.

The daily productivity figures change dramatically.

Source: Sookdeo (2005:61)

Consider the following example:

	Output	Rejects	Reject %	Net output	Worker hours	Productivity
Old system	60	10	16	50	24	$50/24 = 2.1$ units per worker-hour
New system	48	3	6	45	16	$45/16 = 2.8$ units per worker-hour

It can be seen from the above that by decreasing the labour by 33% (2 workers instead of 3) and decreasing output by only 10% (45 instead of 50), productivity has increased by 33% (2.8 compared to 2.1).

This example clearly indicates how effectively one can use **units** as a measuring element. In this example, the number of fan units manufactured in a specific time frame indicate how productive the workers were, that is, productivity improved by 33%.

Example 2: Using the measuring element as monetary units:

Let us assume the entire productivity of an organisation must be measured and the unit of measurement is money value. Let us then also assume the following:

The turnover of the enterprise (output) in 2010 was equivalent to R100 000 and the capital (input) used to achieve this output, was R80 000. In 2011, under similar conditions, the turnover was R150 000 and the capital used was R80 000. This increase in turnover was not due to price increases. The difference in productivity of this company can be determined as follows:

YEAR 2010:

$$\begin{aligned}\text{Productivity} &= \text{Output} \\ &= \frac{\text{R } 100\,000}{\text{R } 80\,000} \\ &= \mathbf{1.25 \text{ (factor)}}$$

YEAR 2011:

$$\begin{aligned}\text{Productivity} &= \text{Output} \\ &= \frac{\text{R } 150\,000}{\text{R } 80\,000} \\ &= \mathbf{1.88 \text{ (factor)}}$$

(If these factors are seen in isolation, it does not mean anything.)

By comparing 2010 to 2011, we find that:

$$\begin{aligned}\text{Increase in productivity} &= \frac{(1.88 - 1.25)}{1.25} \times \frac{100}{1} \\ &= \underline{50\%}\end{aligned}$$

Note: Previous year's data is always seen as the basis year.

Therefore:

The productivity showed an increase of **50%**.

This means that the company has increased its productivity (output) by 50%, while keeping its input the same. Naturally, the opposite is also true, and productivity can be increased by keeping the output constant and decreasing the input.

3.2.3 Productivity and turnover

If the turnover of an organisation has increased, it means that the enterprise produced more of a specific product or service, compared to a previous corresponding period. It could also mean that a price increase resulted in an increase in the turnover. This increase in turnover could also have been as a result of an increase in input.

An increase in turnover does not necessarily mean that productivity has increased. The relationship between output and input during different periods, and not only changes in output, must be studied to determine the real change in productivity. In example 2 above, we expressed the input and output in terms of monetary units. Similar results can, however, be obtained by expressing input and output in terms of labour hours, machine hours or in units. The measuring unit will therefore depend on the circumstances or the activity of which the productivity is measured and can differ from organisation to organisation, department to department or process to process.

3.2.4 Productivity and prosperity

Heizer and Render (2011:45) state that the operations manager's job is to improve the ratio of outputs to inputs. Increased productivity in itself is not an objective but rather a way by which the social level and economic prosperity of a country and its people can be lifted. The standard of living of the people of a country, as expressed by their earnings per capita is directly related to the capability of individual organisations to utilise the available production factors (resources) optimally and to make goods and services available at the lowest possible price. This is largely determined by the relationship between the total output and total input of all organisations and households in the country. The increase in the productivity of individual organisations therefore has a large influence on the country's economic well-being. It will therefore be short-sighted of any country not to encourage and develop this principle.

3.3 MOTION STUDY

Niebel and Freivalds (2003:11) define motion study as the study of body motions used in performing and operation to improve the operation by eliminating unnecessary motions, simplifying necessary motions and then establishing the most favourable motion sequence for maximum efficiency. Meyers and Stewart (2002:40) state that motion study can save a larger percentage of manufacturing costs than anything else that can be done in a manufacturing plant. By changing to an automatic machine, many steps in a process can be eliminated or automated. The purpose of motion study is to eliminate unnecessary motions and to identify the best sequence of motions for maximum efficiency (Stevenson, 2007:322).

Motion study not only includes the analysis of the movements used in performing work but also takes the tools, equipment and material that the worker uses, the conditions surrounding the worker and the workplace into consideration. The objective is to design a work method, which will result in high operator productivity with the least possible fatigue. Motion study is a

subdivision of work study and is utilised especially in the fields of method study, procedure studies, system analysis and design, and the handling of material. It therefore contributes indirectly to management's decision-making process by increasing productivity through improved methods and procedures. Due to the assembly processes being highly labour-intensive, this technique will assist the researcher in improving the operations.

3.4 VALUE ANALYSIS

Stevenson (2002:530) defines value analysis as the examination of the function of purchased parts and materials in an effort to reduce the cost and/or to improve the performance of those items. Heizer and Render (2011:197) state that, although value engineering focuses on pre-production design improvement, value analysis, a related technique, takes place during the production process, when it is clear that a new product is a success. Value analysis seeks improvements that lead to either a better product or a product which is manufactured more economically. The techniques and advantages for value analysis are the same as for value engineering, although minor changes in implementation may be necessary because value analysis is taking place while the product is being produced.

The above definitions imply clearly that value analysis comprises the identification of areas of high cost as well as the investigation of the possibilities of how to reduce or eliminate high costs without affecting the quality and function of the product. It is a given that any reduction or the elimination of certain costs automatically results in an improvement of productivity. Due to the high value of purchased parts, the researcher will, after the completion of the study, consider a value analysis exercise for Company A.

3.5 VARIETY REDUCTION

Sookdeo (2012a:34) states that variety reduction is the process by which the unnecessary variety of parts and materials used in various stages of manufacturing a product – from the design to the production or sales stage – is reduced or eliminated. In most organisations, variety is unavoidable. While a degree of variety is desirable, it must be borne in mind that as variety increases, organisational problems and costs also increase. The control of variety is necessary, and the task of decreasing variety is one of the most profitable ventures any organisation can undertake. Variety can be decreased in three ways:

- simplification – the decrease of unnecessary variety;
- standardisation – the control of the necessary variety; and

- specialisation – a concentration of effort in organisations where special knowledge is available.

Variety reduction consists of a combination of all three the above-mentioned ways, and can be used at any place in the organisation, simultaneously or at different points. It is a continuous process and will, through the application of certain techniques, prevent the increase of variety in many areas. Variety reduction assists management by ensuring that there are not too many different products in one organisation. Simply speaking, the smaller the variety of products, the easier is it for management to ensure effectiveness. Company A can start solving this problem by making employees aware of uncontrolled variety. Due to the large variety of products at Company A, the researcher will consider a recommendation to management regarding a variety reduction exercise.

3.6 LINE BALANCING

Stevenson (2007:250) states that line balancing is the process of assigning tasks to work stations in such a way that the work stations have approximately equal time requirements. The goal of line balancing is to obtain task groupings that represent approximately equal time requirements. This minimises the idle time along the line and results in high utilisation of labour and equipment. Slack et al. (2007:211) define line balancing as the activity of attempting to equalise the load on each station or part of a line layout of mass process. Van Tonder (2002:59) states that unbalanced production lines are a major problem in the assembly department. Unbalanced lines cause an increase in work-in-progress at certain stations, while at others, the operators are idle whilst waiting for work to get to them and down a set assembly line.

All product lines in the assembly department of Company A were unbalanced at the time of the research. The researcher therefore studied this technique in practice in the assembly department at Company A and report on the outcomes.

3.7 ERGONOMICS

Ergonomics is currently a hot topic. Organisations have been implementing ergonomics programmes for more than 30 years. Initially, the purposes of these programmes were to improve operational efficiency by applying the knowledge of human capabilities and limitations to the design of work. In recent years, organisations have increasingly focused on employee well-being. What do we know about the human body and mind at work? Given what we know, how then should we design the work task, tools and the interface with the

machine, and work procedures so that humans can perform safely, efficiently and with satisfaction – perhaps even enjoy working (Larson, 2012:29)?

3.7.1 Towards a definition of ergonomics

Heizer and Render (2011:421) state that the operations manager is interested in building a good interface between humans, the environment and machines. Studies of this interface are known as ergonomics. Ergonomics means the study of work. The term human factors engineering is often substituted for the word ergonomics. Understanding ergonomic issues helps to improve human performance.

Ergonomics is a topic that affects us all, yet few of us have a good understanding of what the term actually means or realise how it affects us. Ergonomics is a term used to describe the study of the physical arrangement of the workspace; that is, how a person interfaces with his or her immediate working area (Chase, Jacobs & Aquilano 2006; Slack, Chambers & Johnston 2010). In very simple terms, ergonomics is about fitting the job to the person performing the job to reduce the risk of injuries and to minimise fatigue.

The Ergonomics society of South Africa (2015) defines ergonomics as the science of work. It focuses on designing a job for the worker. Stevenson (2012:294) states that ergonomics is the incorporation of human factors in the design of the workplace. This often involves manipulating an individual's work area so that it fits the worker better. In essence, ergonomics is all about understanding human beings and human behaviour. Ergonomics can also be described as a system of interaction between components in the workplace, which include the worker, the work environment both physical and organisational, the task and the workspace. The primary objective of ergonomics is to ensure a good fit between workers and their jobs, thereby maximising worker comfort, safety, productivity and efficiency.

The opposite of this, and what typically happens in the workplace, is that a worker is forced to work within the confines of the job or workstation that is already in place. This may require employees to work in awkward postures, perform the same motion repeatedly or lift heavy loads – all of which could cause work-related musculoskeletal disorders (WMSD). These injuries often start as minor aches and pains but can develop into disabling injuries that affect activities of daily living such as laundry, hobbies (knitting, golf, etc.) and even the ability to pick up children. In the late 1800s, Frederick Winslow Taylor used the principles of scientific management to match the mine operator's abilities to achieve maximum safety, comfort and efficiency thereby increasing productivity by 400%. His methods in work study apply to this day, and will continue in every task being performed (Heizer & Render, 2001:391).

Workplaces depend on efficient movement of product or best locations for machines. This is often done without giving thought to how people are supposed to fit into their workplace. Issues such as injuries, errors in production (repairs) and efficient motions are often neglected. People are generally expected to adapt themselves to fit into whatever arrangement has been devised, believing that it has no associated costs. Space limitations are a major contributor to poor efficiencies. The human body cannot adapt to every situation. People have differences and limitations and this issue is frequently not evaluated thoroughly before contracting people for the job. Heizer and Render (2011:422) state that male and female adults come in limited configurations; therefore, the design of tools and the workplace depends on the study of people to determine what they can or cannot do.

3.7.2 Principles of ergonomics

Chase et al. (2006:185) state that, in applying ergonomics, we strive to fit the work to the body rather than vice versa. Some fundamental ergonomic principles that should be followed in the workplace include:

- *Use proper tools:*

Tools should be appropriate for the specific tasks being performed. Your tools should allow you to keep your hands and wrists straight – the position they would be in if they were hanging relaxed at your side.

- *Bend the tool not the wrist:*

The tool should fit comfortably into your hand. If the grip size is too large or too small, it will be uncomfortable and will increase the risk of injury. Tools should not have sharp edges, create contact stresses in your hand, or vibrate.

- *Keep repetitive motions to a minimum:*

Our workstations or tasks can often be redesigned to reduce the number of repetitive motions that must be performed. Using a power-driven screwdriver or tools with a ratchet device can reduce the number of twisting motions with the arm. Some tasks can be automated or redesigned to eliminate repetitive movements and musculoskeletal injuries.

- *Avoid awkward postures:*

Your job should not require you to work with your hands above shoulder height on a regular basis. Arms should be kept low and close to your body. Bending and twisting of your wrists, back and neck should also be avoided.

- *Use safe lifting procedures:*

Avoid lifting objects that are too heavy. Use more than one person or a mechanical device to reduce the load. Your workstation should not require you to lift objects above your head or twist your back while lifting. Keep the load close to your body and ensure that you have a good grip. Heavy and frequently lifted objects should be stored between knee and shoulder height – not on the ground or above your head.

- *Get proper rest:*

You need to rest your body and mind in order to prevent injuries. Give your muscles a rest during your coffee breaks, lunches and weekends by doing something different from what you do in your job. For example, if you stand all day while performing your job you should sit down to rest your legs and feet during your breaks. If you sit down when working, you should stand up and walk around during your breaks to give your back a rest and to increase circulation in your legs. It must be remembered that musculoskeletal injuries can be prevented.

3.7.3 Main ergonomic risk factors

If a job does not fit a worker, the worker is more likely to be exposed to risk factors that may lead to musculoskeletal injury. The main ergonomic risk factors include the following:

- Repetition: tasks or body movements carried out repeatedly.
- Awkward postures: body positions that are not considered neutral or ideal, such as twisting your neck to view your monitor or reaching forward or to the side to use your mouse.
- Static forces: maintaining a position for a long period of time (i.e. prolonged sitting, viewing the monitor with a bent neck, or reaching for the keyboard).

Every person responds to ergonomic risk factors in different ways. For example, one worker may have symptoms of an injury while another worker performing the same tasks may not have symptoms. Ergonomic risk factors should be identified and reduced to lower the risk of

injury. When selecting equipment, adjustability is the most important feature. Even though a product claims to be ergonomic it may not suit your needs. An ergonomic workplace can effectively eliminate the following:

- occupational injury and illness;
- workers' compensation and sickness and accident costs;
- medical visits; and
- absenteeism.

Such workplace can further improve the following:

- productivity;
- quality while reducing waste; and
- worker comfort on the job.

The aim of the literature survey on ergonomics was to gain insight into the various poor ergonomic practices in the assembly department at Company A and to create an understanding amongst management and staff that simple changes would improve health and safety of the workforce while simultaneously improving performance and enhancing organisational capability. Ergonomics aims to prevent injuries by controlling the risk factors such as force, repetition, posture and vibration that can cause injuries. Given the working conditions of employees at the time of the study, ergonomic interventions were a priority during the course of this study.

3.8 JUST IN TIME (JIT) AND LEAN MANUFACTURING

Slack et al. (2007:469) state that generally, lean manufacturing can be viewed as a philosophy of operations management. Within this philosophy, there is a collection of tools and techniques that both implement and support the lean philosophy. These techniques are more generally called just-in-time (JIT) techniques. JIT techniques consist of an integrated set of activities, which are designed to achieve high-volume production whilst using minimal inventories of parts that arrive at the workstation exactly when they are needed (Jacobs & Chase, 2011:50).

Stevenson (2007:679) states that the term JIT is used to refer to an operations system in which materials are moved through the system, and services are delivered with precise timing so that they are delivered at each step of the process just as they are needed; hence,

the name JIT. Initially, the term JIT referred to the movement of materials, parts and semi-finished goods within a production system. Over time, the scope of JIT broadened and the term became associated with lean operations. Nowadays the two terms are often used interchangeably to refer to a highly coordinated, repetitive manufacturing or service system designed to produce a high volume of output with fewer resources than more traditional repetitive systems, but with the ability to accommodate more variety than traditional systems. These two paragraphs justify the decision to link these two philosophies as they are often used interchangeably. Lean thinking can be applied to any type of organisation. Although its origins were designed for an automotive production environment, the principles and techniques are transferable.

Goetsch and Davis (2006:696) state that when people who should know are asked to define JIT, the typical response is, "JIT is your materials delivered just when you need them". JIT manufacturing has become a management philosophy that seeks to eliminate all forms of waste in manufacturing processes and their support activities. JIT permits the production of only what is needed, when it is needed and only in the quantity needed. JIT is a disciplined approach to improving overall productivity and eliminating waste. It provides for cost-effective production and delivery of only the necessary quantity of parts at the right quality, at the right time and place whilst using a minimum amount of facilities, equipment, materials and human resources (Slack et al., 2007:466).

Kulkarni et al. (2014:429) states that lean manufacturing is a perspective to manufacturing that searches for an opportunity to reduce the operation time of processes, increase manoeuvrability and improve the corresponding attributes. Seth and Gupta (2005:45) state that lean manufacturing refers to a manufacturing paradigm based on the fundamental goal of continuously minimising waste to maximise flow. The goal of lean manufacturing is to reduce waste in human effort, inventory, time to market, and manufacturing space to become highly responsive to customer demand while producing quality products in the most efficient and economical manner. Slack et al. (2007:466) state that the key principle of lean operations is relatively straightforward to understand. It means moving towards the elimination of all waste in order to develop an operation that is faster and more dependable than previous methods, and it produces higher-quality products and services and above all, operates at low cost. Meyers and Stewart (2002:01) state that lean manufacturing is a concept whereby all production people work together to eliminate waste.

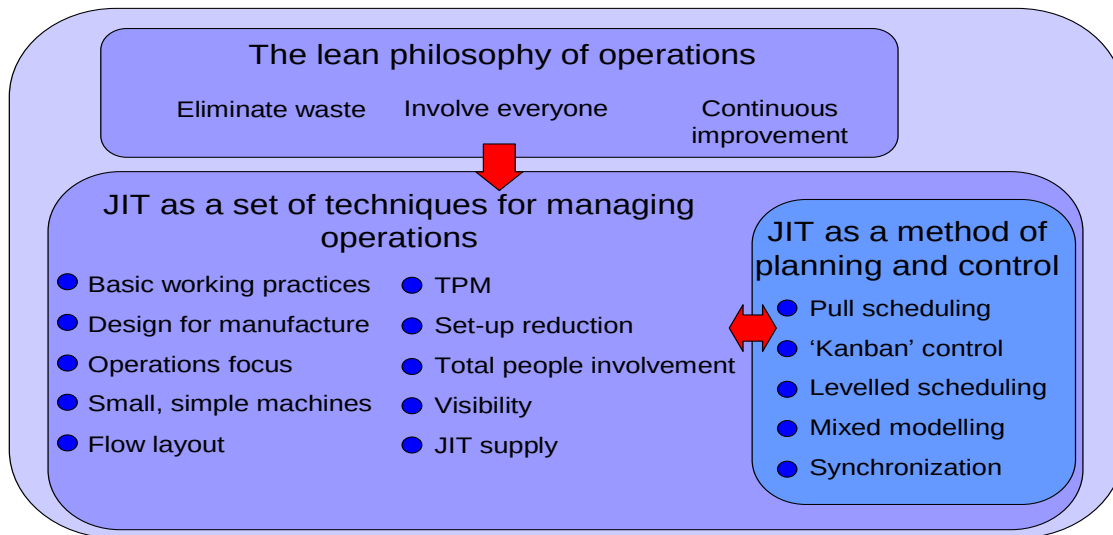


Figure 3.1: The lean philosophy of operations

(Source: Slack et al., 2007:469)

3.8.1 Lean principles

In their book, *Lean thinking*, Womack and Jones (2003) summarise the core of the lean approach into five key principles that show how the concepts can be extended beyond automotive production to any type of business:

- Specify what does and does not create a value perspective.
- Identify all steps necessary to design, order and produce the product across the whole value stream to highlight non-value-adding waste.
- Install only those actions that create value flow without interruption, eliminate detours, waiting or scrap.
- Only make what is pulled by the customer.
- Strive for perfection by continually removing successive layers of waste, as they are uncovered.

These five principles are fundamental to elimination of waste, are easy to remember, yet not easy to achieve. These five key principles need to be communicated and used by everyone in the organisation who becomes involved in the lean transformation process. Lean thinking is, therefore, a journey of sustained performance improvement, using minimal resources and not a one-off programme (Stevenson, 2007:679).

3.8.2 The tools and techniques of lean producers

The model developed by Karlsson and Ahlstrom (1996) illustrated in Figure 3.2 incorporates the entire value stream lean enterprise network; therefore it was selected for discussion in this study. Based on this model and from the review of literature, it could be established that lean manufacturing principles in the production environment are waste elimination, continuous improvement, multifunctional teams, zero defects, JIT techniques, vertical information systems, decentralised responsibilities, integrated functions and pull systems. These are defined in the following sub-sections.

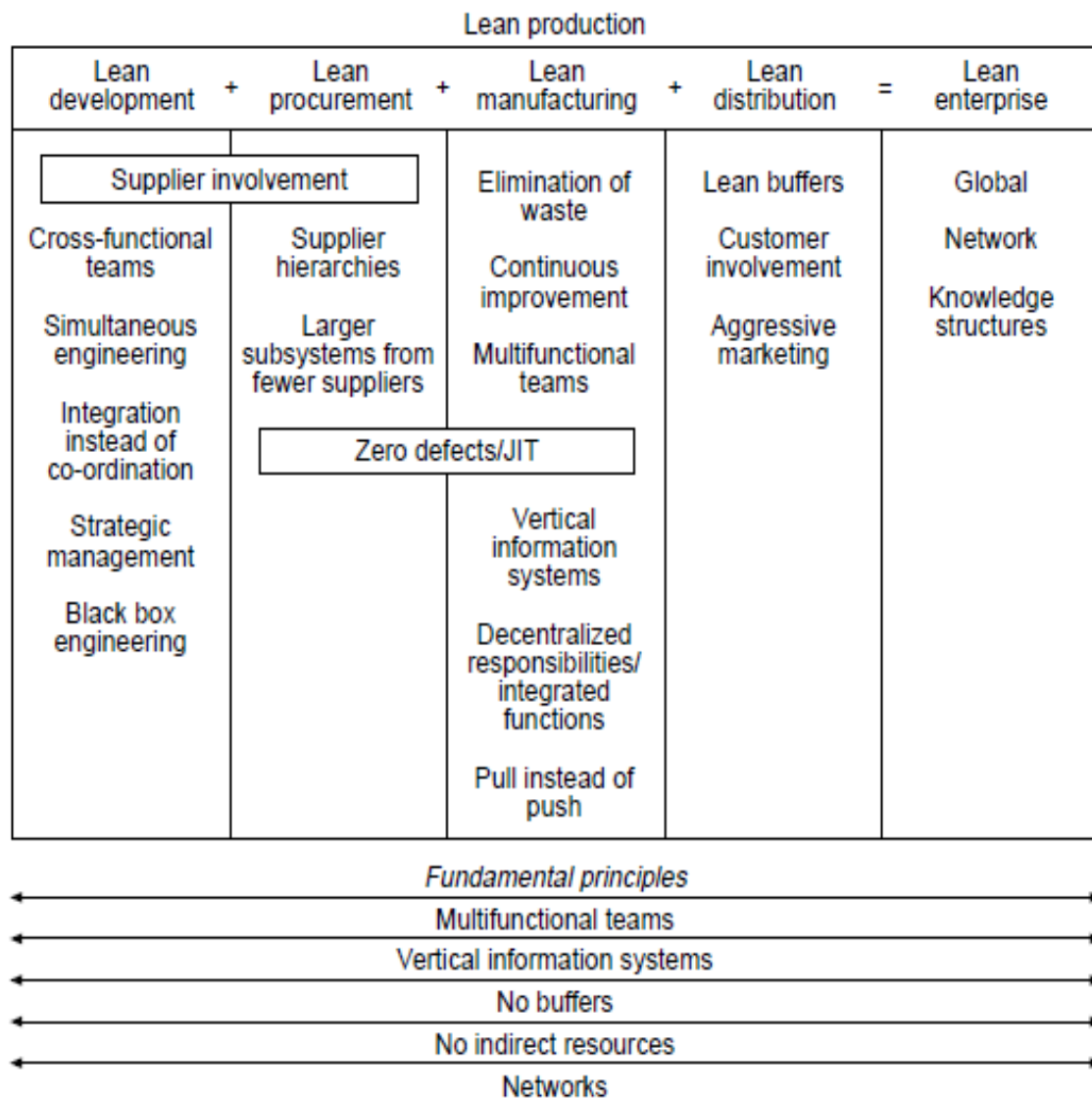


Figure 3.2: The principles of lean manufacturing

(Adapted from Karlsson and Ahlstrom, 1996:26)

Heizer and Render (2001:529) state that companies that integrate the use of total quality management (TQM), JIT, and employee empowerment are usually lean producers. They claim that lean producers share the following attributes:

- They use JIT techniques to eliminate virtually all inventories.
- They build systems that help employees produce a perfect part every time.
- They reduce space requirements by minimising the distance a part travels.
- They develop close relationships with suppliers, helping them to understand their needs and their customer's needs.
- They educate suppliers to accept responsibility for helping meet customer needs.
- They focus on only having value-adding activities to drive costs down.
- They develop the workforce and constantly improve job design, training, employee participation and commitment and teamwork.
- They make jobs more challenging, pushing responsibility to the lowest level possible.

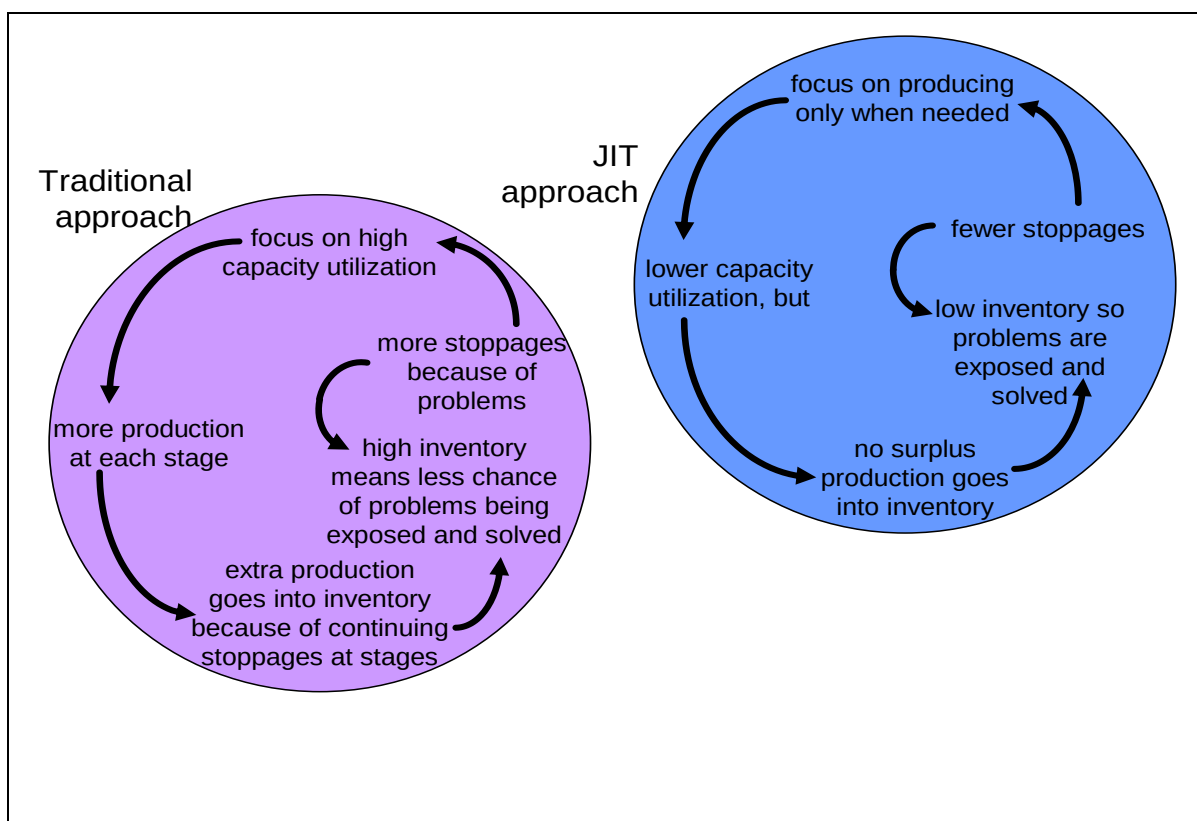


Figure 3.3: JIT and capacity utilisation

(Source: Slack et al., 2007:469)

3.9 BUSINESS PROCESS REENGINEERING (BPR)

Burke (2004:114) states that reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed. He highlights four key words in his definition: fundamental, radical, dramatic and processes, indicating that the most important single term in the definition of companies attempting to implement BPR, is process. The approach seeks to make revolutionary changes as opposed to evolutionary changes (Jacobs & Chase, 2011:51).

Slack et al. (2007:598) state that BPR is a philosophy that recommends the redesign of processes to fulfil defined external customer needs. BPR is a blend of a number of ideas, which have been current in operations management for some time. JIT concepts, process flow charting, critical examination in method study operations network management and customer-focused operations all contribute to the BPR concept.

3.10 U-CELL ASSEMBLY METHOD VERSUS TRADITIONAL ASSEMBLY LINE METHOD

Najarian (2002:01) states that cellular operations must be seen in contrast to the traditional line approach to production. Traditional manufacturing operations are organised by functional specialty into plant departments. This means, for example, that all presses are in one department, all milling machines in another, all welding machines in another and so forth. Workers are spread out along linear-shaped production lines and inevitably produce goods in large batches or lots. Batch-oriented linear production means that an operation completes all of the shop orders and then moves to the next operation for further processing. In a JIT cellular organisation, just the opposite is the norm. Production is organised by product rather than by function with equipment dedicated or partially dedicated to a family of products. Production in such 'cells' is conducted sequentially in the order in which operations must be performed to produce the end item. Workers in this type of environment are in close proximity to one another and are performing operations on lots of one.

3.10.1 Line assembly

Table 3.1 below indicates the methods used for the line assembly process. Various assembly stations are situated along a conveyer belt, and each station is dedicated to a specific type of assembly process for a specific item. In a typical situation, this can involve up to six to eight stations, each requiring an operator to run it. Let us take the example of a tap. It must be

noted here that this is just one example and that processes might have varied for the different types of taps that were assembled.

Table 3.1: Process for the assembly of a tap

Operation number	Description of operation
1. Fit head part	The operator at station one of the line will start the assembly process by inserting the head part into the tap. He/she will then place the sub-assembled item on the conveyer belt to be transported onto the next work station in line.
2. Pressure test	This operator picks up the sub-assembled item and conducts a pressure test to check for leakages. When the operator has finished testing, he/she will place the sub-assembled tested item onto the conveyer.
3. Fit cover and handle	This operator picks up the sub-assembled item and fits a cover and the tap handle. When this operator has finished, he/she places the sub-assembled item on the conveyer belt.
4. Fit indices	This operator picks up the sub-assembled item and screws on the handle and fits the indices (hot or cold). When the operator has finished, he/she places the sub-assembled item on the conveyer.
5. Clean/polish and check	Here, the operator picks up the tap from the conveyor and cleans/polishes the tap whilst doing a quality check. He/she then inserts it into a plastic packet and places it on the table for packaging into boxes.
6. Packaging	This is the final stage of the assembly process. Here, the operator packs the taps into boxes as per the required quantity per box. He/she inserts a label for identification, weighs the box to ensure the right number of taps are packaged and then places it onto a pallet.



Figure 3.4: Example of an assembly line

3.10.2 U-cell assembly

Figure 3.5 shows a typical u-cell assembly process. This process involves only one operator, not six to eight as might be needed for the line assembly process. Here, one operator carries out all six of the above steps on his/her own. The operator does not have to put the tap down once he/she has started the assembly process. This eliminates the time lost due to transportation on the conveyor and also eliminates the amount of handling damage that might occur during the line assembly process.



Figure 3.5: Example of a u-cell assembly

At the time of the research, Company A utilised both u-cell assembly and line assembly processes. A comparative study between these two methods was conducted in order to determine whether the u-cell approach in the assembly of components was better, and more productive, when being compared with the old, traditional method of assembling items along a production line.

3.11 EFFICIENCY

Throughout history, performance measures have been used to assess the success of organisations. The modern accounting framework dates back to the Middle Ages, and since that time, assessment of performance has been based predominantly on financial criteria (Kennerley & Neely, 2003). Presently, there is no 'body of knowledge' in South Africa with regard to the field of performance measurement, and literature surveys have not yielded a proper definition of an ERS. It is common knowledge that employing a measurement system

automatically leads to better monitoring of organisational outputs (De Waal, Goedegebuure & Geradts, 2011).

Efficiency means doing something at the lowest possible cost. This must however not be confused with the term **effectiveness**, which means doing the right things to create the most value for the organisation. This can be explained by the following, which we come across in our daily lives. At a counter in a bank, being efficient means using the fewest staff possible at the counter. Being effective, though, means minimising the amount of time the customers need to wait in line to be served. Efficiency is the ratio of the actual output of a single operator, line of operators or group of lines expressed in standard minutes produced, divided by attended minutes over the full duration that work has been carried out (Chase et al., 2006:08).

In order to avoid confusion, it is also important to separate the terms **efficiency** and **utilisation** as an organisation's effectiveness is defined by these two measures (Stevenson, 2007:180). Russell and Taylor (2009:664) define efficiency as how well a machine or worker performs according to a set standard, whilst utilisation refers to the percentage of available working time that a worker actually works or a machine actually runs. Stevenson (2007:180) provides the following definition: Efficiency is the ratio of actual output to effective capacity, and capacity utilisations is the ratio of actual output to design capacity.

$$\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}}$$

$$\text{Utilisation} = \frac{\text{Actual output}}{\text{Design capacity}}$$

Both of the above measures are expressed as percentages. The following shows the method of calculating operator efficiency.

Example:

One operator works 8 hours in a day. The standard time to produce one unit is 3.5 standard minutes. The operator produces (output) 86 units during his working day.

Therefore:

$$86 \text{ units} \times 3.5 \text{ standard minutes} = 301 \text{ standard minutes}$$

$$301 / (8 \times 60) \times 100 = \underline{62.71\% \text{ operator efficiency.}}$$

Based on the above information, the researcher provides the following definition as his interpretation of an ERS:

An ERS is a reporting mechanism that an organisation uses to determine its output on a regular basis and subsequent comparison with the resources that were utilised to attain the realised output. An ERS is used to provide feedback to employees and management on the performance of the organisation. This mechanism must be generated using the techniques of work study, firstly to, improve the method of working and secondly, to set standard times for its operations.

This interpretation is supported by Franco-Santos, Kennerley, Micheli, Martinez, Mason, Marr, Gray and Neely (2007), who state that a performance measurement system is mainly perceived as a “set of metrics used to quantify both the efficiency and effectiveness of actions” or as the reporting process that gives feedback to employees on the outcome of actions. Action taken from the information received from an efficiency report results in improvements in behaviour, motivation and processes (Fryer, Antony & Ogden, 2009).

CHAPTER 4

LITERATURE SURVEY: WORK STUDY

4.1 INTRODUCTION

In the previous chapter, the concept of productivity was discussed in detail, as the study revolved around the enhancement of productivity at Company A. This was followed by a look at various management aids that were developed through the years to assist managers in their daily functions and to ensure the efficiency and effectiveness of their organisations. In this chapter, the question why work study is so valuable to an organisation, is firstly discussed. The literature survey will include the objectives, financial implications, procedure, structure, importance and value of work study. Furthermore, the human factor in work study, the reaction of groups to work study and work study officers and their relations with others in the workplace are discussed. One of the main obstacles in the application of work study in an organisation is obtaining the co-operation of supervisors and workers.

The two principal techniques of work study, namely method study and work measurement are discussed in detail in Chapter 5.

4.2 WORK STUDY

Sookdeo (2012a:05) states that work study succeeds because it is systematic both in the investigation of the problem being investigated and in the development of its solution. Kanawaty (1995:09) defines work study as the systematic examination of the methods of carrying out activities so as to improve the effective use of resources and to set up standards of performance for the activities being carried out. **Work study** is a generic term for those techniques, particularly method study and work measurement, which are used in the examination of human work in all its contexts and which lead systematically to the investigation of all the factors which affect the efficiency and economy of the situations being reviewed in order to effect improvements (Pycraft et al., 2010:248). Prokopenko (1987:121) defines work study as a combination of two groups of techniques, method study and work measurement, which are used to examine people's work and to indicate the factors which affect efficiency.

Method study can be defined as the recording and examination of any type of work with the purpose of developing a more efficient method of working and thereby reducing costs (Sookdeo, 2012a). Work measurement is the application of techniques designed to establish the time for a suitably qualified worker to carry out a task at a defined rate of working (Kanawaty, 1995:243). Jacobs and Chase (2011:179) state that the fundamental purpose of work measurement is to set time standards for a job.

These two techniques of work study are constantly in interaction, and aim at the eventual improvement of the productivity of an organisation. Work study is normally used in an attempt to increase output from a given quantity of resources with little or no further capital investment. This is achieved by systematically analysing existing operations, processes and work methods. Figure 4.1 shows that the primary objective of work study is to improve productivity. This diagram also shows how work study uses its two techniques to improve productivity.

4.2.1 Objectives of work study

The primary objective of work study is to utilise its two techniques to improve productivity. Furthermore, the objective of work study is to assist management in obtaining the optimum utilisation of human and material resources available to the organisation for the accomplishment of the work that has to be done. In order to attain its objectives, work study concentrates on the following three aspects (Sookdeo, 2012a:10):

- the most efficient and effective application of the plant and equipment;
- the most efficient and effective application of human resources; and
- the evaluation of material usage.

Niebel and Freivalds (2009:02) state that the objective of the manufacturing manager is to produce a quality product, on schedule, at the lowest possible cost. This is possible by improving the efficiency of labour and other resources and utilising scarce resources more effectively and efficiently. Work study investigations are one way of improving productivity. We can use method study to improve a method, and we can use work measurement to determine standard times for the new method. Improved methods automatically improve productivity.

Currie (1981:47) states that the objective of work study is to assist management to obtain the optimum use of the human and material resources available to an organisation for the accomplishment of the work upon which it is engaged. Fundamentally, this objective has three aspects, namely:

- the most effective use of plant and equipment;
- the most effective use of human effort; and
- the evaluation of human work.

4.2.2 Financial implications of work study

Sookdeo (2012a:12) states that the application of work study techniques is not done “free of charge”. There are costs involved and at this stage, it is desirable to discuss the cost implication of the application of work study techniques briefly. The costs regarding the application of work study and its techniques are relatively low in comparison with other techniques to improve productivity, for example operational research, network analysis and system analysis. Improvements can be seen much quicker, in some cases practically immediately after implementation. It is because of this that work study is such a popular aid to management and is used widely by the private and public sector today. Finally, we can comfortably say that work study concentrates on the effective and efficient application of resources available to an organisation, not only to improve the organisation’s productivity but also to improve the prosperity of the country as a whole.

4.2.3 Work study procedure

Pycraft et al. (2010:248) state that it takes an investigative approach to improve operations. In reality, in order to complete a thorough work study investigation, it is necessary to have a starting point and an ending point. You would not be able to make a success of your investigation if it were carried out without a set procedure and an objective in mind. It is essential to have a procedure for work study because these procedures ensure a systematic course of action, which details the complete method of conducting an investigation. Work study procedures consist of several steps which must be followed in sequence. It must be emphasised that not one of these steps should be skipped when doing a proper work study investigation.

Sookdeo (2012a:13) outlines the basic work study procedure as a set of eight steps:

Step 1: **Select** the job or process to be studied.

Step 2: **Record** or collect all the relevant data about the job or process, using the most suitable data collecting techniques so that the data will be in the most convenient form to be analysed.

- Step 3: **Examine** the recorded information critically and challenge everything that is done, considering in turn the purpose of the activity, the place where it is performed, the sequence in which it is done, the person who is doing it, and the means by which it is done.
- Step 4: **Develop** the most economic method or process, taking into account all the circumstances and drawing, as appropriate, on various operations management techniques.
- Step 5: **Evaluate** the results attained by the improved method compared with the quantity of work involved and calculate a standard time for it.
- Step 6: **Define** the new method and the related standard time and present it to all those concerned in writing and/or by using demonstrations.
- Step 7: **Install** the new method, training those involved as an agreed practice with the allotted standard time of the operation.
- Step 8: **Maintain** the new standard practice by monitoring the results and comparing them with the original targets.

4.2.4 Structure of work study

The structure of work study reflects the systematic nature of work study, and illustrates how the techniques of method study and work measurement complement each other to eventually ensure an improvement in productivity. The diagram below shows the basic procedure of both method study and work measurement. These will be discussed in detail later in this chapter. Currie (1981:50) drew up the following structure of work study.

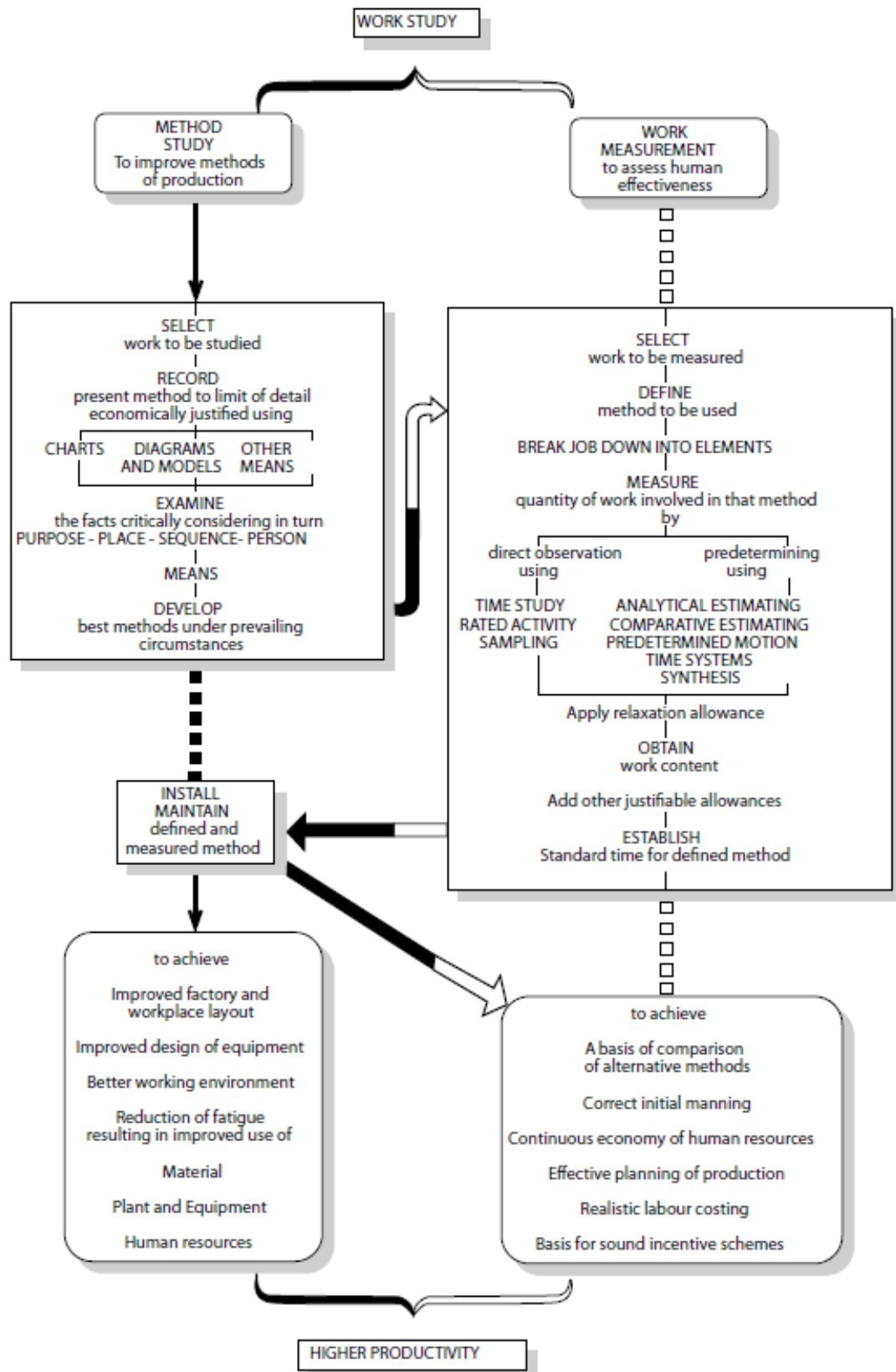


Figure 4.1: The structure of work study (Currie, 1981:50)

4.2.5 The importance of work study

The importance of work study as a management aid is being recognised on a larger scale as organisations gear up to become more effective and efficient in their operations (Sookdeo, 2012a:05). In South Africa, organisations have already proved the importance of work study and related techniques in practice and continue to derive tremendous benefits from its implementation. It is therefore very important that:

- the work study officer understands and applies work study techniques; and that,
- management in all functions and divisions within an organisation are aware of what work study can offer them.

Study.info (2011) summarises the importance of work study as the following:

- It is a means of raising the productivity of an organisation by the reorganisation of work, a method that normally involves little or no capital expenditure on facilities and equipment.
- It is systematic. This ensures that no factor affecting the efficiency of an operation is overlooked, whether in analysing the original practices or in developing the new method and that all the facts about the operation are available.
- It is the most accurate means yet evolved of setting standards of performance on which the effective planning and control of production depends.
- It can contribute to the improvement of safety and working conditions at work by exposing hazardous operations and developing safe methods of performing operations.
- The savings resulting from properly applied work study start at once and continue as long as the operation continues in the improved form.
- It is a 'tool' which can be applied everywhere. It can be used with success wherever work is conducted, not only in the manufacturing sector but also in the services sector.
- Work study is relatively cheap and easy to apply.

4.2.6 The value of work study to an organisation

There is nothing new about investigations and improvements at the workplace. Good managers have been investigating and improving work ever since human effort was first organised on a large scale. The prime value of work study lies in the fact that, by carrying out its systematic procedures, a manager can achieve results as good as or better than the less systematic person was able to achieve in the past (Sookdeo, 2012a:05).

Niebel and Freivalds (2003:01) state that certain changes continually taking place in the industrial and business environment must be considered both economically and practically. These include the globalisation of both the market and the producer, the layering of corporations in an effort to become more competitive without deteriorating quality, the growth of computerisation in all facets of an enterprise, and the ever-expanding application of the information highway.

Work study succeeds because it is systematic both in the investigation of the problem being considered and in the development of its solution. Conducting systematic investigations is time-consuming, and management and staff do not have the available time to conduct them. This is where work study comes in (Slack et al., 2010:259). Management needs work study because it uses continuous observation and studies at the workplace in order to obtain the facts required. This means that management requires someone who is able to carry out investigations on a full-time basis without the interruptions of normal working duties. In other words, a work study officer is needed. Kanawaty (1995:18) states that it is one of the most penetrating tools of investigation available to management. It makes an excellent weapon for starting an attack on inefficiency in an organisation.

It is for this reason that work study is generally regarded as a 'tool' of management. The investigator used work study and its related techniques to carry out the complete investigation for the purposes of this study.

4.3 THE HUMAN FACTOR IN WORK STUDY

For the purpose of this study, the term **human factor** refers to the feelings, emotions and behaviour of employees in the workplace and must not be confused with the term **ergonomics**. Kanawaty (1995:25) states that the human factor is one of the most crucial elements in enterprise operations, for it is through people that management can control the utilisation of its resources and the sale of its products and services. To perform to the best of their ability, employees must be motivated to do so. One of the greatest difficulties of obtaining the active co-operation of workers is the fear that raising productivity will lead to unemployment. This resistance can generally be reduced to a minimum if everybody concerned understands the nature of and the reason for each step taken and if they are involved in the implementation of ergonomic improvements.

4.4 REACTION OF GROUPS TO WORK STUDY

Sookdeo (2005:137) states that during the implementation of productivity improvement techniques by work study, it has been found that the greatest resistance is experienced from groups. The work study officer must therefore know the basic principles of group forming. The officer must always remember that he/she stands outside the group being studied and is sometimes regarded by the group as a threat to their existence.

This problem becomes quite clear in a situation where a work study investigation brings about the dissolving of a group. In such a case, it is the task of the work study officer to convince the specific group of the necessity of such a step. This may sometimes even mean that every member of the group has to be approached personally to explain the reasons for the change(s). If possible, such a step must therefore have the approval of the group. Individuals have a natural resistance to change. This also applies to groups, especially formal groups, which have existed for a long time with certain traditions and habits. Due to the nature of work study, these habits are now being questioned. An investigation or study could, for example, show that unnecessary material and time have been wasted. The work study officer should not accuse the group in such cases, but rather inform the group of the new facts and then encourage them to avoid a repetition of the same 'mistakes'. At no time should the group or individuals in the group therefore feel that they have failed personally. In order to do their best, workers must be motivated to do so (Kanawaty, 1995:25).

At all times, the work study officer must try to win and maintain the trust and co-operation of any group which is being investigated. If he/she succeeds, the problems mentioned above will in most cases be solved automatically, which will ensure good co-operation within the organisation in the long run.

4.5 WORK STUDY OFFICERS AND THEIR RELATIONS WITH OTHERS

In the past, work study officers mainly dealt with increasing the productivity of the worker. Today, with the increasing complexity of modern organisations, higher productivity is only one of many fields (e.g. setting of standard times, rating, etc.) dealt with by work study officers. The work study officer gets results by working with people and is constantly in interaction with management, the supervisor or foreman and the workers (Sookdeo, 2005:149).

Over the past few years, organisations have found that their efficiency can be improved considerably by paying more attention especially to supervisors and workers. Unfortunately,

many work study officers think that the objectives of management are more important than the needs and objectives of the individual. Therefore, we will look briefly at how the work study officer should approach these different groups.

4.5.1 Work study officers and management

In many organisations, the head of the work study department is a member of top management. It is the duty of this head to inform top management constantly of the possible uses of work study. The work study officer must be able to rely on the support of top management to do his/her work successfully, and the importance of the work study officer in the organisation should be passed on to the supervisors, foremen and workers by management (Kanawaty, 1995:26).

Example 1:

Management should publicise the benefits of all work study investigations to the organisation to all concerned. This would encourage them to co-operate with the work study officer. If an organisation operates in this way, work study officers can be an important link between top management and the workers. Problems arising from the work situation can then be conveyed to top management by the work study officer.

Example 2:

If a department lacks efficiency, the work study officer may advise management of the need for additional resources, such as more staff or equipment. Management is therefore constantly informed regarding the needs of the workers while the workers in turn will feel that management is interested in what they do.

4.5.2 Work study officers and the supervisor

The best manager gets results through people, and so do work study officers. If they cannot 'sell' their ideas to the people in the line functions of an organisation, the investigation will most definitely fail. During an investigation or study, work study officers must constantly try to get the supervisors and workers involved. By doing this, workers and supervisors will feel that they had a share in the final results, and they will consequently accept changes more easily (Kanawaty, 1995:27).

It is essential for work study officers to discuss the reason and procedures for the investigation with the supervisor before they start the investigation. The supervisor must therefore know exactly what is to be done and why it has to be done. Since the supervisor is

more concerned with the practical side of the work than management, and is consequently more directly involved in work study, his/her work study orientation would be more detailed than that of management. The work study officer must therefore have knowledge of the most important techniques of method study and work measurement and should, for example, have the opportunity to carry out one or two simple method and time studies. Work study officers can only keep the friendship and respect of the supervisor if they do not create the impression that they want to take over their position wrongfully (Sookdeo, 2005:150).

Work study officers must also adhere to the following rules:

- (a) All instructions must be given through the supervisor.
- (b) Workers with problems outside the field of work study must be referred to the supervisor.
- (c) They should not create the impression that they are criticising the supervisor.
- (d) They must never allow themselves to be 'used' to get decisions changed. For example, a supervisor may need more workers, but the work study officer's investigation does not show this. The supervisor might then force the work study officer to change the results of the investigation.
- (e) They must consult the supervisor concerning the tasks to be studied as well as all technical matters concerning the work process.
- (f) They should be introduced to the workers by the supervisor.

4.5.3 Work study officers and the workers

There is a natural resistance to change (RTC) by workers whenever work study is introduced into a department. In the past, workers were often hostile and resisted work study. As discussed earlier, this was mainly due to the improper introduction of the work study officer and his/her presence and task in the organisation/department. Work study can have a positive influence on relations between management, supervisors and workers because of the following:

- (a) The fact that a member of management (the work study officer) takes the trouble to discuss the workers' task and problems makes the workers feel that management really takes an interest in them as individuals. Work study officers must therefore

always bear the individual with his/her own needs and objectives in mind if they want to succeed.

- (b) A work study investigation is often a unique experience for the workers. Usually it is the first time that a properly trained person works with the workers in the workshop. This situation helps to bridge the gulf between the workers and management.
- (c) If work study is used properly and the workers are not left in the dark concerning the reason for the investigation, it will stimulate self-confidence. This can be achieved through consultation with workers.
- (d) Work study improves the flow of the work. Workers are normally glad when interruptions are eliminated so that they can carry on with the task, especially when they are doing piecework.

4.5.4 Work study and trade unions

Sookdeo (2005:153) states that in most industrial countries, including South Africa, we find that most workers are represented by trade unions, especially in large organisations. Trade unions make it their objective to negotiate with management concerning better working conditions, salaries and working hours for their workers. Trade union representatives should therefore be consulted and informed about the objectives of the study. They should also be informed that all work being done by the researcher will be available to them for perusal. They should also be informed that the application of work study does not always have a negative effect on members of trade unions. During negotiation processes between management and trade unions, work study plays an important role in that work study investigations could lead to a decrease in personnel. This decrease in personnel normally occurs through investigations that lead to more efficient methods and processes. Work study can assist an organisation in the following ways, namely to:

- eliminate unnecessary red tape;
- improve working conditions;
- create promotion possibilities for workers;
- indirectly strengthen the organisation as a whole; and
- ensure the security of the trade union members.

CHAPTER 5

LITERATURE SURVEY: WORK STUDY TECHNIQUES

5.1 INTRODUCTION

In the previous chapter, the researcher defined the term **work study** (see 4.2) and also discussed the human factor in work study (see 4.3), the reaction of groups to work study (see 4.4) and the relationship between the work study officer and others, see 4.5). In this chapter, the literature survey study revolves around the two principal techniques of work study, namely method study and work measurement. Kulkarni et al. (2014:432) state that in order to understand the work study methodologies, one must understand the importance of method study and work measurement. These two techniques are discussed in detail in this chapter. The discussion includes the objectives, scope, structure and procedures of these two techniques. Since method study is considered to be a systematic investigation (Slack et al., 2010:259), the researcher will define a systematic investigation and show the value of such a systematic approach to a problem. The definition, principles, objectives, advantages and procedures of systematic investigations are also discussed.

5.2 METHOD STUDY

Yusoffa, Jaffarb, Abbasc and Saadd (2012) state that method study is concerned with the reduction of the work content of a job or operation. This is the first of the two principal techniques of work study. Method study is conducted first as it is impractical to measure the work of an inefficient method. The discussion here starts with the definition and nature of method study and then looks at the objectives, scope and structure of the same.

In order to fully understand the techniques of work study, it is important to reconsider the structure of work study. Figure 5.1 was presented in Chapter 4 (see 4.2.4), but is repeated here for clarity.

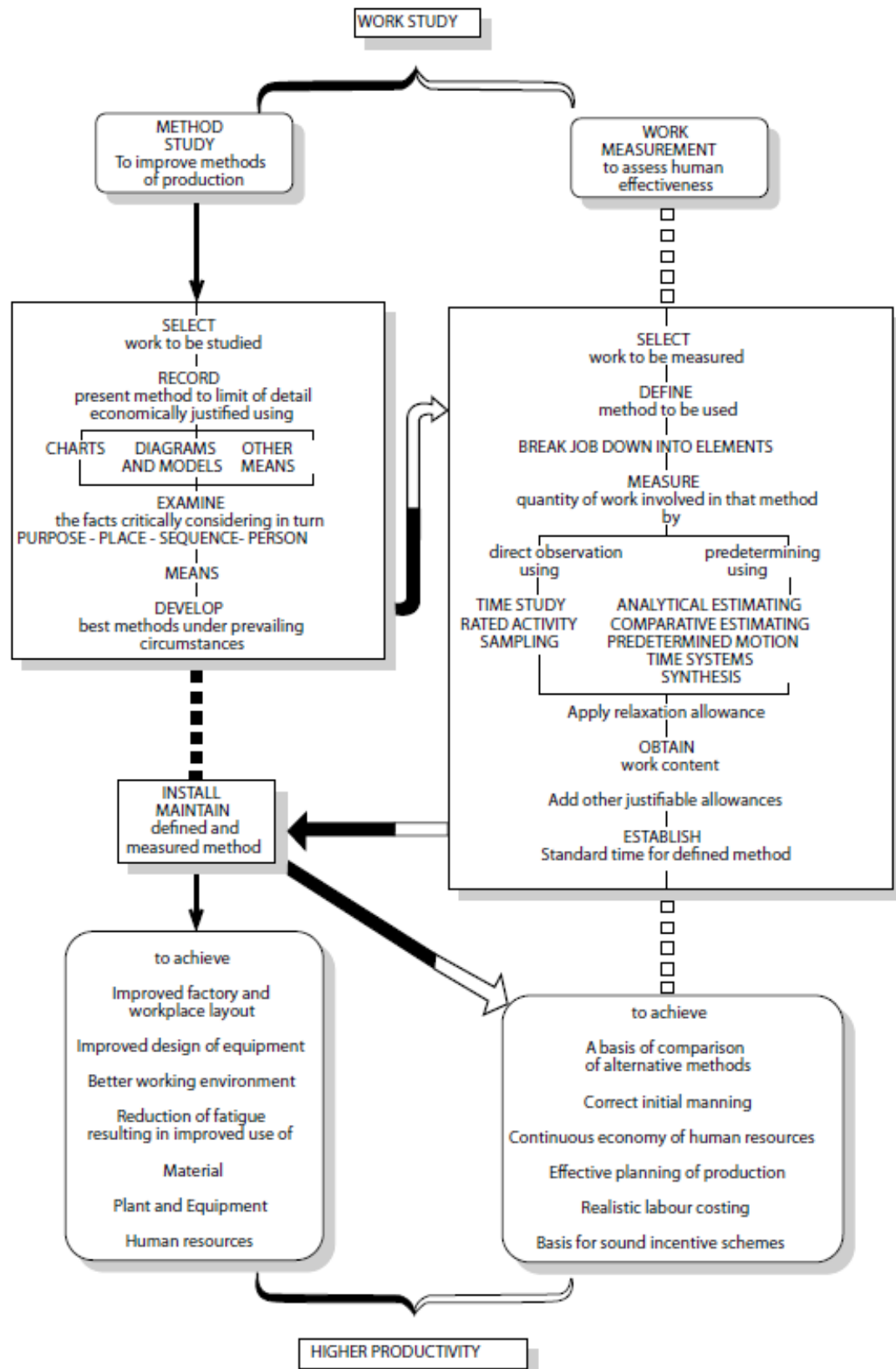


Figure 5.1: The structure of work study (Currie, 1981:50)

Pycraft et al. (2010:248) define method study as the systematic recording and critical examination of the existing and proposed methods of doing work, as a means of developing and applying easier and more effective methods and reducing costs. The BNET Business Dictionary defines **method study** as the systematic recording, examination and analysis of existing and proposed ways of conducting work tasks in order to discover the most efficient and economical methods of performing them.

The basic procedure followed in method study is as follows: select the area to be studied, record the data, examine the data, develop alternative approaches, define the new method, install the new method, and maintain the new method. Method study is conducted prior to work measurement. The technique was initially developed to evaluate manufacturing processes but is now used more widely to evaluate alternative courses of action. It is based on research into motion study conducted by Frank and Lillian Gilbreth during the 1920s and 1930s.

Slack et al. (2010:243) state that method study determines the methods and activities to be included in jobs. Method study can also be seen as the systematic recording and critical examination of the factors and resources involved in an operation, in order to develop a more efficient method and to reduce costs. Kanawaty (1995:75) defines method study as the systematic recording and critical examination of ways of doing things, in order to make improvements. It can be seen from the above two definitions that method study offers a systematic approach to problem solving. When conducting a method study investigation, the objective is to make the work method or process more effective and to eliminate unnecessary and inefficient operations and movements. The remaining operations and movements are then simplified to determine the shortest possible 'route' and the most effective sequence of operations. Method study therefore tries to solve problems and is constantly identifying problems to determine what caused them and what can be done to solve and avoid them in future.

It is therefore important to remember that when starting a method study investigation, analytical thinking is required in the first place. Before any existing or planned method can be improved, it is necessary to analyse the specific process, procedure or task in detail. Throughout the years, this detailed investigation has been developed into a fine art known as 'method study' and consists of certain basic steps or procedures.

5.2.1 The objectives of method study

Bhatawdekar (2010) states that one of the objectives of method study is the improvement in the use of all inputs, and to develop better ways of doing things and reducing costs in the

organisation. It also contributes to improving efficiency by eliminating unnecessary work and delays and preventing waste. The objectives of method study mentioned above can be achieved through –

- improved planning and design of factories and offices, including factory and office layouts, workplace layouts, etc.;
- improved work procedures, processes and methods;
- improved utilisation of raw materials, plant and equipment;
- an improved work environment,
- improved design and design specifications of the end product.

Method study therefore concentrates on stating the real facts concerning a particular situation, investigating these facts critically, and finding the best possible solution under the current circumstances. An important aspect, which must be mentioned, is that a method, process or procedure which was considered the most efficient ten years ago, is not necessarily the best under current circumstances.

A simple example in this regard:

Ten years ago, a bakery produced 1 000 loaves of bread per day. Today, that same bakery produces 5 000 loaves of bread per day. The reasons for increased productivity: the bakery upgraded their ovens and they purchased large highly computerised ovens which have an output of 5 000 loaves per day.

5.2.2 The scope of method study

There is a traditional view that method study can only be applied to light work. This statement does not recognise the full potential of this technique. The scope of method study is much wider and it will be explored briefly here (Bhatawdekar, 2010).

The application of method study in any organisation affects all hierarchical levels. This means that all levels in an organisation, from top management down to the shop floor workers, are affected by the application of method study. Method study implies the study of detailed movements by the individual when carrying out a specific task. This investigation is also known as **motion study**. According to Niebel and Freivalds (2006:148), motion study is the careful analysis of body motions employed in doing a job. Seminal literature by Currie (1981:57) states that method study can be applied anywhere and everywhere, since any method, process or procedure is open to improvements

Some of these movements or motions are so small that they cannot be observed with the naked eye, and film analysis techniques have to be used. A watchmaker is a good example where motion study is applicable, and the technique of film analysis has to be used during an investigation. A watchmaker uses very small parts with tremendous speed and accuracy to assemble a watch. These movements and elements may be too fast for a work study officer to see with the naked eye. Method study also implies the study of large groups of individuals (workers) in the organisation, as well as the application of scarce resources available to the organisation. Examples are:

- layout studies;
- work procedures;
- improved design specifications; and
- wage incentive schemes.

From the above discussion, it can be seen that method study is applied in a variety of situations, such as studying the motions of individuals, large and small groups of workers. It is clear that method study can be applied at all places where people are engaged in work. Due to the variety of method study applications, it is important that a work study officer has the following attributes in order to conduct a successful method study (Improsyst, 2010).

- correct attitude and a good knowledge of relevant techniques;
- the required desire and perseverance to obtain results;
- the ability to obtain results; and
- an understanding of the human factors involved in the situation.

5.2.3 The structure of method study

The structure of work study consists of the techniques of method study and work measurement. These two techniques are constantly interacting. Method study aims to improve methods of production whilst work measurement aims at assessing the duration of a process or procedure, and (Sookdeo, 2012a:65). This means that a method study is carried out in order to assess the present method of working. Here the method, i.e. how the work is done, is investigated. Thereafter, the recorded data is analysed utilising the questioning technique (see 5.2.4.3) in order to develop an improved method of working. This is called the proposed method. The best way to describe the structure of method study is in the form of the following diagram:

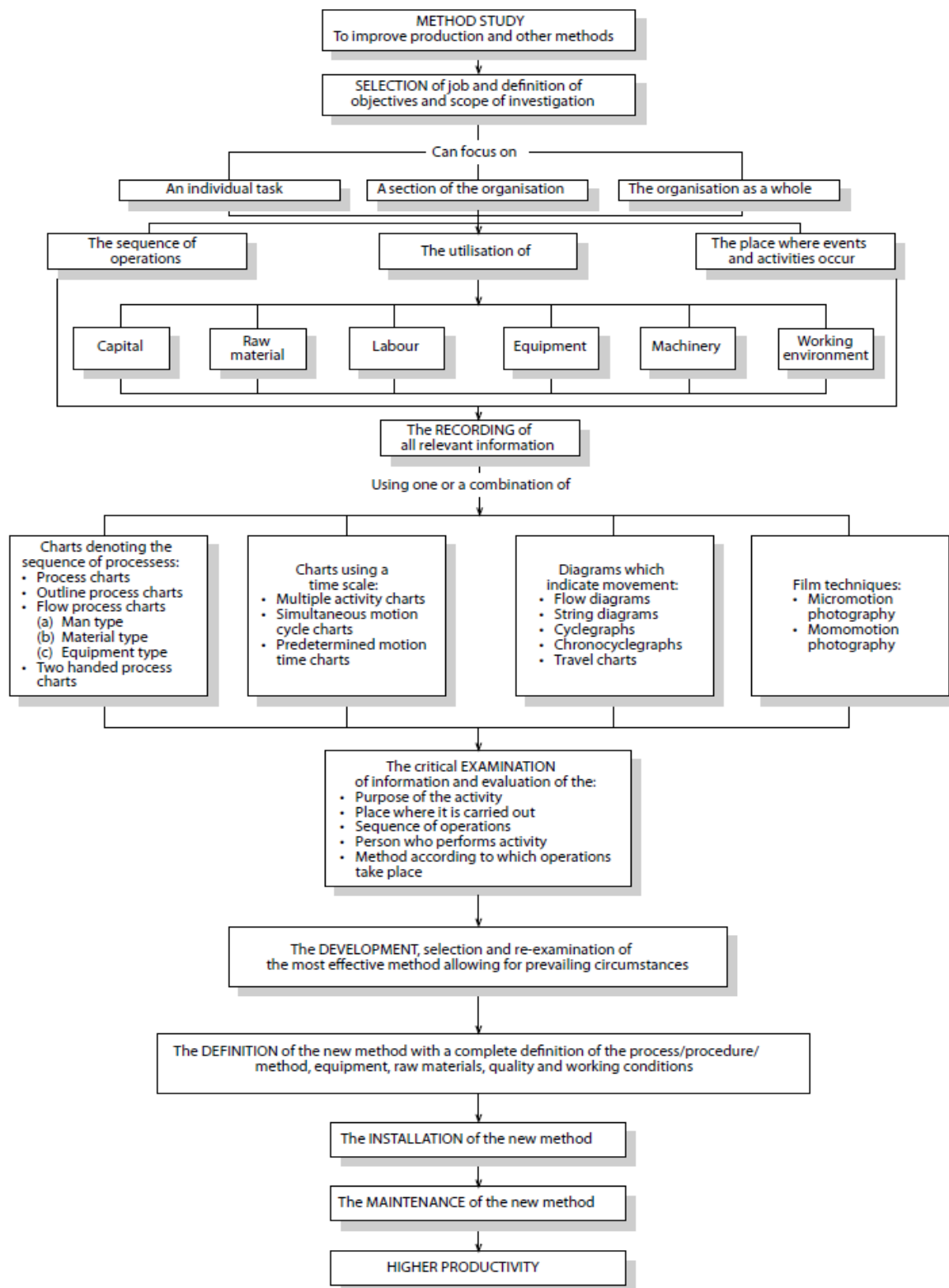


Figure 5.2: Structure of method study (Sookdeo, 2012a:66)

It is clear from Figure 5.2 that method study covers a wide spectrum in the organisation and is applicable to individual tasks as well as to the organisation as a whole. A further important

aspect of this structure is the sequence in which the steps of an investigation must be carried out. By keeping to this sequence, the success of an investigation can largely be ensured.

5.2.4 Method study procedure

Pycraft et al. (2010:249) state that method study is a systematic approach to finding the best method. Similar to work study, there is a set of procedures that must be followed in order to achieve success in a method study investigation. In Figure 3.2, seven essential steps of method study were identified. These steps represent the procedure that must be followed when conducting a method study investigation (Slack et al., 2010:258), namely:

- Step 1: Selection
- Step 2: Recording
- Step 3: Examination
- Step 4: Development
- Step 5: Definition
- Step 6: Installation
- Step 7: Maintenance

Pycraft et al. (2010:249) outlines six steps, eliminating 'Definition' and Kanawaty (1995:75) outlines eight steps to include 'Evaluation' as step number 5. For the purposes of this study, the researcher used the above seven steps. These seven steps are discussed briefly below.

5.2.4.1 The *SELECTION* of the task to be studied

When selecting the task or process which has to be studied, there are certain factors which the management services practitioner should bear in mind. These factors that will determine the desirability of the examination, namely:

- economic considerations;
- technical considerations; and
- human reactions.

In any organisation where materials, documents and/or manual labour are utilised, there usually are a wide variety of tasks on which method studies can be carried out. When a task or process is selected for the purpose of a method study, it is useful to have a checklist of items to be covered. A good rule to remember is that the tasks which have the largest effect

on the efficiency and therefore the profitability of the organisation as a whole must be investigated first.

5.2.4.2 *The RECORDING of relevant data*

A variety of recording techniques are available to the work study officer. Examples of these techniques are charts and diagrams. No matter which recording technique is selected, the main purpose is to record all the relevant information concerning the process systematically and objectively. This may mean that an existing method or process is observed and recorded step by step. The information received must be based on direct observation. For the purposes of this study, the researcher utilised flow process charts to chart the activities of the selected observations in order to effect possible improvements. The following should not be considered:

- second-hand reports;
- the opinion of the manager or supervisor (on how he/she thinks the work should be done); and
- the worker's description of how the work should be done.

For the purposes of this study, flow process charts were used to record the assembly process of the tap under investigation. The following depicts an example of a flow process chart.

FLOW PROCESS CHART / VLOEIPROSESKAART

[illegible]

Figure 5.3: Flow process chart

5.2.4.3 The critical EXAMINATION of all relevant data

All data obtained and recorded as per subsection 5.2.4.2 above are now critically examined and analysed in order to establish an improved method or procedure. The examination starts with the identification of all unnecessary activities in the existing method or procedure. These activities must then be rearranged, simplified, combined, eliminated and improved in order to obtain a new, improved method. This examination takes place via the use of the questioning technique. Currie (1981:104) states that the critical examination of data is achieved by utilising two sets of detailed questions. The primary questions indicate the facts and the reasons underlying them, and secondary questions indicate the alternatives and consequently the means of improvement.

Kanawaty (1995:94) defines the questioning technique as the means by which the critical examination is conducted, each activity being subjected in turn to a systematic and progressive series of questions. To help the work study officer with the detailed analysis of information, certain questions concerning the classified information can be asked.

Let us firstly look at the primary questions. Here, the question sequence follows a specific pattern, which investigates the problem and its activities. Now, one may ask, "What is the purpose of asking these primary questions?" The answer is to:

ELIMINATE	unnecessary activities
COMBINE	certain activities
RE-ARRANGE	the activities
REALLOCATE	tasks
SIMPLIFY	the method

As already mentioned, the purpose of the primary questions is to indicate the underlying reasons why certain activities are carried out. Table 5.1 presents a summary of the primary questions. The above information concerning the primary questions can be combined into one table as shown below:

Table 5.1: Summary of primary questions (Slack et al., 2010:260).

PURPOSE	What is done? Why is it done?	In view of the ELIMINATION of unnecessary work.
PLACE	Where is it done? Why is it done there?	In view of the COMBINATION and/or RE-ARRANGEMENT of activities
SEQUENCE	When is it done? Why is it done then?	
PERSON	Who does it? Why is it done by that person?	In view of REALLOCATION of the task.
MEANS	How is it done? Why is it done like that?	In view of the SIMPLIFICATION of the task.

Let us now look at the secondary questions. The secondary questions are the second phase of the questioning technique. Here, the answers obtained from the primary questions, are subjected to further questioning. These secondary questions try to find alternatives concerning purpose, place, sequence, person and means of the problem being investigated. It has to do with the development of new or improved methods, processes or procedures. The secondary questions which can be asked are as follows:

Table 5.2: Summary of secondary questions

PURPOSE	What else could be done? What should be done?
PLACE	Where else could it be done? Where else should it be done?
SEQUENCE (time)	When else could it be done? When else should it be done?
PERSON	Who else could do it? Who should do it?
MEANS	How else could it be done? How should it be done?

It is clear from the above table that alternative solutions are sought. By combining the primary and secondary questions, a complete idea of the questioning technique can be developed. These combined primary and secondary questions are illustrated in the table below and can be used as a useful frame of reference, especially in method study investigations.

Table 5.3: Summary of primary and secondary questions combined

PURPOSE	What is done? Why is it done? <i>What else could be done?</i> <i>What should be done?</i>	In view of the ELIMINATION of unnecessary work.
PLACE	Where is it done? Why is it done there? <i>Where else could it be done?</i> <i>Where else should it be done?</i>	In view of the COMBINATION and/or RE-ARRANGEMENT of activities
SEQUENCE	When is it done? Why is it done then? <i>When else could it be done?</i> <i>When else should it be done?</i>	
PERSON	Who does it? Why is it done by that person? <i>Who else could do it?</i> <i>Who should do it?</i>	In view of REALLOCATION of the task.
MEANS	How is it done? Why is it done like that? <i>How else could it be done?</i> <i>How should it be done?</i>	In view of the SIMPLIFICATION of the task.

From the facts presented above, Table 5.4 presents an example of a questioning technique sheet:

Table 5.4: Questioning technique sheet

The present facts		Alternatives	Selected alternative for development
P U R P O S E			
What is achieved?	Is it necessary: Yes/No? If Yes – why?	What else could be done?	What is done?
P L A C E			
Where is it done?	Why is it done there?	Where else could it be done?	Where is it done?
S E Q U E N C E			
When is it done?	Why is it done then?	When else could it be done?	When is it done?
P E R S O N			
Who does it?	Why does that person do it?	Who else could do it?	Who does it?
M E A N S			
How is it done:	Why that way?	How else could it be done?	How?

5.2.4.4 The DEVELOPMENT, selection and re-examination of alternative solutions

An important feature of a critical examination is that it develops a variety of potential improved ways to carry out the task or process being studied. The degree to which a work study officer will succeed depends on his/her knowledge and judgement of the merits of a

proposed method. In a manufacturing organisation, where this judgement requires a great deal of technical knowledge, the work study officer can turn to the superior knowledge of the supervisor or manager concerned. Such an improved method or process is known as the 'new method'.

5.2.4.5 *The DEFINITION of the new method*

Before the new method can be implemented, it must be described in detail. Documents must be drawn up which describe the:

- process/procedure/method;
- equipment;
- raw materials;
- quality; and
- working conditions required by the new method.

The reason for this is that upon implementation, everyone involved will know **what** must be done, **when** it must be done, **why** it must be done and **how** it will be done.

5.2.4.6 *The INSTALLATION of the new method*

This step takes longer than all the other steps of a method study investigation. Although the new method has been accepted, a plan of action has not yet been decided on. A planned schedule may be necessary, especially for difficult projects that require many changes.

It is the task of the work study officer to ensure that the implementation is carried out smoothly and that the new method or performance occurs exactly as originally planned. He/she must also ensure that the department knows exactly what the new method is all about. Good human relations and the thoroughness with which this step is carried out will largely determine the success of the new method.

5.2.4.7 *The MAINTENANCE of the new method*

Experience has taught us that after the new method has been implemented, changes may occur with time. These changes can be attributed to changes made by the operator or supervisor or because of suggestion schemes. Management uses suggestion schemes to elicit ideas for improvements from the workers within a company (Sookdeo, 2005:173).

In many cases, the operator or supervisor will implement a completely different method from the one intended without the knowledge of the work study officer. This usually happens due to the operator's or supervisor's experience of working with the processes for a long time. It is consequently important that the work study officer realise that his/her task in establishing a new method does not end with the implementation. It is the responsibility of the work study department to ensure that the new method is actually implemented and maintained for as long as the method exists.

The work study officer must therefore constantly inspect and check the workplace or division. We can now go on to discuss systematic investigations.

5.3 SYSTEMATIC INVESTIGATIONS

In 5.2 above, it was stated that Kanawaty (1995:75) defines method study as the systematic recording and critical examination of ways of doing things, in order to make improvements. This is enhanced by Kulkarni, Kshire and Chandratre (2014:432) who state that method study is a systematic investigation. Here the investigator will define a systematic investigation and show the value of such a systematic approach to a problem. Under systematic investigations, we will look at the definition, principles, objectives, advantages and procedures.

5.3.1 Definition of a systematic investigation

Yusoffa et al. (2012) state that before any measurement commences, the work to be measured is analysed and broken down into measurable elements. A systematic investigation can be defined as a systematic approach to a problem with the purpose of solving the problem in the most advantageous way possible. A systematic approach therefore –

- places the problem in the right perspective;
- defines the purpose of the investigation; and
- ensures that all actions of the investigator are aimed at the ultimate achievement of the objective.

A systematic approach will further ensure that only relevant information is taken into consideration, and this puts the investigating officer in a better position to get his/her suggestions approved.

5.3.2 Principles of a systematic investigation

A systematic investigation is based on the following principles:

- a) The purpose of the investigation must be clearly understood and drafted during the preliminary survey and agreed upon before starting the task itself.
- b) All relevant information concerning the problem under investigation must be obtained and recorded. Information is obtained through personal observation, interviews, relevant documentation, etc.
- c) The accuracy and quantity of information will be determined by the nature of the problem. Some investigations may require detailed information, while others only require a broad outline.
- d) Good relations must be maintained throughout the investigation. Special attention should be given to the departmental manager, the supervisors and the staff. The objectives of the investigation must be clearly explained. All recommendations must be discussed with all involved. The work study officer must therefore not appear to be an expert but rather the project leader. By doing this, the staff will be prepared to share their specialised knowledge with him/her.
- e) Tentative conclusions should be formed as the investigation progresses. Even in the early stages, conclusions must be tested and accepted or discarded. Final conclusions must, however, be based on indisputable facts.
- f) The investigation must be carried out according to a plan that was drafted beforehand. The plan must be of such a nature that the work study officer's time is spent in the best way and that the investigation will, as far as possible, not be interrupted. Such a plan should also be flexible.
- g) The final conclusions and recommendations must not come as a surprise to the staff. This will happen if they are not involved in the investigation. Always acknowledge the contributions of all staff members.
- h) The recommendations must be practical. This means that they can be easily implemented without incurring major costs.

5.3.3 Objectives of a systematic investigation

Most work study investigations are carried out in response to requests from management. In many cases, these requests originate from earlier recommendations of work study investigations. To ensure the success of a work study investigation, there must be a definite objective (or objectives), so that the work study officer can work towards this objective. The following are possible objectives of an investigation, namely to –

- improve or develop an existing or new organisation structure;
- improve or develop existing or new procedures and/or methods;
- reduce costs or make the work of management easier;
- prevent or reduce errors, or improve the service;
- test or commission the practical use of new machinery or equipment;
- investigate the possibility of reducing staff; and
- use the production and other assets of an organisation fully.

Similar to work study, the purpose of a systematic investigation is the efficient application of natural and other resources. The systematic approach in work study investigations assists in speeding up the achievement of the proposed objectives.

5.3.4 The advantages of a systematic investigation

The advantages of a systematic investigation are the following:

- Investigation ensures that the problem is seen in the right perspective. By seeing the problem in the right perspective deviations from or loose interpretations of the original instruction will therefore not happen easily and the over- or under-emphasis of information is more easily controlled.
- The purpose of the investigation is clearly formulated, explained to all and all actions are directly in line with the purpose.
- All relevant data is taken into consideration. Scientifically founded recording techniques ensure that all relevant information is obtained.
- The chances of finding a better solution to a specific problem are much greater if a systematic approach is followed than when the investigation is carried out at random.

5.3.5 Method study as a systematic investigation technique

In point 5.2.4 above, we identified the seven essential steps of method study as selection, recording, examination, development, definition, installation and maintenance. The relationship between the general procedures for a systematic investigation and the method study procedures can now be determined. This relationship is illustrated in Table 5.5 below.

Table 5.5: Relationship between method study and systematic investigation procedures

STEP NO.	METHOD STUDY PROCEDURES	SYSTEMATIC INVESTIGATION PROCEDURES
1	SELECTION of the task and description of objectives phase	RECONNAISSANCE PHASE
2	RECORDING of relevant data	DEVELOPMENT PHASE
3	CRITICAL EXAMINATION of all relevant data	
4	DEVELOPMENT , selection and re-investigation of the more efficient method	
5	DEFINITION of the new method	
6	INSTALLATION of the new method	EVALUATION PHASE
7	MAINTENANCE of the new method	

The difference between the method study procedure and the systematic investigation procedure is that the method study procedure is specifically directed at the improvement or development of existing or new methods, processes and procedures, whereas the systematic investigation procedures are applicable to all aspects or problems which are to be investigated.

The systematic investigation procedures as discussed in this chapter therefore form the basic guidelines according to which systematic investigations are to be undertaken. Method study can therefore be regarded as one of various systematic investigation techniques which are directed mainly at the improvement of an existing work performance method or the development of a new one.

5.3.6 Systematic investigation procedures

It is sometimes impossible to establish definite procedures which are applicable to all systematic investigations of all types of problems. There is, however, a basic framework within which all systematic investigations can be done. They can be divided into three basic phases, namely reconnaissance, development and evaluation.

In the next section, we will look briefly at each phase and show how it is related to method study.

5.3.6.1 Reconnaissance phase

Before a detailed study can be carried out, the work study officer must determine the following:

- Does the problem fall under management services?
- What gave rise to the instruction for an investigation?
- What will the purpose of the proposed investigation be?
- Is it really desirable to carry out an investigation?

Answers to all these questions must be obtained during the reconnaissance phase. This phase is broken down into the following four steps:

Table 5.6: Four steps of the reconnaissance phase

STEP	ACTION
1	Determine the preliminary objectives and description of the investigation.
2	Determine a suitable time and duration for the study or investigation in consultation with management and personnel involved.
3	Conduct a preliminary survey and analysis of information. This includes interviews, inspection tours, checking of reports, etc.
4	Formulate a final description of the purpose of the investigation based on the information obtained.

After completion of the reconnaissance phase, the work study officer should have the answers to the above questions. These answers will assist in the decision whether to carry out the investigation or not, which must also be taken at this stage.

5.3.6.2 *Development phase*

This phase will only start if it was found during the reconnaissance phase that it is desirable to go on with the investigation. The development phase consists of a detailed investigation of all aspects concerning the problem. This phase must be carried out according to the following procedure:

- Plan the investigation in detail.
- Programme the investigation or draw up a timetable.
- Obtain and record information.
- Classify the information, analyse it and formulate alternative solutions.
- Decide on the best solution.
- Report and submit the solution for approval.

The success of the investigation depends largely on the thoroughness with which this phase is carried out. After the report has been approved, the evaluation phase can now proceed.

5.3.6.3 *Evaluation phase*

This is the last phase of a systematic investigation and consists mainly of the following:

- Preparation for implementation. This comprises ordering new equipment, designing new forms and compiling and introducing instructions for implementation.
- Introduction of the new solution as set out in an approved programme or timetable.
- Evaluation of the results (this is also known as maintenance).

5.3.7 *Summary of method study and systematic investigations*

The value of method study for any organisation lies in the fact that it offers a systematic approach to problem solving and that it can be applied virtually everywhere since any method, process or procedure can be improved. Seen in a micro context, method study consists of the study of the detailed movements of a worker while carrying out his/her task. In a macro context, method study is the study of large groups of people, or machinery, or the organisation as a whole. Method study can be applied successfully in virtually all organisations where human labour is used.

The success of a method study investigation depends on the extent to which the steps and their sequence are adhered to. Good relations must also be maintained with the group or

individual under observation. A work study officer must therefore not only have a sound knowledge of the techniques but must also be able to 'sell' his/her new improved method, process or procedure to the manager, supervisor or workers concerned.

Systematic investigations offer a systematic approach to problem solving and it is applicable to virtually all aspects which are investigated or questioned. Examples of these are organisation structures, procedures, methods, layouts, costs, variety reduction investigations, wage incentive schemes and many more.

5.4 WORK MEASUREMENT

Yusoffa et al. (2012) state that work measurement is mostly concerned with the investigation and reduction of any ineffective time associated with a job or operation. The Institute of Management Services (2014) states that work measurement is the process of establishing the time that a given task would take when performed by a qualified worker working at a defined level of performance. Work measurement is the second of the two principal techniques of work study. Kanawaty (1995:243) defines work measurement as the application of techniques designed to establish the time for a qualified worker to carry out a task at a defined rate of working. Stevenson (2012:301) defines work measurement as the length of time that it should take to complete a job.

Here, the objectives, nature and scope and structure of work measurement will be discussed as well as some of the requirements regarding the application of work measurement. The basic procedure of work measurement will also be discussed. This section concludes with a look at the techniques of work measurement (direct and indirect) and a discussion of how these were used to attain the standard times for this study.

Work measurement was the domain of the 'time and motion man' who used a stopwatch to determine the duration of activities (Slack et al., 2010:254). The measurement of human work has always been a problem for management. Providing goods and services to a customer at a predetermined cost is dependent on the accuracy with which the amount of human work can be forecast and organised. Previously, it was common practice to make estimates and set targets based on historical data but these were unsatisfactory guides. It is here that work measurement plays such an important role. Work measurement allows for standard times to be set and this provides for a far more satisfactory basis on which to plan.

In the present study, all selected operations were measured via the time study technique in order to set standard times and to set targets for efficiency reporting. Kulkarni et al.

(2014:432) state that time study can be defined as a technique to estimate the time to be allowed for a qualified worker working at normal pace to complete a specified task by using a specified method.

5.4.1 The objectives of work measurement

The primary objective of work measurement is to set time standards for a specific task (Chase et al., 2006:190). Work measurement is concerned with investigating, reducing and subsequently eliminating inefficient time, i.e. the time during which no effective work is being performed. The objectives of work measurement are twofold, namely to determine –

- the amount of work, mainly in terms of volume and quality; and
- how long it will take to complete the work. A reasonable time is therefore determined in which a specific piece of work is done satisfactorily according to a specific method by a trained worker.

The application possibilities of work measurement are countless. Work measurement –

- serves as an important aid to evaluating new or improved methods, and by comparing the durations of alternative solutions with one another, the method with the shortest duration may be identified as a possible best solution;
- serves as an aid to determine present and future requirements regarding labour, materials, machinery, floor space, personnel, etc.;
- serves as an aid to planning and scheduling work (production);
- serves as a basis for the control of production and labour;
- is an important aid to compiling budgets;
- serves as a basis for a realistic and fair wage incentive system;
- can be used to determine the scope of peaks and slumps in, for example, the output of a factory; and
- is used to determine standard times.

These application possibilities are discussed in detail under the scope of work measurement (see 5.4.3). Let us now look at the nature of work measurement:

5.4.2 The nature of work measurement

Dagdevirena et al. (2011:564) state that it is not possible to be consistent and efficient primarily in preparing manufacturing plans and programmes, short- and long term forecasts, cost control, pricing and the other technical and managerial activities in a company with a time estimation that is not based on the standard time. Work study consists of the application of various techniques, especially method study and work measurement which, if applied correctly, will together increase productivity. There is a definite relationship between method study and work measurement, and a clear distinction can be seen between method study and work measurement. Method study concentrates on reducing the work by eliminating or simplifying unnecessary movements of materials and workers, whilst work measurement tries to determine the duration of a task as well as to identify ineffective time with the aim to eventually eliminate it. Niebel and Freivalds (2009:405) state that the nature of work measurement techniques are based on establishing a time standard for carrying out a given task, taking the various allowances into consideration.

Work measurement can only be applied after the last method has been identified and defined. This means that work measurement is only possible if the work study officer is satisfied that the method is carried out in the most efficient way. This makes it possible to determine accurate time standards, which form an important frame of reference for management decision-making.

5.4.3 The scope of work measurement

Work measurement is one of the most effective tools available to management and, when used in conjunction with method study, forms an excellent weapon when starting an attack on inefficiency in any organisation (Pycraft et al., 2010:248). Similar to method study, work measurement can be applied anywhere where work is performed. In 5.4.1, above, we listed the application possibilities of work measurement. In order to get a good indication of the scope of work measurement in an organisation, the next section presents some of the possibilities.

5.4.3.1 *Serves as an accurate method or aid for control of work performance*

One of the objectives of work measurement is determining standard times for tasks. A standard time implies either the time a worker should take to complete a task, or the time necessary to process a given amount of material. A standard time, as allocated to a certain task, must therefore be such that an average trained worker can maintain it quite easily over a long period. After the standard time has been determined properly by using work

measurement techniques, it must be submitted, firstly, to the foreman, supervisor, worker and management concerned, for approval, and then to all departments in the organisation which could possibly apply it. One of these applications is the control of work performance.

The control of work performance involves the comparison of the real performances with pre-determined standard times, identifying deviations and if necessary, correcting them. To maintain effective time standards, regular attention should be paid to the comparison of actual performance with standard performance, which will highlight any possible suspect standard times. Such irregular deviations should be eliminated.

This unsatisfactory situation or deviation from the standard times is usually discovered by the foreman, supervisor, worker or wages department. In practice, there is a tendency to immediately attribute the causes for deviations to an inaccurate standard. Deviations can, however, be attributed to many causes, of which the following are the most important.

- material shortages;
- poor work scheduling;
- poor control and supervision over workers;
- too many delays;
- monotonous work;
- ineffective training of operators or workers;
- the attitude of the worker;
- the attitude of the group; and
- the inability of the worker to carry out the task.

Taking the above-mentioned factors into consideration, it is clear that by comparing real performances with standard times, management is not only able to control the workers, but it is an important aid when evaluating the effectiveness of a method. The simple fact that time standards exist also enables the workers, to whom they apply, to evaluate their own performances by comparing it with the standard.

5.4.3.2 Serves as an important aid when planning and controlling labour complements

With the work content and time for each task known, the personnel department is able to determine exactly what the need for the number of workers will be during a specific period.

The work content, which is a natural result of work measurement, also enables the personnel department to recruit the right worker for the right task. Personnel planning can therefore be more purposeful and effective. Proper time standards can be used to help determine the following:

- number of workers necessary during a specific period;
- the skills that these workers should possess;
- the compilation of training programmes; and
- defining tasks, keeping recruitment and training in mind.

5.4.3.3 Serves as an important aid to costing

When determining price (determining the selling price of a product or service), costs to supply the product or service play an important role. It is foolish to sell a product at a price lower than the manufacturing costs. In this respect, time standards can help to determine the following:

- the costs of labour necessary to manufacture the product;
- the influence that size, shape, colour, materials or tolerance may have on the cost of the product;
- the costs regarding equipment necessary for the manufacturing of a product or rendering of a service; and
- the influence of batch sizes on the production costs (examples are set-up costs and storage costs).

In most organisations, especially in the manufacturing sector, there are costing departments, which are primarily responsible for the estimation of the costs of the individual product or service, as well as the production costs of the organisation as a whole. Time standards and other cost-related studies are analysed and a cost schedule per product is compiled. This cost schedule is made available to the marketing division. They use it, together with more relevant information, to determine a price schedule.

5.4.3.4 Serves as an important aid to scheduling

By scheduling the production of products, an attempt is made to utilise important resources such as labour, machinery and other equipment to the maximum. Time standards are used in production scheduling to:

- determine the work load of workers (operators) and machines;
- determine the number of machines and workers necessary to maintain a certain output;
- select the best method of manufacture; and
- determine the completion dates of various orders.

5.4.3.5 Serves as an important aid to effective plant and machine utilisation

While scheduling plans and controls the activities of the production department as a whole, machine utilisation involves the effective utilisation of machinery and their operators. The costs of machinery and equipment, especially in manufacturing companies, sometimes amount to 40% of the total production costs. The effective utilisation of this equipment is therefore of the utmost importance and any organisation should try to utilise such expensive equipment to the maximum.

With the help of work measurement, the various capacities of machines (that is the volume which can be produced within any reasonable period), must be determined. If the demand for products is known, production can be scheduled in such a way that maximum utilisation of machinery and other equipment is maintained. With the help of the work contents and time standards as acquired through work measurement, it is therefore possible to:

- utilise the plant and its personnel to the maximum;
- determine the number of machines required to do the work;
- determine the necessity for new plant;
- determine objectives and keep to it; and
- increase the morale of the operators.

5.4.3.6 Serves as an important aid to planning

Planning is that aspect of management which considers the future activities of an organisation in order to prepare for these activities. To be able to plan properly, it is imperative to have some kind of measure of the work content of a task as well as its duration. Time standards are therefore imperative for work planning to determine the following:

- the total time for each production phase or of a series of successive production phases;
- the most effective method by which the work can be done;
- the capacity of the plant, its departments and/or the machinery and other equipment;

- the labour force necessary to produce the planned outputs; and
- the cash flow of the organisation for the relevant period of time.

The above-mentioned are but a few of the many uses of time standards for planning purposes. It is most important to remember that planning determines the future activities of the organisation. If the duration of these activities is known beforehand, it enables a planner to predict the future with much more confidence.

5.4.3.7 Serves as an important basis when developing an incentive system

Incentive wages are part of the total wage package and basically consist of extra remuneration for extra performance or work done. The purpose of incentive wages is therefore to remunerate a worker in a fair way for hard work. A worker, who produces more than the standard output, receives, apart from his normal wages, additional remuneration for any output above the standard. The value of this additional remuneration is determined by the degree to which the worker performs above standard.

Example:

If a standard determines that a worker should produce ten pieces of work per day, and the worker produces twelve pieces of work, he/she will be remunerated additionally for the two pieces he/she had completed above the set standard. Such remuneration does not necessarily mean additional wages, but could be, for example, extra leave, or any other form of remuneration which is acceptable to the worker.

It is therefore clear that standards used in wage incentive schemes, must be accurate and reliable. Meticulous measurement is therefore a fundamental requirement for the successful application of wage incentive schemes. The most common unit of measure used, is time. When time is the unit of measure, it is a good policy to use time standards determined by time studies (or other accurate work measurement techniques) as a basis for incentive schemes. This will mean that, if a worker performs better than the time standard (performing the task in a shorter time than the standard time), he/she should be remunerated additionally. It can therefore be said that time standards are a healthy basis for wage incentive schemes and the success of such schemes will largely depend on the accuracy and reliability of the time standards.

5.4.3.8 Serves as an important basis for training and the planning thereof

To develop a reliable and accurate time standard, it is essential to record in detail the work contents of the task being studied. Actually, the description of a time study is no more than a description of the work contents. In an organisation, training in new or improved methods can be handled by the work study officer or any other qualified person. In many organisations this task is carried out by the supervisor concerned with or without any help from the personnel department or work study officer.

Work measurement comprises a detailed description of all the movements necessary to perform a specific task, which makes it quite useful to the work study officer, or anybody involved in the training of personnel. In many cases, especially while training personnel to perform tasks of a repetitive nature, it is essential that the trainer has all the details regarding the work method and the time standard concerned. The value of time standards for training lies in the fact that, if the standard time of a specific method is known, the progress of the worker being trained can be evaluated by comparing the time he/she takes to do the task with the standard. As the training progresses, the worker should move closer to the standard. As soon as the worker performs according to standard, he/she should be regarded as trained.

If training is done for new or improved methods, the trainer should have the necessary knowledge and abilities. A description of the new or improved method, procedure or work contents as well as its time standard is also inevitable in the training process and is a fundamental piece of information for the trainer.

5.4.4 The structure of work measurement

Further to the discussion of the structure of method study (see 5.2.3), work measurement aims at assessing the duration of a process or procedure.

Firstly, a method study was carried out during the present research in order to develop a new method. Secondly, in order to ensure that the new method is effective, the duration of the new method was measured. This determined how long it would take to complete the new method. The effectiveness of the proposed new method had to be measured according to time standards which were determined by work measurement techniques. This simply means that before the implementation of the proposed method, time standards for all the activities of the proposed method had to be completed (Krajewski, Ritzman & Malhotra, 2010:151)

The best way to describe the structure of work measurement is in the form of the following diagram:

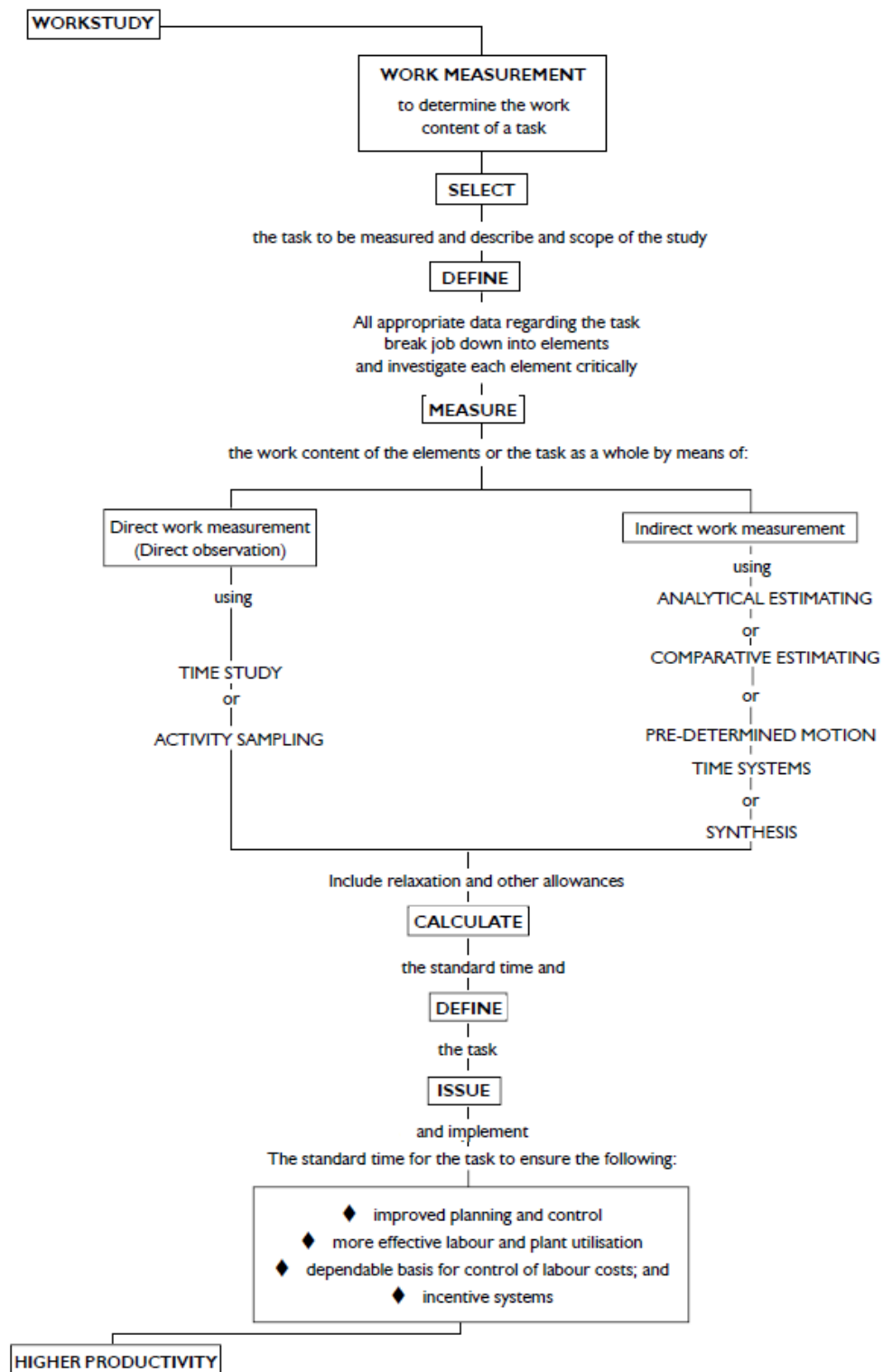


Figure 5.4: The structure of work measurement (Sookdeo, 2012b:24)

It is clear from Figure 5.4 that work measurement covers a wide spectrum in the organisation and is applicable to individual tasks as well as to the organisation as a whole. A further important aspect of this structure is the sequence in which the steps of an investigation must be carried out. By keeping to this sequence, the success of an investigation can, to a large extent, be ensured. Figure 5.4 emphasises the successive steps to be followed when determining the work content of a task with the help of various work measurement techniques. These steps should, however, be regarded as basic steps, differing in detail from one technique to the next (Stevenson, 2012:301). The work measurement techniques mentioned in this diagram are:

- time study;
- work (activity) sampling;
- synthesis;
- analytical estimating; and
- pre-determined motion time systems (PMTS).

Figure 5.4 shows that the work measurement techniques are divided into two important parts, namely direct work measurement and indirect work measurement. Sookdeo (2007a:29) provides the following definitions of these two techniques:

Direct work measurement	Indirect work measurement
These are techniques that are used to determine the work content of existing methods. It involves the direct observation of, for example, a worker (operator) performing a task at his/her workplace.	These can be used to determine not only existing, but also planned methods. When applying these techniques, it is therefore unnecessary to observe the task directly, but a standard time is determined, using existing data.

The researcher concentrated on the technique known as **time study** as this is the most popular technique for determining a standard time of a given task. It is important to note here that, when discussing any of the five techniques, the steps as explained in Figure 5.4, should be compared to the steps of the specific technique itself.

5.4.5 Requirements regarding the application of work measurement

At the start of a work measurement investigation, both the management and workers are sceptical and even sometimes hostile towards the investigator. In the present-day economy, not only is improved production expected from us all, but in fact, optimal productivity (Sookdeo, 2007a:30). This can only be achieved if the worker knows what exactly his/her output should be within a specific period, and what the standard procedure is according to which his/her task should be performed.

The implementation of work measurement therefore presupposes certain favourable environmental factors, which are important in creating the right climate for work measurement. A few of these considerations are policy matters, co-operation of the workers, and standardisation of methods.

5.4.5.1 Policy matters

Sookdeo (2007a:31) states that, in order to prevent misunderstandings, it is absolutely essential for the management of the undertaking to prescribe a work study policy, which would serve as a framework of reference within which the work study officer may act. If this statement is true with regard to work study in general, it is all the more true of work measurement. Work study is a management aid. Management must therefore:

- convince the workers that work measurement is executed on their behalf;
- ensure that work measurement is conducted by a trained specialist;
- not deny the workers' responsibility for the pursuit of efficiency; and
- show an active and lively interest in the work measurement project.

It may be possible that management has little knowledge of work measurement. It will therefore be necessary for the work study officer to spell out the policy with regard to work measurement to management, and must therefore advise management on the following important factors:

- the authority of the work measurement expert;
- the activities which are to be measured;
- the priorities which exist concerning different departments;
- responsibility with regard to the implementation and maintenance of results; and

- the position of workers who may become redundant as a result of the work measurement.

5.4.5.2 Co-operation of the workers

A work study officer cannot conduct work measurement if there is no co-operation from the people involved in the study. Niebel and Freivalds (2009:407) state that the work study analyst should tell all involved, as the most important requirement is that the supervisors and the workers who are involved in the investigation, be thoroughly acquainted with the purpose of the work measurement study. The work study officer cannot conduct work measurement in a department or on a worker without informing them of exactly what is being done. Regard must be paid to the reactions of all employees affected by the study (Currie, 1981:247). Some other very important points to note are:

- It must be emphasised that the work study officer is interested in the work as such and if therefore, he/she uses a work measurement technique, it would be on the grounds of his/her interest in the work, and not in the worker.
- The work study officer knows that the above statement reflects the real state of affairs, but the worker does not know it. Therefore the worker feels that he/she is being observed and evaluated.
- If the results show that the same volume of work may be done by a smaller number of workers, and the worker does not know what the policy of the management with regard to 'redundant' workers is, the worker feels that he/she has been weighed and found wanting.

Work study officers are trained in handling workers who do not co-operate and are knowledgeable in overcoming this resistance. Prior to the start of work measurement, the work study officer must gain the confidence and co-operation of the workers and supervisors if he/she is to succeed. If the work study officer experiences too much resistance on the side of the staff, management may be compelled to put a stop to the whole work measurement project. The workers must be made to feel that they are participating in the study as this is an important consideration (Kanawaty, 1995:29). The most effective method of ensuring participation is to inform everybody concerned with the project of the purpose thereof, namely:

- explain what the project aims at;
- explain the policy in detail;
- try to find sympathetic solutions to workers' problems; and

- explain to workers, step by step, how management will proceed in the work measurement project.

5.4.5.3 *Standardisation of methods*

Yusoffa et al. (2012) state that before any measurement commences, the work to be measured should be analysed and broken down into measurable elements which are suitable for the time study technique.

In the structure of work study, method study, which is directed at performing the work efficiently and with the least effort, must be completed before work measurement can start. The purpose of work measurement is indeed measuring the time it takes the worker to execute the standard method. It is obvious therefore that determining a standard in terms of time is of no value if the method which is followed is inefficient or has to be changed. The dilemma of work study is indeed that the phenomenal development in technology, to mention only one area, continuously brings about new methods of work, in which work study itself has no small part. These changes demand continuous adaptation with regard to standards.

5.4.6 The basic work measurement procedure

Similar to work study and method study, work measurement also has a basic procedure that must be followed when carrying out a work measurement investigation. In Figure 5.4, the structure of work measurement is described as a graphical representation of the basic steps which should be followed when doing work measurement. In order to achieve success in a work measurement investigation, this procedure must be followed. Kanawaty (1995:247) identifies the following steps that represent the procedure that must be followed when conducting a work measurement: select, record, examine, measure, compile and define. These steps can briefly be described as follows:

STEP NO.	PROCEDURE	DESCRIPTION
1	SELECT	– the work to be studied.
2	RECORD	– all the relevant data relating to the circumstances in which the work is being done, the methods and the elements of activity in them.
3	EXAMINE	– the recorded data and the detailed breakdown critically to ensure to ensure that the most effective method and motions are being used and that unproductive and foreign elements are separated from productive elements.
4	MEASURE	– the quantity of work involved in each element in terms of time, using the appropriate work measurement technique.
5	COMPILE	– the standard time for the operation, which in the case of a stopwatch time study will include rest allowances.
6	DEFINE	– precisely the series of activities and method of operation for which the time has been compiled, and issue the time as standard for the activities and methods specified.

Figure 5.5: The basic work measurement procedure

5.4.7 Work measurement techniques

In practice, there are a large variety of work measurement techniques. Some measure volume and quality, while others measure the duration of work. Under this topic, the techniques which measure the duration of the work are discussed briefly. Work measurement techniques which determine the duration of a task, can be divided into two basic groups (Kanawaty, 1995:248):

DIRECT	INDIRECT
Time study	Synthesis
Work (activity) sampling	Structured estimating (analytical and comparative)
	Pre-determined motion time systems (PMTS)

Figure 5.6: Work measurement techniques

The above techniques are defined as follows:

5.4.7.1 Time study

Dagdevirena et al. (2011:563) state that time study records the process times and levels of a pre-determined work using specified conditions. Stevenson (2012:301) states that time study was formally introduced by Frederick Winslow Taylor in the late 19th century. Kanawaty (1995:265) defines time study as a work measurement technique for recording the times of performing a specific job or its elements carried out under specified conditions, and for analysing the data so as to obtain the time necessary for an operator to carry it out at defined rate of performance. Time study is the most widely recognised work measurement method. The work measurement symbol remains the stopwatch (Thomas, 2006:36). Time study is a direct observation technique where the work study officer observes an operator doing a job, recording the time of that job and simultaneously rating the pace at which the worker does the job. The concept of rating is discussed below in 5.4.8.

Dagdevirena et al. (2011:563) state that time study is cost-effective and can be applied only under specific conditions, depending on the experience of the person performing the time study. Before starting a time study, the worker must be told what the purpose of the study is. This eliminates suspicions and allows the worker to find his/her normal rhythm of work. The work study officer must be certain that the method used to do the work is, according to him/her, the best method. He/she must also ensure that the correct equipment is used and that the appropriate materials are available. If there is doubt, it would be wise to carry out a method study before considering the task for work measurement.

Time study must be recorded by direct observation using a time measuring device (stopwatch) and would include the ratings for individual elements. Stopwatch time study is utilised to develop a time standard based on observations of one worker taken over a number of cycles. This time standard is then applied to the work of all others in the organisation who perform the same task (Stevenson, 2012:301). Time study is one of two direct work measurement techniques available to a work study officer, and is designed to measure tasks which are repetitive in nature, that is, where the main activity or a group of activities occur time after time. Time study may be applied to work cycles with short or long duration. Time study has to do with tasks of a highly repetitive nature. Those tasks which constantly change and which are non-repetitive in all aspects are not suitable for time studies. In this instance, one of the other techniques should rather be considered. In many cases, however, some elements of a task occur repeatedly and they may be measured with

the help of time study. Such cases occur especially when work study is practiced in an administrative environment.

5.4.7.1.1 Pre-requisites for the use of time study

One very important characteristic of time study is that, as the number of observations of a specific activity increases, the accuracy of the results increases accordingly. This simply means that the more observations a work study officer takes, the more accurate the standard time will be. If applied correctly, the use of the time study technique therefore holds the possibility of establishing time standards of a high level of accuracy. To be able to maintain a high level of accuracy, which ensures an effective time study, there are certain pre-requisites with which a task must comply (Heizer and Render, 2011:427). The task being studied must for instance be of a repetitive nature and must be repeated a sufficient number of times during the study until the required level of accuracy has been reached. Clear specifications of the method to be used, such as where the task should start and end as well as details concerning the materials, equipment and working conditions, should be available before the time study can begin. The employee (operator) must also be fully informed about the study and its purpose. The amount of relaxation and other allowances for the task being studied must be calculated accurately, and the rating of the task being studied must be determinable within reasonable limits.

If the task being studied does not meet all the above-mentioned requirements, another work measurement technique should rather be used to determine the work content. In order to carry out time studies, certain items of equipment are essential.

5.4.7.1.2 Time study equipment

Before the steps or procedures are applied when doing a time study, it is suggested that the basic equipment a work study officer would need when doing a time study be considered. The equipment described here also has functional value concerning other work measurement techniques. The application possibilities of the equipment are not limited to time studies. A stopwatch, for example, is essential in all the other work measurement techniques. Niebel and Freivalds (2003:408) state that the minimum equipment required to conduct a time study comprises a stopwatch, a time study board, time study sheets and a pocket calculator.

The stopwatch is certainly the most common instrument used to determine the duration of a task or an element thereof. Although a normal wrist watch or wall clock can be used, it does not have the required accuracy. In practice, there two main types of stopwatches in general

use for times study, namely mechanical and electronic watches. While the normal hand-watch or wall clock is divided into sixty (60) equal sections each part representing one second, the stopwatch used for time study is divided into one hundred (100) equal sections. The advantage is rather obvious: each second can immediately be divided into fractions of seconds. This type of stopwatch is also known as the centi-minute stopwatch. The difference between the normal 'second' stopwatch and the centi-minute stopwatch is better explained by the following example:

Example:

Let's say the duration was determined by using a stopwatch which records in seconds:

Time recorded: **1 minute 21 seconds**

To calculate the standard time, this time must be expressed in fractions of a minute.

Therefore:

1 minute/60 seconds = 0.016666 minutes

i.e. 1 second = 0.016666 minutes

Then:

1 minute 21 seconds = $1 + \frac{21}{60}$

= **1.35 centi-minutes**

By using a centi-minute stopwatch, this value will be displayed directly on the big dial and will be available immediately. There is no need to do this calculation. Each of the 100 equal sections of the centi-minute stopwatch represents 0.01 minutes.

5.4.7.1.3 The time study board

A time study board is a simple flat board usually made from laminated wood or plastic on which a time study sheet can be clamped (Niebel and Freivalds, 2003:410). This board must be –

- larger than the largest form used for the recording of information, e.g. A4 standard size;
- have a clamp onto which a stopwatch can be mounted so that one hand of the management services practitioner is free to write;
- have the stopwatch clamped to the right-hand side of the board for a right-handed person, and vice versa; and

- be designed so that it can be held comfortably and firmly against the body with one hand while the other arm is relatively free to write with, and if necessary, to turn the time study sheet over.

A time study board is not only useful for time studies, but may also be used to do any work study investigation which necessitates direct observation.

5.4.7.1.4 Time study sheets

The design of a time study sheet differs from organisation to organisation as much as the information differs among organisations. Time study sheets are usually standardised within an organisation to ensure that no important information is lost during a study. The following shows the most common sheets used today.

[illegible]

Figure 5.7: Element breakdown sheet

[illegible]

Figure 5.9: Time study continuation sheet

Step 1: SELECT	The task/tasks on which a time study has to be carried out. This step can be divided into three parts, namely: Part 1: Determine which task or tasks should be subjected to time study according to the instructions received. Define the task giving as much detail as possible. Part 2: Obtain permission from the person who issued the instruction to do a time study. (The danger of resistance against stopwatches should not be ignored.) The person who requested the time study should first give his/her approval for all the circumstances surrounding the study before it is to be started. Part 3: Select a suitably qualified worker (average worker) to perform the task which must be measured.
Step 2: RECORD	Record all relevant data regarding the process, procedure or task to be studied and define it. This step consists of the following: (a) A provisional investigation to: • obtain the co-operation of the supervisors and their subordinates; • study the work to obtain confirmation of the instruction as mentioned in the previous point; • study the working conditions; • identify and classify the elements of the task; • determine the duration of the elements provisionally, as elements shorter than 8 centi-minutes cannot be measured easily; and • determine the breakpoints of the elements. (b) Define the task: Included here are elements, breakpoints, work method, working conditions and equipment in detail.
Step 3: MEASURE	The actual duration of each element; evaluate the pace at which the worker carries out the activity (rating) and record it on the time study sheet. Proceed with the study until sufficient readings have been obtained.
Step 4: CALCULATE	The standard time or allowed time of the task. This step consists of the following sub-steps: (a) normalise the observed time by considering the performance rating to obtain a basic time; (b) determine the selected basic time (SBT) for each element; (c) calculate the average SBT per chosen unit (where applicable); (d) calculate the relaxation allowance for each element; (e) add the relaxation allowances to the SBT to get the allowed time per element; (f) add all the allowed times to get the total allowed time for the task; (g) calculate the contingency allowance where applicable; and (h) add the contingency allowance to the total allowed time to obtain the standard time for the task.

Step 5:	The following are of importance:
Obtain APPROVAL, implement and maintain	(a) draw up a work specification; (b) management, supervisor and workers concerned approve standard time; (c) publish standard time by issuing the time study summary sheet or the whole time study; and (d) ensure that implemented standard is maintained, and if necessary, that it is revised from time to time.

Figure 5.12: The basic procedure for time study

5.4.7.2 Work sampling

Work sampling is also known as activity sampling and is a direct observation technique. Chase et al. (2006:385) state that work sampling entails random sampling observations of work activities, designed to give a statistically valid picture of how time is spent by a worker or the utilisation of equipment. Finkler, Knickman, Hendrickson, Lipkin and Thompson (1993:578) state that the work sampling technique collects data at intervals of time.

Heizer and Render (2001:416) state that work sampling is an estimate of the percentage of time that a worker spends on various tasks. It requires random observations to record the activity that a worker is performing. Niebel and Freivalds (2009:545) state that work sampling is a technique used to investigate the proportions of total time devoted to the various activities that constitute a job or work situation. The results of work sampling are effective for determining machine and personnel utilisation, allowances applicable to the job and production standards. Thomas (2006:38) argues that work sampling measures work by observing work many times at random intervals. It requires firm discipline, careful planning, and precise record keeping. Work sampling can also be more economical than time study, and it can be very realistic. Realistic and precise values often depend on a large number of observations. It is less distracting and therefore less offensive to the operator.

From the above definitions, it can be deduced that work sampling is a technique in which a large number of successive observations are made over a period of time of one or a group of machines, processes or workers. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity or delay is a measure of the percentage of time during which that activity or delay occurs. It is a fact-finding tool of management which in some cases is less costly than other work measurement techniques. A further development of work sampling is rated work sampling. This is an extension of work sampling in which a rating is applied to each observation.

The different formulae that were used are:

- Number of observations:
$$N = \frac{4P(100 - P)}{L^2}$$
- Error limit:
$$L = \frac{\sqrt{4P(100 - P)}}{N}$$

Due the large number of employees in the assembly department, the researcher used work sampling as a direct measurement technique to determine the percentage occurrence of the different activities.

5.4.7.3 Synthesis

Synthesis is an indirect work measurement technique. Slack et al. (2007:267) state that synthesis is a work measurement technique for building up the time for a job or parts of a job at a defined level of performance by totalling element times obtained previously from time studies or other jobs containing the elements concerned or from synthetic data. Synthesis therefore maintains the point of view that certain activities or elements occur in various tasks within an organisation. By identifying these activities or elements, and by developing a common data bank, it is therefore possible to determine the standard time of, for example, a new method by simply adding together the times of the elements as obtained from the databank.

Synthetic data are tables and formulae obtained from synthesis after the analysis of cumulative work measurement data, and are filed in such a way that activity times can be easily traced.

Many organisations compile lists of the above times in book format and keep them up to date as new elements are introduced. In some cases, it is possible to reduce numbers to simple charts or sometimes to mathematical equations. A good classification system for future use of the information is essential, and the master file, containing the original information, must be kept in a safe place. An important advantage of synthesis is that it enables the work study officer to determine time standards without observing the relevant task personally. Time standards for planned methods can also be pre-determined. The disadvantage of synthesis is that synthetic data cannot be transferred from one organisation to another.

5.4.7.4 Estimating

Estimating can be defined as a means of assessing the time required to carry out work, based on the knowledge and experience of similar types of work, without a detailed breakdown of the work into elements and their corresponding times at a defined level of performance. There are two types of estimating, namely analytical estimating and comparative estimating.

5.4.7.4.1 Analytical estimating

Analytical estimating is also an indirect work measurement technique. Currie (1981:138) defines analytical estimating as a work measurement technique or a development of estimating, whereby the time required to carry out elements of a job at a defined level of performance is estimated partly from knowledge and practical experience of the elements concerned and partly from synthetic data. Pycraft et al. (2010:253) offer the following definition: "Analytical estimating is a development of estimating whereby the time required to carry out the elements of the job at a defined level of performance is estimated from knowledge and experience of the elements concerned."

This technique, developed in 1940, is used mainly to do estimating regarding certain repetitive tasks, such as maintenance work, servicing, handling of material and storing. In this case, the principle of breaking down the job into elements is adhered to. After the elements have been identified, time must be allocated to the specific elements which, as indicated by the definition, can only be done by persons having the knowledge and practical experience on the one hand and synthetic data on the other. An important disadvantage of analytical estimating is that time standards obtained in such a way, are not always accurate, and consequently cannot be used in incentive systems.

5.4.7.4.2 Comparative estimating

The Association of Project management (2015) defines comparative estimating as a work measurement technique in which the time for a job is evaluated by comparing the work in it with the work in a series of similar jobs (benchmarks), the work content of which has been measured. It is also an estimating technique based on the comparison with, and factoring from, the cost of similar, previous work.

5.4.7.5 Pre-determined motion time systems (PMTSs)

PMTSs involve the use of published data on standard elemental times. It is also an indirect work measurement technique whereby times established for basic human motions (classified

according to the nature of the motion and the conditions under which it is made) are used to compile the time for a job at a defined level of performance (Stevenson, 2012:307). PMTSs establish times for basic human motions (classified according to the nature of the motion and the conditions under which it is made), which are used to build up the time for a job at a defined level of performance (Pycraft et al., 2010:253). The nature of PMTSs can easily be explained on the basis of a simple cycle, such as placing a washer over a bolt: the operator *reaches* for the washer, *grasps* the washer, *moves* the washer to the bolt, *positions* it on the bolt, and *releases* it.

PMTSs maintain the point of view that most tasks consist of the above-mentioned five movements, and that the duration of each movement will basically be the same for a qualified and trained worker, regardless of where or for whom he/she works. By using the PMTS lists (Kanawaty, 1995), the work content of a task can therefore be determined before the task begins and without observing it directly.

5.4.8 Rating

The Institute of Management Services (2014) states that direct observation techniques, such as time study and analytical estimating, include a process for converting observed times to times for the qualified worker working at a defined level of performance. The commonest of these processes is known as **rating**. Rating (also known as performance rating) is the assessment of the worker's rate of work, relative to the observer's concept of the rate corresponding to the standard rate (Kanawaty, 1995:240). Rating, therefore, is a comparison between the level of performance as observed and what the work study officer regards to be a standard. This standard is known as standard performance. It is therefore clear that some kind of common norm should exist, which is regarded by all work study officers as a standard work performance. Research has been done for many years and many criteria have been developed which can be used as a basis for comparison. Pycraft et al. (2010:252) define rating as a work study technique that attempts to assess a worker's rate of working relative to the observer's concept of standard performance.

Stevenson (2007:329) states that the work study officer must time the job and rate the performance. People's psychological and physical abilities differ; therefore, their work performance will also differ. To observe any worker, therefore, without taking into consideration the pace at which the work has been carried out, is unacceptable. Furthermore, to obtain a realistic and reliable standard, the work study officer carrying out the time study must be able to compare the observed work performance with a predetermined standard performance and rate the pace at which the work is performed accordingly.

Performance rating must be included during time study to normalise the job (Chase et al., 2006:192). Due to the subjective nature of performance rating, it is important that all work study officers know exactly what the factors are which will influence the duration of a task or element. Work study officers should not only know what the method is according to which the task is carried out, but they must also have the necessary experience and perform regular rating exercises. This will ensure a uniform evaluation and therefore also accurate standard times throughout the whole organisation.

5.4.9 Summary of work measurement

Work measurement and method study cannot be treated as two separate parts of work study, but should rather be regarded as an integrated whole which together results in higher productivity. While method study has the main objective of improving existing or proposed methods, work measurement concentrates on determining the scope of the work. Time standards, as determined by work measurement, are invaluable to any work study officer. Examples of this are the evaluation of alternative methods by which a specific task can be carried out, which may lead to the method with the shortest duration being chosen as the best alternative. Work measurement must not be seen in isolation, but rather as an important interdependent part of method study helping to achieve higher productivity.

The value of work measurement is, however, not limited to the evaluation of new or improved methods, but is generally used by various departments within an organisation and can be seen in the important and essential information it presents for planning, scheduling, training, costing and estimation. Some of these application possibilities were briefly discussed in paragraph 5.4.1.

This section concluded with a look at the techniques of work measurement and direct and indirect work measurement techniques were distinguished. Five work measurement techniques were identified, namely time study, work sampling, synthesis, structured estimating and PMTS. These techniques can be applied individually or together to obtain the work content of a task.

CHAPTER 6

DATA COLLECTION AND ANALYSIS PROCEDURES

6.1 INTRODUCTION

In the previous chapter, the research design, the rationale behind the methodology employed and the way the research was conducted were described. This included a discussion of the study in terms of the design, the research instrument used, the target population and the sample. In this chapter, the researcher explains the data collection and data analysis procedures. The data for this study was collected firstly, via the method study investigation, secondly, via the work measurement investigation and thirdly, via two questionnaires.

The methodology used to collect and analyse data was discussed in the chapter. The discussion referred to the method study investigation, departmental layout improvement and the work measurement investigation. The response rate of both questionnaires was also discussed in this chapter.

6.2 THE DATA COLLECTION AND ANALYSIS PROCEDURES

6.2.1 The method study investigation

The basic approach to a method study investigation consists of the seven steps of the method study procedure (see 5.2.4) to guarantee the success of the investigation. In the present study, the data collected from the investigation was analysed using the set procedure of the method study technique. Process charting was used to chart all the steps involved in the complete assembly of a selected tap. The present method of this assembly procedure was charted and an improved (proposed method) was charted. Thereafter, a comparison between the present and proposed methods was shown, including the savings that resulted from this investigation.

In this chapter, the researcher will also present an improved version of the layout of the assembly department in order to show a more effective layout (see Annexure E).

6.2.1.1 Process charting

The method study investigation consisted of using process charts to outline the activities of selected taps with the aim of improving the processes. Flow process charts were selected as the main chart as this type of chart uses all the symbols. The flow process chart utilises the following symbols (Niebel & Freivalds, 2009:34):

Table 6.1: Symbols used in process charting

 OPERATION	Indicates the main steps in a procedure. Usually, the part, material or product concerned is modified or changed during an operation. It will be seen that the symbol for an operation is also used when charting a procedure, for example a clerical routine. An operation is said to take place when information is given or received, or when planning or calculating takes place.
 INSPECTION	Indicates an inspection for quality and/or check for quantity. An inspection does not take the material any nearer to becoming a completed product. It merely verifies that an operation has been carried out correctly in terms of quality and/or quantity.
 TRANSPORT	Indicates the movement of workers, material and equipment from one place to another. Transport thus occurs when an object is moved from one place to another, except when such movements are part of an operation or are caused by a worker at the workstation during an operation or inspection.
 TEMPORARY STORAGE OR DELAY	Indicates a temporary delay in the sequence of events. An example is work waiting between consecutive operations, or any object laid aside temporarily without record until required. Other examples are boxes waiting to be unpacked or a letter waiting to be signed.
 PERMANENT STORAGE	Indicates a controlled storage in which material is received into or issued from a store under some form of authorisation. A permanent storage thus occurs when an object is kept and protected against unauthorised removal. The difference between 'permanent storage' and 'temporary storage' is that a requisition or other form of formal authorisation is generally required to get an article out of permanent storage, but not out of temporary storage.
 COMBINED ACTIVITIES	When activities performed at the same time or by the same worker at the same workstation need to be shown, the symbols for those activities are combined. For example, the circle within the square represents a combined operation and inspection.

Figure 6.1 shows an example of a flow process chart.

[illegible]

Figure 6.1: Flow process chart

The following are some of the many charts that can be used during a method study investigation:

- Outline process chart;
- Flow process chart;
- Multiple activity chart and
- Single-column process chart.

The flow process chart was chosen for the method study investigation. This chart was designed by the researcher whilst working as a work study officer in industry (Sookdeo, 2005:236). The rationale behind using this chart was that this chart uses all the symbols of process charting. The researcher charted all the steps of the present method of the process and then critically examined all the steps with the aim of improving the process.

6.2.1.2 *Departmental layouts*

During a method study investigation, it is imperative that the complete procedure of the 'present' method of working be recorded and then analysed in order to effect improvements. The layout of the relevant department must be examined in order to identify areas of high traffic, possible hazards and extensive movement. The aim was to show areas of ineffectiveness due to poor layout of equipment and processes, excessive transportation (movement) of employees and products. Thereafter, the aim was to improve the layout (proposed method), to eliminate/reduce excessive movement and to show an effective flow of materials and employees within the assembly department.

6.2.2 The work measurement investigation

The work measurement investigation follows the method study investigation and consists of work sampling and time studies. The rationale of conducting the method study investigation prior to the work measurement investigation was, simply, that one should not set a time standard on an inefficient method. It consisted of work sampling and time studies. Data collected from the work measurement investigation was analysed using the set procedures of this technique. Work sampling studies were analysed to determine the percentage occurrences of the activities carried out. Time studies were analysed using the procedure for time study. Relaxation and contingency allowances were allocated in order to develop standard times for the selected processes. The standard times generated by the time studies were used to develop the ERS.

6.2.2.1 Work sampling

Niebel and Freivalds (2009:546) state that the theory of work sampling is based on the fundamental law of probability. This means that at any given instant, an event can either be present or absent. Work sampling is also known as **activity sampling** and is a direct observation technique. This technique is defined in Chapter five (see 5.4.7.2) of this thesis as a technique in which a large number of successive observations are made over a period of time of one machine, process or worker or a group of machines, processes or workers. Chase, Jacobs and Aquilano (2006:385) state that work sampling entails random sampling observations of work activities, designed to give a statistically valid picture of how time is spent by a worker or the utilisation of equipment. Each observation records what is happening at that instant, and the percentage of observations recorded for a particular activity or delay is a measure of the percentage of time during which that activity or delay occurs. Work sampling is a fact-finding tool of management which in some cases is less costly than other work measurement techniques.

A pilot study was initially conducted in order to determine the error level that would be acceptable and the exact number of observations that would be necessary in order to attain that error level. This pilot study was analysed and the results are shown under data presentation. Further to this, the results of the pilot study acted as an indicator regarding the total number of observations that need to be carried out to determine a true reflection of the percentage occurrences of the activities of the employees in the assembly department. Three distinct categories were identified in this study:

- A = which represents 'absent from workplace';
- W = which represents 'working'; and
- I = which represents 'idle' (not working).

The results of the work sampling allowed the researcher to report on the percentage occurrence of employees regarding each of the three critical activities.

6.2.2.1.1 The work sampling pilot study

A total of fifty (50) observations were carried out over two and a half hours. Eighteen (18) operators working on the three assembly lines were chosen for the pilot study. The researcher used a random number table in order to select ten observations from the pilot study, which would be used to calculate the error limit and the number of observations to be used. Due to the sample size of 50 observations, the researcher selected ten observations to determine exactly how many observations would be required for the main study. An error limit of $\pm 5\%$ and a confidence level of 95% were applicable for this pilot study.

The observations selected had to be fewer than or equal to 50. Repeat observation numbers had to be ignored. This is shown below.

a. Selection of the 10 observations for the pilot study

Table 6.2: Table of random numbers (cf. Kanawaty, 1995:256)

49	54	43	54	82
57	24	55	06	88
16	95	55	67	19
78	64	56	07	82
09	47	27	96	54
44	17	16	58	09
82	97	77	77	99
82	97	77	77	81
50	92	26	11	97
83	39	50	08	30
40	33	20	38	26
96	83	50	87	75
88	42	95	45	72
33	27	14	34	09
50	27	89	87	19

b. Tabulating the selected observations prior to analysis

Table 6.3: Tabulation of selected observations

Operator number	O b s e r v a t i o n n u m b e r									
	49	16	9	44	50	40	33	24	47	17
1	A	W	A	A	A	A	W	W	A	W
2	A	W	A	A	A	I	W	A	W	W
3	A	W	W	A	A	I	I	A	A	W
4	I	I	I	A	A	I	A	I	A	W
5	A	W	W	I	A	I	I	I	A	W
6	A	W	I	I	A	A	I	W	I	W
7	A	A	W	I	I	I	I	A	I	A
8	I	W	W	I	A	W	I	W	I	W
9	A	W	I	I	A	W	I	I	A	W
10	I	I	A	I	A	I	W	W	A	A
11	A	I	I	I	A	A	I	W	A	I
12	I	I	A	I	A	I	W	W	A	I
13	A	I	I	I	A	W	A	W	A	I

14	A	A	I	A	A	I	I	W	A	I
15	A	A	I	A	A	I	W	I	A	W
16	A	W	I	I	A	A	I	A	A	W
17	A	W	I	I	A	I	I	I	A	I
18	A	W	A	A	A	W	I	W	A	W

c. Analysis of the 10 selected observations

Table 6.4: Analysis of selected observations

Operator number	A Absent from workplace	W Working	I Idle	TOTAL
1	6	4	0	10
2	5	4	1	10
3	5	3	2	10
4	4	1	5	10
5	3	3	4	10
6	3	3	4	10
7	4	1	5	10
8	1	5	4	10
9	3	3	4	10
10	4	2	4	10
11	4	1	5	10
12	3	2	5	10
13	4	2	4	10
14	5	1	4	10
15	5	2	3	10
16	5	2	3	10
17	3	1	6	10
18	5	4	1	10
Total	72	44	64	180

Table 6.5: Percentage occurrence per activity of the pilot study

	A	W	I	Total
Total	72	44	64	180
%	40.00	24.44	35.56	100.00

The researcher combined activities A and I as they represent the ‘non-working’ elements of the study. Therefore:

The total percentage time that operators were found to be working = **24.44%** and

The total percentage time that operators were found to be idle (40 + 35.56) = **75.56%**

d). Number of observations after the pilot study

$$\begin{aligned} N &= \frac{4P(100 - P)}{L^2} \\ &= \frac{4(75.56) \times (100 - 75.56)}{5^2} \\ &= \frac{302.24 \times 24.44}{25} \\ &= 295 \text{ observations} \end{aligned}$$

Therefore:

$$\begin{aligned} &= 295 \text{ observations} - 50 \text{ already completed during the pilot study} \\ &= \underline{\underline{245 \text{ more observations}}} \end{aligned}$$

The above shows that the required number of observations needed to get a true reflection of the activities stated above is 245.

6.2.2.2 Time study

Time study is a direct work measurement technique. This technique is discussed extensively in Chapter 5, see 5.4. In the present study, time studies were conducted on a selected tap in order to determine the standard time for the complete assembly of this particular tap. These standard times were used in the development of the ERS. Kanawaty (1995:480) states that a standard time is the total time in which a job should be completed at standard performance. A stopwatch was used to conduct these time studies as stopwatch time study is the most common technique for setting time standards in the manufacturing environment. The standard time to manufacture a certain product or to process an item is an important piece of manufacturing information, and stopwatch time study is often the only method acceptable to both management and labour (Meyers & Stewart, 2002:159).

Time study is defined in Chapter 5, (see 5.4.7.1), but for the purposes of this study, the definition is repeated here. Time study is a direct work measurement technique for recording the times of performing a certain specific task or its elements, carried out under specified conditions, and for analysing the data so as to obtain the time necessary for an operator to carry out a task at a defined rate of performance (Kanawaty, 1995:265). The following example provides an explanation of how a time study is analysed.

The task in the present study comprised ten elements. The work study officer used a stopwatch to determine the elemental times of each of the ten elements. He/she also allocated a rating (see 5.4.8) to each element. The table below shows the steps in the calculation of a standard time for a specific task. Each one of these columns is discussed below.

Table 6.6: Method of calculating standard time

Element number	Observed time	Observed rating	Basic time	Frequency	Selected basic time	Relaxation allowance %	Actual time per element
1	0.96	75	0.72	1/1	0.72	15	0.83
2	1.36	70	0.95	1/1	0.95	16	1.10
3	2.01	60	1.21	1/1	1.21	18	1.43
4	0.55	85	0.47	1/1	0.47	13	0.53
5	0.90	75	0.68	1/1	0.68	15	0.78
6	1.55	70	0.81	1/1	0.81	16	0.94
7	1.77	70	1.24	1/1	1.24	16	1.44
8	2.13	60	1.28	1/1	1.28	18	1.51
9	0.77	75	0.58	1/1	0.58	14	0.66
10	0.69	80	0.55	1/1	0.55	14	0.63
Total actual time:							9.85
Contingency allowance (5%):							0.49
Standard time:							10.34

The standard time for this task was calculated to be 10.34 centiminutes.

6.2.2.2.1 Observed time

In order to determine the standard time for a task, the task has to be broken down into elements. Kanawaty (1995:477) defines an element as a distinct part of a specified job selected for convenience of observation, measurement and analysis. Thereafter, each element of the task is timed and a duration is determined for each. This is called the observed time. The observed time for element 1 was 0.96 centi-minutes.

6.2.2.2.2 Rating

The rate of performance refers to the concept of rating which is the 'pace' at which the worker performs a task. A rating is also allocated to each element and this is termed **observed rating**. This is in accordance with the pace at which the operator works and in

accordance with the observer's concept of rating (Niebel & Freivalds, 2009:425). Element 1 was rated at 75%.

6.2.2.2.3 *Basic time*

Kanawaty (1995:477) defines basic time as the time for carrying out an element of work at standard rating (100%). The researcher has to calculate the basic time for each element. This is done by multiplying the observed time by the rating to yield the basic time for each element. This can be shown as a formula:

$$\frac{\text{Observed time} \times \text{Observed rating}}{\text{Standard rating (100)}}$$

Therefore:

The basic time for element 1 was calculated as:

$$\frac{0.96 \times 75}{100} = \underline{0.72 \text{ centi-minutes.}}$$

6.2.2.2.4 *Frequency*

The frequency refers to 'how often' each element occurs in a work cycle. This is shown in Table 6.6. Kanawaty (1995:315) states that repetitive elements, by definition, occur at least once in every cycle of the operation; so, the entry to be made against a repetitive element will read 1/1 or 2/1, indicating that the element, for instance, occurs once in every cycle (1/1) or twice in every cycle (2/1), etc.

6.2.2.2.5 *Selected basic time*

This time is obtained after taking the frequency into account. In Table 6.6, the basic time for element 1 is 0.72 and the frequency is 1/1. Hence, the selected basic time is calculated as follows:

$$0.72 \times 1 / 1 = 0.72 \text{ centi-minutes}$$

If the frequency was 2/1, then the selected basic time would be:

$$0.72 \times 2 / 1 = 1.44 \text{ centi-minutes}$$

6.2.2.2.6 *Relaxation allowance, actual time and total actual time*

Kanawaty (1995:480) defines relaxation allowances as an addition to the selected basic time to provide the worker with the opportunity to recover from the physiological and psychological effects of carrying out specified work under specified conditions and to allow attention to personal needs. The amount of allowance depends on the nature of the job.

The rest allowance allocated to element 1 is 15%. Hence, the actual time for element 1 is calculated as follows:

$$0.72 + 15\% = \underline{0.83 \text{ centi-minutes}}$$

6.2.2.2.7 *Total actual time*

This is a total of the actual times.

6.2.2.2.8 *Contingency allowance and standard time*

Kanawaty (1995:480) defines contingency allowance as a small allowance of time which may be included in a standard time to meet legitimate and expected items of work or delays, the precise measurement of which is uneconomical because of their infrequent or irregular occurrence.

In Table 6.6, the contingency allowance is given as 5%. Hence, the standard time is calculated as follows:

$$9.85 + 5\% = \underline{10.34 \text{ centi-minutes.}}$$

6.2.3 **The questionnaires**

Two separate questionnaires were developed for the purposes of this study.

Questionnaire 1 (see Appendix B) was distributed to employees of the assembly department of Company A. The researcher explained the purpose of the survey to the manager and supervisors. They, in turn communicated the purpose of the questionnaire to the employees. The explanation of the purpose was an attempt to avoid any assumptions that the employees may have had, which were irrelevant to the study. The purpose of the study as stated to the employees was to identify problems encountered by employees of the assembly department with a view to improving performance.

Questionnaire 2 was distributed to selected students registered in the Department of Quality and Operations Management and who were also employees of organisations in South Africa. The attached covering letter to Questionnaire 2 (see Appendix C) explained to respondents that the purpose of the survey was to gather their critical responses to determine whether organisations have performance standards/targets and measurement criteria for their manufacturing processes. It also explained that the overall aim was to develop an ERS that organisations could use to measure the outputs of their manufacturing processes.

6.2.3.1 The response rate

A total of one hundred and fourteen (114) copies of Questionnaire 1 were distributed and a total of eighty-four (84) respondents returned the questionnaire. This constituted a response rate of 73.68%. The responses were found to be above average and were accepted for the purpose of this study.

A total of eight hundred (800) questionnaires were distributed and a total of two hundred and thirty (230) respondents returned the questionnaire. This constituted a response rate of 28.75%. The responses were found to be low but were accepted for the purpose of this study.

In Table 6.7 below, the response rate denotes the total number of respondents, divided by the number of questionnaires that were distributed.

Table 6.7: Response rate

	Questionnaire 1	Questionnaire 2
Distributed	114	800
Responses	84	230
Response rate	73.68%	28.75%

6.2.3.2 Data capturing and analysis of the questionnaire

Questionnaire 1

On receipt of the questionnaires, arrangements were made with a statistician from a company named Statistical Services for the data capturing and processing of the questionnaires. Statistical Services is a company that provides a professional, statistical consultation service to postgraduate students and researchers in respect of statistical analysis. The questionnaire data was imported in SAS/JMP version 9.0, a statistical package used by Statistical Services.

Data analysis included a combination of descriptive statistics of each category to look at the distribution of respondents. Analysis of variance (ANOVA) inferential statistics were performed to measure the difference of the index score and the different demographic questions. Further to this, the statistician conducted a reliability analysis using the Cronbach alpha to measure the consistency of questions in each category. Normality tests were also conducted on certain categories using the goodness-of-fit test (Shapiro–Wilk W test) to determine whether the data sets were well modelled by a normal distribution or not. Chi-square tests and linear regression tests were also performed on certain categories to indicate whether there were significant associations within the categories.

The spreadsheets were supplied in electronic format to the researcher. The researcher generated certain frequency graphs using Excel, and these were then transported to the Word document. The analysis contains graphs and tables with explanations.

Questionnaire 2

Questionnaire 2 followed a self-administered approach, where a computer-aided Web-based questionnaire was used. Responses were submitted to a dedicated uniform reference locator (URL) and the analyses were conducted by a statistician from the BMR at Unisa. Descriptive analyses of all questions were performed to look at the distribution of the respondents. The researcher then selected certain questions that were relevant to the outcome of this study and requested cross-tabulations and chi Square tests to be performed by the statistician. The aim was to see whether there were associations between the selected questions.

CHAPTER 7

RESULTS AND DISCUSSION OF FINDINGS

PART 1

7.1 INTRODUCTION

In the previous chapter, the researcher explained the data collection and data analysis procedures. This chapter presents the results and a discussion of the findings of the work study investigation. It comprises the analysis and results of the method study investigation, the work measurement investigation and the departmental layouts.

The method study investigation utilised process charts and layout improvement as a means of developing new and improved methods of working. The aim of this was to show as an exemplar, exactly how any organisation could use the work study technique to improve present working methods, to improve productivity and to improve the overall effectiveness of their organisation.

The work measurement investigation consisted of work sampling and time studies. Work sampling was carried out to determine the percentage occurrences of three basic activities of employees in any organisation, namely working, idle and absent from workplace. The aim was to show the average percentage of time that employees of the assembly department spent on these three activities. This universally accepted technique (work sampling) can also be used by organisations to sample employee activities quickly. Time studies were conducted to determine the duration of processes in order to develop standard times for the operations. In this case, the duration of all elements of all steps in the assembly process of a popular tap was determined and analysed and standard times set. This was used to develop the ERS.

The method used by the assembly department layout at the time of the research was drawn and then critically analysed to show improvements. Two improved proposed layouts are presented in this chapter (see Annexures D and E)

This chapter will show the complete integration of theory into practice via the two work study techniques.

7.2 METHOD STUDY INVESTIGATION

The Institute of Management Services (2014) states that method study is the process of subjecting work to systematic, critical scrutiny to make it more effective and/or more efficient. Method study is one of the keys to achieving productivity improvement. This is the first of the two principal techniques of work study, and is conducted first as it is impractical to measure the work of an inefficient method. Pycraft et al. (2010:248) define method study as the systematic recording and critical examination of the existing and proposed methods of doing work as a means of developing and applying easier and more effective methods and reducing costs. The basic procedure followed in method study is as follows:

- select the area to be studied;
- record and examine the data;
- develop alternative approaches;
- define and install the new method; and
- maintain the new method.

The task was selected, and the next step was to record all the relevant information regarding the assembly process.

7.2.1 Recording the steps in the assembly process of a tap

The method study investigation consisted of intensive 'observation and recording' of the current method of working in the assembly department of Company A, specifically, the assembly of a specific type of tap (Star Pillar Tap No: 217/15). The information was recorded onto flow process charts. An example of this is provided in Figure 5.3. Flow process charts were compiled for each step of the assembly process. This was placed here for ease of access to the reader.

The assembly process consisted of the seven steps indicated below. This means that on the assembly line (see Figure 7.1), seven different operators were utilised to assemble this tap. The seven steps are:

- Step 1: Fit head part
- Step 2: Water pressure test
- Step 3: Fit back nut to tap (brass)
- Step 4: Fit cover and handle
- Step 5: Fit indice (cold)
- Step 6: Cleaning and polishing
- Step 7: Packaging



Figure 7.1: Example of an assembly line

7.2.2 Critical examination of process charts of the assembly process

Step 1: Fit head part

This step consists of fitting of the head part to the body of the tap. Figure 7.2 shows the procedure for this step. This step consisted of sixteen elements. Each element of step 1 was described and a symbol allocated to it. A summary of the different symbols of the present method was completed.

This procedure was critically examined (3rd step of the method study procedure). Steps 1, 4 and 7 were improved and a proposed method was compiled on a separate flow process chart (see Figure 7.3). It can be seen from Figure 7.3 that there were significant improvements in this step. The total number of 'operation' elements decreased from 10 to 5

steps, the 'transport' step decreased from 4 to 1, the 'delay' and 'inspection' step decreased by 1 element each. Hence, it can be seen that there was a savings of 10 elements, which shows an improvement in the assembly process of Step 1. A new summary was completed showing the comparison between the present and proposed savings. The savings are shown in red in Table 7.1.

Table 7.1: Summary of savings: Step 1

Symbol	Present method	Proposed method	Savings
Operation	10	5	5
Transport	4	1	3
Delay	1	0	1
Storage	0	0	0
Inspection	1	0	1
TOTAL:	16	6	10

The rationale for the savings in Step 1 is as follows. Note that steps 1 to 8, 15 and 16 have been eliminated in Figure 7.3 because these ten elements will now be conducted as 'inside work'. Kanawaty (1995:348) states that 'inside work' comprises those elements which can be performed by a worker within the machine- (or process-) controlled time. This simply means that all the preparatory elements leading up to Step 1 must be done before Step 1 starts. Hence, the time that it takes to complete Step 1, is significantly minimised.

Step 2: Water pressure test

In this step (see Figure 7.4), the tap was tested to determine whether there are any leakages. This step consisted of fifteen elements. Each element of step 2 was described and a symbol allocated to it. After critically examining this step, no improvements could be made as all the elements were compulsory.

Step 3: Fit back nut to tap

In this step (see Figure 7.5), a back nut was fitted to the body of the tap. This step consisted of six elements. There were no improvements that could be made as all the elements were compulsory.

Step 4: Fit cover and handle

In this step, a cover and handle were fitted to the body of the tap. A quality check was also conducted during this step. This step consisted of eleven elements. Steps 1, 4 and 7 were

improved and a proposed method was compiled on a separate flow process chart (see Figure 7.6). It can be seen from Figure 7.7 that there were significant improvements in this step. The total number of 'operation' elements decreased from 7 to 5 steps and the 'transport' decreased from 3 to 0. Hence, there was a savings of five elements, which shows an improvement in the assembly process of Step 4. A new summary was completed showing the comparison between the present and proposed savings. The savings are shown in red in Table 7.2.

Table 7.2: Summary of savings: Step 4

Symbol	Present method	Proposed method	Savings
Operation	7	5	2
Transport	3	0	3
Delay	0	0	0
Storage	0	0	0
Inspection	1	1	0
TOTAL:	11	6	5

The rationale for the savings in Step 4 is as follows. Similar to Step 1, steps 1 to 5 have been eliminated in Figure 7.7. These five elements will now be conducted as 'inside work'.

Step 5: Fit indice (cold)

In this step (see Figure 7.8), a plastic fixture was screwed onto the handle of the tap using a mechanical screwdriver, which was positioned above the workplace and in easy reach of the worker. This indicated that the tap was a cold water tap. This step consisted of six elements. There were no improvements that could be made as all the elements were compulsory.

Step 6: Cleaning and polishing

In this step (see Figure 7.9), the tap was wiped clean using a cloth and polish. The tap was inserted into a plastic packet and a quality check was conducted. This step consisted of five elements. There were no improvements that could be made as all the elements were compulsory.

Step 7: Packaging

In this step (see Figure 7.10), the packaging box was made up, and 10 taps were placed into the box. The box was sealed and weighed to determine the quantity. This step consisted of seven elements. Figure 7.11 shows that one element (Aside box on table) was eliminated.

Hence, there was a saving of one element, which shows an improvement in the assembly process of Step 7. The rationale for this was that the packaged boxes should be placed onto the pallet immediately after they had been closed.

7.2.3 Improvements and savings

The present method of each of the seven steps were observed and charted. Thereafter, each step was critically examined with the aim of improving it. Table 7.3 shows that there was improvement of Steps 1, 4 and 7 to realise a total savings of 16 elements. The present and proposed methods of each of these three steps were charted on the flow process charts. Further to this, a rationale for the savings that were realised was provided. Table 7.3 shows a summary of the present and the proposed methods with the savings that had been realised. This is an indication of the value of a method study investigation and how it can improve productivity in an organisation. The duration of each of the improved steps would now be reduced, thereby improving the capacity of the assembly process.

Table 7.3: Summary of savings

Step number	Description	Number of elements		
		Present method	Proposed method	Savings
1.	Fit head part	16	6	10
2.	Water pressure test	15	15	0
3.	Fit back nut (brass)	6	6	0
4.	Fit cover and handle	11	6	5
5.	Fit indice (cold)	6	6	0
6.	Cleaning and polishing	5	5	0
7.	Packaging	7	6	1
	Total savings:	66	50	16

FLOW PROCESS CHART						
LOCATION: Assembly Department			SUMMARY			
ACTIVITY: Assembly: Star Pillar Tap No: 217/15			EVENT	PRESENT	PROPOSED	SAVINGS
DATE: 12-10-2009			OPERATION	10		
OPERATOR: Line 2B		ANALYST: B. Sookdeo	TRANSPORT	4		
CIRCLE APPROPRIATE METHOD AND TYPE: METHOD: <u>PRESENT</u> / PROPOSED TYPE: <u>WORKER</u> / MATERIAL / MACHINE			DELAY	1		
			STORAGE			
			INSPECTION	1		
DESCRIPTION OF OPERATION: Step 1: Fit head part			TIME (mins.)			
			DISTANCE (metres)	100		
STEP NO.	DESCRIPTION OF ELEMENTS	SYMBOL	TIME (in minutes)	DISTANCE (in metres)	REMARKS	
		○ □ D ⇄ ▽				
1	Prepare workplace	○ □ D ⇄ ▽				
2	Fetch jig from store	○ □ D ⇄ ▽		40		
3	Position at workplace	○ □ D ⇄ ▽				
4	Fetch head parts from storage	○ □ D ⇄ ▽		10		
5	Position at workplace	○ □ D ⇄ ▽				
6	Fetches body parts from storage	○ □ D ⇄ ▽		10		
7	Position at workplace	○ □ D ⇄ ▽				
8	Wait for other stations to set up	○ □ D ⇄ ▽				
		○ □ D ⇄ ▽				
9	Pick up body part and pos. in jig	○ □ D ⇄ ▽				
10	Pick up head part and pos. in body	○ □ D ⇄ ▽				
11	Screw on head part	○ □ D ⇄ ▽				
12	Pick up assembled head part	○ □ D ⇄ ▽				
13	Inspect head part	○ □ D ⇄ ▽				
14	Aside head part onto conveyor	○ □ D ⇄ ▽				
		○ □ D ⇄ ▽				
15	Remove and aside empty boxes	○ □ D ⇄ ▽				
16	Take jig back to store	○ □ D ⇄ ▽		40		

Figure 7.2: Flow process chart: Step 1: Fit head part (present method)

FLOW PROCESS CHART							
LOCATION: Assembly Department				SUMMARY			
ACTIVITY: Assembly: Star Pillar Tap No: 217/15				EVENT	PRESENT	PROPOSED	SAVINGS
DATE: 12-10-2009				OPERATION	10	5	5
OPERATOR: Line 2B		ANALYST: B. Sookdeo		TRANSPORT	4	1	3
CIRCLE APPROPRIATE METHOD AND TYPE: METHOD: PRESENT / <u>PROPOSED</u> TYPE: <u>WORKER</u> / MATERIAL / MACHINE				DELAY	1	0	1
				STORAGE	0	0	0
				INSPECTION	1	0	1
DESCRIPTION OF OPERATION: Step 1: Fit head part:				TOTAL:	16	6	10
				DISTANCE (metres)	100	0	0
STEP NO.	DESCRIPTION OF ELEMENTS		SYMBOL		TIME (in minutes)	DISTANCE (in metres)	REMARKS
			○	□	D	⇌	▽
1	Pick up body part and pos. in jig		●	□	D	⇌	▽
2	Pick up head part and pos. in body		●	□	D	⇌	▽
3	Screw on head part		●	□	D	⇌	▽
4	Pick up assembled head part		●	□	D	⇌	▽
5	Inspect head part		○	●	D	⇌	▽
6	Aside head part onto conveyor		○	□	D	⇌	▽

Figure 7.3: Flow process chart: Step 1: Fit head part (proposed method)

FLOW PROCESS CHART							
LOCATION: Assembly Department				SUMMARY			
ACTIVITY: Assembly: Star Pillar Tap No: 217/15				EVENT	PRESENT	PROPOSED	SAVINGS
DATE: 12-10-2009				OPERATION	11		
OPERATOR: Line 2B		ANALYST: B. Sookdeo		TRANSPORT	0		
CIRCLE APPROPRIATE METHOD AND TYPE: METHOD: <u>PRESENT</u> / PROPOSED TYPE: <u>WORKER</u> / MATERIAL / MACHINE				DELAY	0		
				STORAGE	0		
				INSPECTION	4		
DESCRIPTION OF OPERATION: Step 2: Water Pressure Test				TOTAL:	15		
				DISTANCE (metres)			
STEP NO.	DESCRIPTION OF ELEMENTS		SYMBOL		TIME (in minutes)	DISTANCE (in metres)	REMARKS
			○	□	D	⇄	▽
1	Pick up tap off conveyor		●	□	D	⇄	▽
2	Position in test facility		○	□	D	⇄	▽
3	Clamp tap in facility		○	□	D	⇄	▽
4	Open tap		○	□	D	⇄	▽
5	Check if water passes through tap		○	△	D	⇄	▽
6	Close tap		○	□	D	⇄	▽
7	Apply 2000 KPA pressure		○	□	D	⇄	▽
8	Close water supply		○	□	D	⇄	▽
9	Check that water remains constant		○	□	D	⇄	▽
10	Inspect for leakages		○	□	D	⇄	▽
11	Open tap (one turn)		○	□	D	⇄	▽
12	Check if spindle turns smoothly		○	□	D	⇄	▽
13	Remove tap from facility		○	□	D	⇄	▽
14	Stamp number		○	□	D	⇄	▽
15	Aside onto conveyor.		●	□	D	⇄	▽

Figure 7.4: Flow process chart: Step 2: Water pressure test (present method)

FLOW PROCESS CHART							
LOCATION: Assembly Department				SUMMARY			
ACTIVITY: Assembly: Star Pillar Tap No: 217/15				EVENT	PRESENT	PROPOSED	SAVINGS
DATE: 12-10-2009				OPERATION	11		
OPERATOR: Line 2B		ANALYST: B. Sookdeo		TRANSPORT	0		
CIRCLE APPROPRIATE METHOD AND TYPE:				DELAY	0		
METHOD: PRESENT / PROPOSED				STORAGE	0		
TYPE: WORKER / MATERIAL / MACHINE				INSPECTION	4		
DESCRIPTION OF OPERATION:				TOTAL:	15		
Step 3: Fit back nut to tap (brass)				DISTANCE (metres)			
STEP NO.	DESCRIPTION OF ELEMENTS	SYMBOL		TIME (in minutes)	DISTANCE (in metres)	REMARKS	
		○	□	D	⇨	▽	
1	Fetch backnuts from storage	○	□	D	→	▽	
2	Position at work station	●	□	D	⇨	▽	
3	Remove and position backnuts on workstation	○	□	D	⇨	▽	
4	Pick up tap off conveyor	●	□	D	⇨	▽	
5	Screw on backnut to tap	○	□	D	⇨	▽	
6	Aside onto conveyor	○	□	D	⇨	▽	

Figure 7.5: Flow process chart: Step 3: Fit back nut to tap (present method)

FLOW PROCESS CHART						
LOCATION: Assembly Department			SUMMARY			
ACTIVITY: Assembly: Star Pillar Tap No: 217/15			EVENT	PRESENT	PROPOSED	SAVINGS
DATE: 12-10-2009			OPERATION	7		
OPERATOR: Line 2B		ANALYST: B. Sookdeo	TRANSPORT	3		
CIRCLE APPROPRIATE METHOD AND TYPE: METHOD: <u>PRESENT</u> / PROPOSED TYPE: <u>WORKER</u> / MATERIAL / MACHINE			DELAY	0		
			STORAGE	0		
			INSPECTION	1		
DESCRIPTION OF OPERATION: Step 4: Fit cover and handle			TOTAL:	11		
			DISTANCE (metres)			
STEP NO.	DESCRIPTION OF ELEMENTS	SYMBOL	TIME (in minutes)	DISTANCE (in metres)	REMARKS	
1	Fetch covers from storage					
2	Position at work station					
3	Fetch handles from storage					
4	Position at work station					
5	Remove covers from wrapping					
6	Pick up tap from conveyor					
7	Attach indices (Hot + washer)					
8	Fit cover to tap					
9	Fit handle to tap					
10	Quality check					
11	Aside onto conveyor					

Figure 7.6: Flow process chart: Step 4: Fit cover and handle (present method)

FLOW PROCESS CHART									
LOCATION: Assembly Department					SUMMARY				
ACTIVITY: Assembly: Star Pillar Tap No: 217/15					EVENT	PRESENT	PROPOSED	SAVINGS	
DATE: 12-10-2009					OPERATION	7	5	2	
OPERATOR: Line 2B			ANALYST: B. Sookdeo		TRANSPORT	3	0	3	
CIRCLE APPROPRIATE METHOD AND TYPE:					DELAY	0	0	0	
METHOD: PRESENT / <u>PROPOSED</u>					STORAGE	0	0	0	
TYPE: <u>WORKER</u> / MATERIAL / MACHINE					INSPECTION	1	1	0	
DESCRIPTION OF OPERATION:					TOTAL:	11	6	5	
Step 4: Fit cover and handle					DISTANCE (metres)				
STEP NO.	DESCRIPTION OF ELEMENTS			SYMBOL		TIME (in minutes)	DISTANCE (in metres)	REMARKS	
				○	□	D	⇌	▽	
1	Pick up tap from conveyor			●	□	D	⇌	▽	
2	Attach indices (Hot + washer)			●	□	D	⇌	▽	
3	Fit cover to tap			●	□	D	⇌	▽	
4	Fit handle to tap			●	□	D	⇌	▽	
5	Quality check			○	□	D	⇌	▽	
				○	□	D	⇌	▽	
6	Aside onto conveyor			●	□	D	⇌	▽	

Figure 7.7: Flow process chart: Step 4: Fit cover and handle (proposed method)

FLOW PROCESS CHART						
LOCATION: Assembly Department			SUMMARY			
ACTIVITY: Assembly: Star Pillar Tap No: 217/15			EVENT	PRESENT	PROPOSED	SAVINGS
DATE: 12-10-2009			OPERATION	5		
OPERATOR: Line 2B		ANALYST: B. Sookdeo	TRANSPORT	0		
CIRCLE APPROPRIATE METHOD AND TYPE: METHOD: <u>PRESENT</u> / PROPOSED TYPE: <u>WORKER</u> / MATERIAL / MACHINE			DELAY	0		
			STORAGE	0		
			INSPECTION	1		
DESCRIPTION OF OPERATION: Step 5: Fit indice (cold)			TOTAL:	6		
			DISTANCE (metres)			
STEP NO.	DESCRIPTION OF ELEMENTS	SYMBOL	TIME (in minutes)	DISTANCE (in metres)	REMARKS	
		○ □ D ⇌ ∇				
1	Pick up tap from conveyor	● □ D ⇌ ∇				
2	Pick up screw and pos. on headpart	● □ D ⇌ ∇				
3	Fasten screw (mech. jig)	● □ D ⇌ ∇				
4	Fit cold indice and hammer in	● □ D ⇌ ∇				
5	Quality check	● □ D ⇌ ∇				
		○ □ D ⇌ ∇				
6	Aside onto conveyor	● □ D ⇌ ∇				

Figure 7.8: Flow process chart: Step 5: Fit indice (cold) (present method)

FLOW PROCESS CHART						
LOCATION: Assembly Department			SUMMARY			
ACTIVITY: Assembly: Star Pillar Tap No: 217/15			EVENT	PRESENT	PROPOSED	SAVINGS
DATE: 12-10-2009			OPERATION	4		
OPERATOR: Line 2B		ANALYST: B. Sookdeo	TRANSPORT	0		
CIRCLE APPROPRIATE METHOD AND TYPE:			DELAY	0		
METHOD: PRESENT / PROPOSED			STORAGE	0		
TYPE: WORKER / MATERIAL / MACHINE			INSPECTION	1		
DESCRIPTION OF OPERATION:			TOTAL:	5		
Step 6: Cleaning and polishing			DISTANCE (metres)			
STEP NO.	DESCRIPTION OF ELEMENTS	SYMBOL	TIME (in minutes)	DISTANCE (in metres)	REMARKS	
		○ □ D ⇌ ∇				
1	Pick up tap from conveyor	● □ D ⇌ ∇				
2	Wipe tap with cloth	● □ D ⇌ ∇				
3	Insert tap in plastic packet	● □ D ⇌ ∇				
4	Quality check	○ ● □ D ⇌ ∇				
5	Aside on table for packaging	○ ● □ D ⇌ ∇				

Figure 7.9: Flow process chart: Step 6: Cleaning and polishing (present method)

FLOW PROCESS CHART						
LOCATION: Assembly Department			SUMMARY			
ACTIVITY: Assembly: Star Pillar Tap No: 217/15			EVENT	PRESENT	PROPOSED	SAVINGS
DATE: 12-10-2009			OPERATION	6		
OPERATOR: Line 2B		ANALYST: B. Sookdeo	TRANSPORT	0		
CIRCLE APPROPRIATE METHOD AND TYPE: METHOD: <u>PRESENT</u> / PROPOSED TYPE: <u>WORKER</u> / MATERIAL / MACHINE			DELAY	0		
			STORAGE	0		
			INSPECTION	1		
DESCRIPTION OF OPERATION: Step 7: Packaging			TOTAL:	7		
			DISTANCE (metres)			
STEP NO.	DESCRIPTION OF ELEMENTS	SYMBOL	TIME (in minutes)	DISTANCE (in metres)	REMARKS	
		○ □ D ⇨ ∇				
1	Pick up box and make up	● □ D ⇨ ∇				
2	Pack taps into box (x 10 taps)	● □ D ⇨ ∇				
3	Close box and seal with tape	● □ D ⇨ ∇				
4	Attach label	● □ D ⇨ ∇				
5	Weigh box (check for quantity)	○ □ D ⇨ ∇				
6	Aside box on table	● □ D ⇨ ∇				
7	Pick up box and place on pallet	● □ D ⇨ ∇				

Figure 7.10: Flow process chart: Step 7: Packaging (present method)

FLOW PROCESS CHART						
LOCATION: Assembly Department			SUMMARY			
ACTIVITY: Assembly: Star Pillar Tap No: 217/15			EVENT	PRESENT	PROPOSED	SAVINGS
DATE: 12-10-2009			OPERATION	6	5	1
OPERATOR: Line 2B		ANALYST: B. Sookdeo	TRANSPORT	0	0	0
CIRCLE APPROPRIATE METHOD AND TYPE: METHOD: PRESENT / <u>PROPOSED</u> TYPE: <u>WORKER</u> / MATERIAL / MACHINE			DELAY	0	0	0
			STORAGE	0	0	0
			INSPECTION	1	1	0
			TOTAL:	7	6	1
DESCRIPTION OF OPERATION: Step 7: Packaging			DISTANCE (metres)			
STEP NO.	DESCRIPTION OF ELEMENTS	SYMBOL	TIME (in minutes)	DISTANCE (in metres)	REMARKS	
		○ □ D ⇌ ∇				
1	Pick up box and make up	○ □ D ⇌ ∇				
2	Pack taps into box (x 10 taps)	○ □ D ⇌ ∇				
3	Close box and seal with tape	○ □ D ⇌ ∇				
4	Attach label	○ □ D ⇌ ∇				
5	Weigh box (check for quantity)	○ □ D ⇌ ∇			<i>Inspection within an operation</i>	
6	Pick up box and place on pallet	○ □ D ⇌ ∇				

Figure 7.11: Flow process chart: Step 7: Packaging (proposed method)

7.3 WORK MEASUREMENT INVESTIGATION

The Institute of Management Services (2014) states that work measurement is the process of establishing the time that a given task would take when performed by a qualified worker working at a defined level of performance. In order to determine the duration of processes, it was firstly important to improve the method of working as it was ineffective to set standard times for inefficient methods. This was carried out via the method study investigation where flow process charts were compiled and processes improved in order to determine the most effective methods of working.

Prior to conducting time studies to determine the duration of the processes, the researcher firstly, conducted a work sampling study. Perkins (2014:01) states that work sampling lets one identify, through observation, the percentage of time employees and/or equipment work productively. In the present study, this involved observing the employees of the assembly department, via direct observation, to determine the total percentage of time that operators were found to be working. This provided management with a quick overview of the situation in their department at the time of this research. The analysis and findings of this study is shown below (see 7.3.1).

Thereafter, time studies were conducted on the same seven assembly process steps of the tap (also identified during the method study investigation) (see 7.2) to determine the duration of each process.

Wicaksana (2013:01) states that time study determines the time required to produce a product and Dagdevirena et al. (2011:563) state that time study records the process times and levels of a pre-determined work using specified conditions. The basic procedure for time study as identified in Figure 5.12 was as follows:

- select the tasks on which a time study has to be carried out;
- record all relevant data regarding the process to be studied and define it;
- measure the actual duration of each element, evaluate the pace (rating) at which the worker carries out the activity, and record it on the time study sheet;
- calculate the standard time of the task;
- obtain approval of the standard time from management, supervisor and workers concerned;
- implement the new time standard; and
- maintain new method and revise it from time to time.

Note that all time study sheets (Figures 7.12 to 7.33) were placed at end of this section. This was placed here for ease of access to the reader. The analysis of the time studies is shown below (see 7.3.2).

7.3.1 Analysis and findings of the main work sampling study

Work sampling was explained in section 5.4.7.2. Further to the results of the pilot study, section 6.2.2.1.1 showed that the total number of observations required to realise a true reflection of the activities was 245. The main work sampling study was conducted over

random durations and on random days over a period of thirty days. This was done in order to ensure a completely random study and to eliminate any bias. Furthermore, this allowed the researcher to assess the complete department over different days and different time periods so as not to generalise his results over a limited duration. The results are shown in Table 7.4.

Table 7.4: Analysis of main work sampling study

Operator number	A Absent from workplace	W Working	I Idle	TOTAL
1	71	106	68	245
2	66	120	59	245
3	61	118	66	245
4	85	130	30	245
5	66	119	60	245
6	77	127	41	245
7	52	133	60	245
8	48	122	75	245
9	59	115	71	245
10	77	129	39	245
11	64	118	63	245
12	55	144	46	245
13	44	121	80	245
14	60	125	60	245
15	58	131	56	245
16	49	135	61	245
17	55	142	48	245
18	59	155	31	245
Total	1106	2290	1014	4410
Percentage occurrence	25.08%	51.93%	22.99%	100%

Similar to the pilot study, activities A and I were combined to show the total percentage time spent 'idle' (not working); therefore –

the total percentage time that operators were found to be working = **51.93%** and;

the total percentage time that operators were found to be idle (25.08 + 22.99) = **48.07%**

7.3.2 Analysis and findings of the time studies

Using a stopwatch, time studies were conducted on all seven steps of the assembly process to determine the duration of each step of the assembly procedure (see 7.2.1 for the seven steps).

The time studies were conducted on the same type of tap that featured in the method study investigation and for which the average basic times of each step was calculated. Thereafter, the average basic times of these seven steps were used to calculate the standard time for the assembly of this tap.

In order to determine the standard time, four different sheets were used:

- Sheet 1: element breakdown sheet;
- Sheet 2: time study observation sheet;
- Sheet 3: time study analysis sheet; and
- Sheet 4: time study summary sheet.

Sheets 1 to 3 were used to calculate each step of the assembly procedure and sheet 4 was used to calculate the standard time for the whole operation.

The duration of the elements of steps 1 to 6 were very short and could not be measured individually. Due this constraint, the researcher was forced to combine the elements of each of these steps. Step 7 (Packaging) consisted of six elements, which were large enough for the researcher to time individually. Steps 1, 4 and 7 were improved and, hence, the duration of the proposed (improved) method was determined. The procedure to calculate the standard time for each of the seven steps is shown separately on each of the relevant time study sheets.

Note:

Step 1 serves as an example, and this exact procedure was followed for all seven steps.

Step 1: Fit head part

- a. *Sheet 1: Element breakdown sheet* (see Figure 7.12)

The assembly procedure for step 1 was broken down into six elements and each element is described on this sheet, for example:

Element 1: Pick up body part and position

- Element 2. Pick up head part and pos. in body
- Element 3. Screw on head part
- Element 4. Pick up assembled head part
- Element 5. Inspect head part
- Element 6. Aside head part onto conveyor

b. **Sheet 2: Time study observation sheet** (see Figure 7.13)

The 'observed times' and 'ratings' per element of **step 1** are indicated on this sheet. These times were determined by the researcher using a stopwatch time study. Following that, the 'basic time' per element was calculated, using the following formula:

$$\text{Basic time} = \frac{\text{Observed time} \times \text{rating}}{\text{Standard rating (100)}}$$

Therefore, for observation 1, the basic time is:

$$= \frac{0.177 \times 85}{100} = 0.150$$

c. **Sheet 3: Time study analysis Sheet** (see Figure 7.14)

All the basic times that were calculated on the observation sheet were carried over to this sheet. Here, the 'total basic time' was calculated and then, using the number of observations, the 'average basic time' to 'fit head part' was calculated.

TOTAL BASIC TIME	4.593
NO. OF OBSERVATIONS	30
AVERAGE BASIC TIME	0.153

The basic times of each element was used to compile the average basic time of each step, which in turn, was used to calculate the standard time for the assembly process. Therefore, each of the seven steps of the assembly procedure had to utilise the above three time study sheets in order to determine the average basic time per step. The three sheets used for each step are shown below.

d. **Sheet 4: Time study summary sheet** (see Figure 7.33)

This sheet was used to summarise all the different steps of the time study investigation in order to calculate the standard time for a task or process. The standard time for the assembly process of this particular was determined as follows:

TOTAL ACTUAL TIME	0.899
Contingency allowance: 4%	0.036
STANDARD TIME (in centi-minutes)	0.935

Note

All the above sheets were designed by the researcher during his employment in industry. These sheets were used extensively during the present study in the work measurement investigation.

7.3.3 Calculation of the standard time for the assembly process

Table 7.5 shows the method used to calculate the standard time for the complete assembly process of the tap. A contingency allowance of 4% was applied. The standard time to assemble the selected tap is: 0.935 centi-minutes. This can also be found in Figure 7.33.

Table 7.5: Standard time for the assembly process

STANDARD TIME CALCULATION							
Step no.	Element description	Basic time	Frequency	SBT per measurement	RA %	Other allowances	Actual time
1	Fit head part	0.153	1/1	0.153	12		0.171
2	Water pressure test	0.154	1/1	0.154	12		0.172
3	Fit back nut to tap	0.103	1/1	0.103	12		0.115
4	Fit cover and handle	0.096	1/1	0.096	12		0.107
5	Fit indice (cold)	0.129	1/1	0.129	12		0.144
6	Cleaning and polishing	0.101	1/1	0.101	12		0.113
7	Packaging	0.069	1/1	0.069	12		0.077
				TOTAL ACTUAL TIME			0.899
				Contingency allowance: 4%			0.036
				STANDARD TIME (in centi-minutes)			0.935

An overall rest allowance of 12% was added as this was a highly repetitive task and a contingency allowance of 4% was applicable to cover for any unforeseen elements that may occur.

ELEMENT BREAKDOWN SHEET		
DEPARTMENT: Assembly Department		STUDY NO: 88/2009
DIVISION: Taps		DATE: 12/10/2009
TAKEN BY: B. Sookdeo		SHEET NO: 01 OF: 88
TIME STARTED:	TIME FINISHED:	STUDY COMMENCES: Pick up body part and position
WORKER:		STUDY ENDS: Aside head part onto conveyor
DESCRIPTION OF TASK: Step 1: Fit head part		ERROR:
ELEMENT NO.	DESCRIPTION OF ELEMENT BREAKDOWN	
1.	Pick up body part and position	
2.	Pick up head part and pos. in body	
3.	Screw on head part	
4.	Pick up assembled head part	
5.	Inspect head part	
6.	Aside head part onto conveyor	

Figure 7.12: Step 1: Element breakdown sheet

TIME STUDY OBSERVATION SHEET							
STUDY NO: 88/2009				DATE: 12/10/2009			
TAKEN BY: B. Sookdeo				SHEET NO.: 02/88			
STUDY COMMENCES: Pick up tap and position in jig							
STUDY ENDS: Aside head part onto conveyor							
DESCRIPTION OF TASK: Step 1: Fit head part						ERROR MARGIN:	
ELEMENT DESCRIPTION	Rating	Observed time	Basic time	ELEMENT DESCRIPTION	Rating	Observed	Basic time
	85	0.177	0.150		85	0.177	0.150
	90	0.169	0.152		80	0.188	0.150
	80	0.192	0.154		75	0.209	0.157
	80	0.193	0.154		80	0.188	0.150
	80	0.195	0.156		80	0.184	0.147
	80	0.197	0.158		75	0.207	0.155
	85	0.182	0.155				
	75	0.205	0.154				
	85	0.180	0.153				
	75	0.200	0.150				
	75	0.203	0.152				
	85	0.179	0.152				
	90	0.166	0.149				
	75	0.201	0.151				
	80	0.189	0.151				
	80	0.192	0.154				
	80	0.196	0.157				
	80	0.194	0.155				
	80	0.188	0.150				
	80	0.199	0.159				
	80	0.199	0.159				
	85	0.179	0.152				
	80	0.191	0.153				
	75	0.202	0.152				

Figure 7.13: Step 1: Time study observation sheet

TIME STUDY ANALYSIS SHEET											
DEPARTMENT: ASSEMBLY				STUDY TAKEN BY: B. SOOKDEO							
DIVISION: TAP ASSEMBLY				DATE: 12/10/2009				STUDY NO: 88/2009			
DESCRIPTION OF TASK: Step 1: Fit head part				TIME FINISHED:				SHEET NO: 03/88			
				TIME STARTED:				TIME OF STUDY:			
WORKER:		ERROR :		ELAPSED TIME:				RECORDED TIME:			
BASIC TIME PER ELEMENT											
		E L E M E N T N U M B E R									
NUMBER OF OBSERVATIONS	1.	0.150	0.159								
	2.	0.152	0.152								
	3.	0.154	0.153								
	4.	0.154	0.152								
	5.	0.156	0.150								
	6.	0.158	0.150								
	7.	0.155	0.157								
	8.	0.154	0.150								
	9.	0.153	0.147								
	10.	0.150	0.155								
	11.	0.152									
	12.	0.152									
	13.	0.149									
	14.	0.151									
	15.	0.151									
	16.	0.154									
	17.	0.157									
	18.	0.155									
	19.	0.150									
	20.	0.159									
TOTAL BASIC TIME:			4.593								
NO. OF OBSERVATIONS:			30								
AVERAGE BASIC TIME			0.153								
TEBS = TIME ELAPSED BEFORE STUDY TEAS = TIME ELAPSED AFTER STUDY											
SBT = SELECTED BASIC TIME AT = ACTUAL TIME											

Figure 7.14: Step 1: Time study analysis sheet

ELEMENT BREAKDOWN SHEET		
DEPARTMENT: Assembly Department		STUDY NO: 88/2009
DIVISION: Taps		DATE: 12/10/2009
TAKEN BY: B.SOOKDEO		SHEET NO: 04 OF: 88
TIME STARTED:	TIME FINISHED:	STUDY COMMENCES: Pick up tap off conveyor
WORKER:		STUDY ENDS: Aside onto conveyor.
DESCRIPTION OF TASK: Step 2: Water pressure test		ERROR:
ELEMENT NO.	DECSCRIPTION OF ELEMENT BREAKDOWN	
1.	Pick up tap off conveyor	
2.	Position in test facility	
3.	Clamp tap in facility	
4.	Open tap	
5.	Check if water passes through tap	
6.	Close tap	
7.	Apply 2000 KPA pressure	
8.	Close water supply	
9.	Check that water remains constant	
10.	Inspect for leakages	
11.	Open tap (one turn)	
12.	Check if spindle turns smoothly	
13.	Remove tap from facility	
14.	Stamp number	
15.	Aside onto conveyor.	

Figure 7.15: Step 2: Element breakdown sheet

TIME STUDY OBSERVATION SHEET							
STUDY NO: 88/2009				DATE: 12/10/2009			
TAKEN BY: B. Sookdeo				SHEET NO.: 05/88			
STUDY COMMENCES: Pick up tap off conveyor							
STUDY ENDS: Aside onto conveyor							
DESCRIPTION OF TASK: Step 2: Water pressure test						ERROR MARGIN:	
ELEMENT DESCRIPTION	Rating	Observed time	Basic time	ELEMENT DESCRIPTION	Rating	Observed time	Basic time
	85	0.177	0.150		85	0.177	0.150
	90	0.169	0.152		85	0.188	0.160
	80	0.192	0.154		75	0.209	0.157
	80	0.193	0.154		85	0.188	0.160
	80	0.195	0.156		85	0.184	0.156
	85	0.177	0.150		75	0.207	0.155
	85	0.182	0.155				
	75	0.205	0.154				
	85	0.180	0.153				
	75	0.200	0.150				
	75	0.203	0.152				
	85	0.179	0.152				
	90	0.166	0.149				
	75	0.201	0.151				
	85	0.189	0.161				
	80	0.192	0.154				
	80	0.196	0.157				
	80	0.194	0.155				
	85	0.188	0.160				
	80	0.199	0.159				
	80	0.199	0.159				
	85	0.179	0.152				
	80	0.191	0.153				
	75	0.202	0.152				

Figure 7.16: Step 2: Time study observation sheet

TIME STUDY ANALYSIS SHEET											
DEPARTMENT: ASSEMBLY				STUDY TAKEN BY: B. SOOKDEO							
DIVISION: TAP ASSEMBLY				DATE: 12/10/2009				STUDY NO: 88/2009			
DESCRIPTION OF TASK: Step 2: Water pressure test				TIME FINISHED:				SHEET NO: 06/88			
				TIME STARTED:				TIME OF STUDY:			
WORKER:		ERROR :		ELAPSED TIME:				RECORDED TIME:			
BASIC TIME PER ELEMENT											
		E L E M E N T N U M B E R									
NUMBER OF OBSERVATIONS	1.	0.150	0.159								
	2.	0.152	0.152								
	3.	0.154	0.153								
	4.	0.154	0.152								
	5.	0.156	0.150								
	6.	0.150	0.160								
	7.	0.155	0.157								
	8.	0.154	0.160								
	9.	0.153	0.156								
	10.	0.150	0.155								
	11.	0.152									
	12.	0.152									
	13.	0.149									
	14.	0.151									
	15.	0.161									
	16.	0.154									
	17.	0.157									
	18.	0.155									
	19.	0.160									
	20.	0.159									
TOTAL BASIC TIME:			4.632								
NO. OF OBSERVATIONS:			30								
AVERAGE BASIC TIME			0.154								
TEBS = TIME ELAPSED BEFORE STUDY TEAS = TIME ELAPSED AFTER STUDY											
SBT = SELECTED BASIC TIME AT = ACTUAL TIME											

Figure 7.17: Step 2: Time study analysis sheet

ELEMENT BREAKDOWN SHEET			
DEPARTMENT: ASSEMBLY		STUDY NO: 88/2009	DATE: 12/10/2009
DIVISION: TAPS		TAKEN BY: B. SOOKDEO	SHEET NO: 07/88
TIME STARTED:	TIME FINISHED:	STUDY COMMENCES: Aside onto conveyor.	
WORKER:		STUDY ENDS: Fetch backnuts from storage	
DESCRIPTION OF TASK: Step 3: Fit back nut to tap (brass)			ERROR:
ELEMENT NO.	DESCRIPTION OF ELEMENT BREAKDOWN		
1.	Fetch backnuts from storage		
2.	Position at work station		
3.	Remove and position backnuts on		
4.	workstation		
5.	Pick up tap off conveyor		
6.	Screw on backnut to tap		
7.	Aside onto conveyor		

Figure 7.18: Step 3: Element breakdown sheet

TIME STUDY OBSERVATION SHEET							
STUDY NO: 88/2009				DATE: 12/10/2009			
TAKEN BY: B. Sookdeo				SHEET NO.: 08/88			
STUDY COMMENCES: Fetch backnuts from storage							
STUDY ENDS: Aside onto conveyor							
DESCRIPTION OF TASK: Step 3: Fit back nut to tap (brass)						ERROR MARGIN:	
ELEMENT DESCRIPTION	Rating	Observed time	Basic time	ELEMENT DESCRIPTION	Rating	Observed time	Basic time
	80	0.135	0.108		70	0.142	0.099
	70	0.139	0.097		70	0.140	0.098
	80	0.136	0.109		85	0.122	0.104
	60	0.163	0.098		70	0.139	0.097
	60	0.167	0.100		85	0.126	0.107
	80	0.136	0.109		80	0.131	0.105
	80	0.130	0.104				
	80	0.136	0.109				
	80	0.136	0.109				
	85	0.129	0.110				
	80	0.136	0.109				
	70	0.140	0.098				
	60	0.157	0.094				
	85	0.122	0.104				
	80	0.136	0.109				
	80	0.130	0.104				
	60	0.155	0.093				
	70	0.145	0.102				
	85	0.125	0.106				
	90	0.111	0.100				
	70	0.139	0.097				
	85	0.129	0.110				
	85	0.129	0.110				
	60	0.165	0.099				

Figure 7.19: Step 3: Time study observation sheet

TIME STUDY ANALYSIS SHEET											
DEPARTMENT: ASSEMBLY				STUDY TAKEN BY: B. SOOKDEO							
DIVISION: TAP ASSEMBLY				DATE: 12/10/2009				STUDY NO: 01/04			
DESCRIPTION OF TASK: Step 3: Fit back nut to tap (brass)				TIME FINISHED:				TEBS + TEAS:			
				TIME STARTED:				TIME OF STUDY:			
WORKER:		ERROR :		ELAPSED TIME:				RECORDED TIME:			
BASIC TIME PER ELEMENT											
		E L E M E N T N U M B E R									
NUMBER OF OBSERVATIONS	1.	0.108	0.097								
	2.	0.097	0.110								
	3.	0.109	0.110								
	4.	0.098	0.099								
	5.	0.100	0.099								
	6.	0.109	0.098								
	7.	0.104	0.104								
	8.	0.109	0.097								
	9.	0.109	0.107								
	10.	0.110	0.105								
	11.	0.109									
	12.	0.098									
	13.	0.094									
	14.	0.104									
	15.	0.109									
	16.	0.104									
	17.	0.093									
	18.	0.102									
	19.	0.106									
	20.	0.100									
TOTAL BASIC TIME:			3.096								
NO. OF OBSERVATIONS:			30								
AVERAGE BASIC TIME:			0.103								
EBS = TIME ELAPSED BEFORE STUDY TEAS = TIME ELAPSED AFTER STUDY											
SBT = SELECTED BASIC TIME AT = ACTUAL TIME											

Figure 7.20: Step 3: Time study analysis sheet

ELEMENT BREAKDOWN SHEET			
DEPARTMENT:		STUDY NO:	DATE:
DIVISION:		TAKEN BY:	SHEET NO: OF:
TIME STARTED:	TIME FINISHED:	STUDY COMMENCES:	
WORKER:		STUDY ENDS:	
DESCRIPTION OF TASK: Step 4:Fit cover and handle			ERROR:
ELEMENT NO.	DECSCRIPTION OF ELEMENT BREAKDOWN		
1.	Pick up tap from conveyor		
2.	Attach indices (Hot + washer)		
3.	Fit cover to tap		
4.	Fit handle to tap		
5.	Quality check		
6.	Aside onto conveyor		

Figure 7.21: Step 4: Element breakdown sheet

TIME STUDY OBSERVATION SHEET							
STUDY NO: 88/2009				DATE: 12/10/2009			
TAKEN BY: B. Sookdeo				SHEET NO.: 01/04			
STUDY COMMENCES: Pick up tap from conveyor							
STUDY ENDS: Aside onto conveyor							
DESCRIPTION OF TASK: Step 4: Fit cover and handle						ERROR MARGIN:	
ELEMENT DESCRIPTION	Rating	Observed time	Basic time	ELEMENT DESCRIPTION	Rating	Observed time	Basic time
	90	0.098	0.088		90	0.101	0.091
	90	0.108	0.097		85	0.119	0.101
	85	0.118	0.100		80	0.123	0.098
	80	0.127	0.102		80	0.122	0.098
	90	0.095	0.086		90	0.105	0.095
	85	0.119	0.101		85	0.116	0.099
	80	0.129	0.103				
	80	0.129	0.103				
	95	0.090	0.086				
	90	0.109	0.098				
	80	0.122	0.098				
	90	0.095	0.086				
	90	0.101	0.091				
	90	0.109	0.098				
	90	0.101	0.091				
	80	0.121	0.097				
	80	0.126	0.101				
	90	0.103	0.093				
	80	0.129	0.103				
	90	0.105	0.095				
	85	0.118	0.100				
	95	0.094	0.089				
	85	0.118	0.100				
	90	0.109	0.098				

Figure 7.22: Step 4: Time study observation sheet

TIME STUDY ANALYSIS SHEET											
DEPARTMENT: ASSEMBLY				STUDY TAKEN BY: B. SOOKDEO							
DIVISION: TAP ASSEMBLY				DATE: 12/10/2009				STUDY NO: 01/04			
DESCRIPTION OF TASK: Step 4: Fit cover and handle				TIME FINISHED:				TEBS + TEAS:			
				TIME STARTED:				TIME OF STUDY:			
WORKER:		ERROR :		ELAPSED TIME:				RECORDED TIME:			
BASIC TIME PER ELEMENT											
		E L E M E N T N U M B E R									
NUMBER OF OBSERVATIONS	1.	0.088	0.100								
	2.	0.097	0.089								
	3.	0.100	0.100								
	4.	0.102	0.098								
	5.	0.086	0.091								
	6.	0.101	0.101								
	7.	0.103	0.098								
	8.	0.103	0.098								
	9.	0.086	0.095								
	10.	0.098	0.099								
	11.	0.098									
	12.	0.086									
	13.	0.091									
	14.	0.098									
	15.	0.091									
	16.	0.097									
	17.	0.101									
	18.	0.093									
	19.	0.103									
	20.	0.095									
TOTAL BASIC TIME:			2.884								
NO. OF OBSERVATIONS:			30								
AVERAGE BASIC TIME			0.096								
EBS = TIME ELAPSED BEFORE STUDY TEAS = TIME ELAPSED AFTER STUDY											
SBT = SELECTED BASIC TIME AT = ACTUAL TIME											

Figure 7.23: Step 4: Time study analysis sheet

ELEMENT BREAKDOWN SHEET			
DEPARTMENT:		STUDY NO:	DATE:
DIVISION:		TAKEN BY:	SHEET NO: OF:
TIME STARTED:	TIME FINISHED:	STUDY COMMENCES:	
WORKER:		STUDY ENDS:	
DESCRIPTION OF TASK: Step 5: Fit indice (cold)			ERROR:
ELEMENT NO.	DECSCRIPTION OF ELEMENT BREAKDOWN		
1.	Pick up tap from conveyor		
2.	Pick up screw and pos. on headpart		
3.	Fasten screw (mech. jig)		
4.	Fit cold indice and hammer in		
5.	Quality check		
6.	Aside onto conveyor		

Figure 7.24: Step 5: Element breakdown sheet

TIME STUDY OBSERVATION SHEET							
STUDY NO: 88/2009				DATE: 12/10/2009			
TAKEN BY: B. Sookdeo				SHEET NO.: 01/04			
STUDY COMMENCES: Pick up tap from conveyor							
STUDY ENDS: Aside onto conveyor							
DESCRIPTION OF TASK: Step 5: Fit indice (cold)						ERROR MARGIN:	
ELEMENT DESCRIPTION	Rating	Observed time	Basic time	ELEMENT DESCRIPTION	Rating	Observed time	Basic time
	80	0.160	0.128		85	0.149	0.127
	90	0.139	0.125		85	0.147	0.125
	85	0.144	0.122		80	0.158	0.126
	80	0.159	0.127		85	0.155	0.132
	85	0.15	0.128		80	0.16	0.128
	80	0.163	0.130		85	0.154	0.131
	75	0.170	0.128				
	75	0.169	0.127				
	80	0.162	0.130				
	75	0.172	0.129				
	75	0.169	0.127				
	85	0.148	0.126				
	75	0.177	0.133				
	75	0.169	0.127				
	75	0.178	0.134				
	75	0.173	0.130				
	75	0.169	0.127				
	85	0.159	0.135				
	80	0.167	0.134				
	80	0.166	0.133				
	75	0.179	0.134				
	80	0.162	0.130				
	75	0.170	0.128				
	75	0.177	0.133				

Figure 7.25: Step 5: Time study observation sheet

TIME STUDY ANALYSIS SHEET											
DEPARTMENT: ASSEMBLY				STUDY TAKEN BY: B. SOOKDEO							
DIVISION: TAP ASSEMBLY				DATE: 12/10/2009				STUDY NO: 01/04			
DESCRIPTION OF TASK: Step 5: Fit indice (cold)				TIME FINISHED:				TEBS + TEAS:			
				TIME STARTED:				TIME OF STUDY:			
WORKER:		ERROR :		ELAPSED TIME:				RECORDED TIME:			
BASIC TIME PER ELEMENT											
		E L E M E N T N U M B E R									
NUMBER OF OBSERVATIONS	1.	0.128	0.134								
	2.	0.125	0.130								
	3.	0.122	0.128								
	4.	0.127	0.133								
	5.	0.128	0.127								
	6.	0.130	0.125								
	7.	0.128	0.126								
	8.	0.127	0.132								
	9.	0.130	0.128								
	10.	0.129	0.131								
	11.	0.127									
	12.	0.126									
	13.	0.133									
	14.	0.127									
	15.	0.134									
	16.	0.130									
	17.	0.127									
	18.	0.135									
	19.	0.134									
	20.	0.133									
TOTAL BASIC TIME:			3.870								
NO. OF OBSERVATIONS:			30								
AVERAGE BASIC TIME			0.129								
EBS = TIME ELAPSED BEFORE STUDY TEAS = TIME ELAPSED AFTER STUDY SBT = SELECTED BASIC TIME AT = ACTUAL TIME											

Figure 7.26: Step 5: Time study analysis sheet

ELEMENT BREAKDOWN SHEET			
DEPARTMENT:		STUDY NO:	DATE:
DIVISION:		TAKEN BY:	SHEET NO: OF:
TIME STARTED:	TIME FINISHED:	STUDY COMMENCES:	
WORKER:		STUDY ENDS:	
DESCRIPTION OF TASK: Step 6: Cleaning and polishing			ERROR:
ELEMENT NO.	DESCRIPTION OF ELEMENT BREAKDOWN		
1.	Pick up tap from conveyor		
2.	Wipe tap with cloth		
3.	Insert tap in plastic packet		
4.	Quality check		
5.	Aside on table for packaging		

Figure 7.27: Step 6: Element breakdown sheet

TIME STUDY OBSERVATION SHEET							
STUDY NO: 88/2009				DATE: 12/10/2009			
TAKEN BY: B. Sookdeo				SHEET NO.: 01/04			
STUDY COMMENCES: Pick up tap from conveyor							
STUDY ENDS: Aside on table for packaging							
DESCRIPTION OF TASK: Step 6: Cleaning and polishing						ERROR MARGIN:	
ELEMENT DESCRIPTION	Rating	Observed time	Basic time	ELEMENT DESCRIPTION	Rating	Observed time	Basic time
Number of taps completed:							
x 3 taps	80	0.372	0.298				
x 4 "	100	0.406	0.406				
x 2 "	80	0.258	0.206				
x 2 "	80	0.288	0.230				
x 2 "	110	0.169	0.186				
x 2 "	110	0.170	0.187				
x 2 "	110	0.189	0.208				
x 4 "	80	0.505	0.404				
x 1 "	60	0.176	0.106				
x 8 "	90	0.901	0.811				

Figure 7.28: Step 6: Time study observation sheet

TIME STUDY ANALYSIS SHEET											
DEPARTMENT: ASSEMBLY				STUDY TAKEN BY: B. SOOKDEO							
DIVISION: TAP ASSEMBLY				DATE: 12/10/2009				STUDY NO: 01/04			
DESCRIPTION OF TASK: Step 6: Cleaning and polishing				TIME FINISHED:				TEBS + TEAS:			
				TIME STARTED:				TIME OF STUDY:			
WORKER:		ERROR :		ELAPSED TIME:				RECORDED TIME:			
BASIC TIME PER ELEMENT											
		ELEMENT NUMBER									
NUMBER OF OBSERVATIONS	1.	0.298									
	2.	0.406									
	3.	0.206									
	4.	0.230									
	5.	0.186									
	6.	0.187									
	7.	0.208									
	8.	0.404									
	9.	0.106									
	10.	0.811									
	11.										
	12.										
	13.										
	14.										
	15.										
	16.										
	17.										
	18.										
	19.										
	20.										
TOTAL BASIC TIME:		3.042									
NO. OF OBSERVATIONS:		30									
AVERAGE BASIC TIME		0.101									
EBS = TIME ELAPSED BEFORE STUDY TEAS = TIME ELAPSED AFTER STUDY											
SBT = SELECTED BASIC TIME AT = ACTUAL TIME											

Figure 7.29: Step 6: Time study analysis sheet

ELEMENT BREAKDOWN SHEET			
DEPARTMENT:		STUDY NO:	DATE:
DIVISION:		TAKEN BY:	SHEET NO: OF:
TIME STARTED:	TIME FINISHED:	STUDY COMMENCES:	
WORKER:		STUDY ENDS:	
DESCRIPTION OF TASK: Step 7: Packaging			ERROR:
ELEMENT NO.	DESCRIPTION OF ELEMENT BREAKDOWN		
1.	Pick up box and make up		
2.	Pack taps into box (x 10 taps)		
3.	Close box and seal with tape		
4.	Attach label		
5.	Weigh box (check for quantity)		
6.	Pick up box and place on pallet		

Figure 7.30: Step 7: Element breakdown sheet

Note:

Step number seven consisted of six elements which were large enough for the researcher to time individually. This is shown below.

TIME STUDY OBSERVATION SHEET							
STUDY NO: 88/2009				DATE: 12/10/2009			
TAKEN BY: B. Sookdeo				SHEET NO.: 01/04			
STUDY COMMENCES: Pick up box and make up							
STUDY ENDS: Pick up box and place on pallet							
DESCRIPTION OF TASK: Step 7: Packaging						ERROR MARGIN:	
ELEMENT DESCRIPTION	Rating	Observed time	Basic time	ELEMENT DESCRIPTION	Rating	Observed time	Basic time
1. Pick up box and make up	85	0.154	0.131	5. Attach label	70	0.179	0.125
	80	0.189	0.151		100	0.068	0.068
	90	0.150	0.135		100	0.072	0.072
	90	0.144	0.130		85	0.109	0.093
	85	0.159	0.135		90	0.090	0.091
2. Pack taps into box	75	1.001	0.751	6. Pick up box and	95	1.000	0.950
(x 10 taps per box)	90	0.706	0.635	place on pallet	90	1.050	0.945
	85	0.872	0.741	x 12 boxes	95	1.011	0.960
	90	0.700	0.630		95	0.999	0.949
	85	0.808	0.687		90	1.060	0.954
2. Close box and seal	90	0.177	0.159				
using tape	80	0.228	0.182				
	85	0.201	0.171				
	90	0.185	0.167				
	90	0.177	0.159				
3. Weigh box (check quantity)	80	0.157	0.126				
	90	0.113	0.102				
	85	0.144	0.122				
	90	0.101	0.091				
	85	0.139	0.118				

Figure 7.31: Step 7: Time study observation sheet

TIME STUDY SUMMARY SHEET							
DEPARTMENT: ASSEMBLY DEPARTMENT				STUDY NUMBER: 01/04		SHEET NO. 01 OF: 01	
DIVISION: LINE ASSEMBLY				NAME:		DATE DATUM: 13/10/2009	
DESCRIPTION OF TASK: COMPLETE ASSEMBLY OF TAP ERROR %:				PERSON STUDIED:			
				TEBS:		TEAS:	
STANDARD TIME CALCULATION							
Step no.	Element description	Basic time	Frequency	SBT per measurement	RA %	Other allowances	Actual time
1	Fit head part	0.153	1/1	0.153	12		0.171
2	Water pressure test	0.154	1/1	0.154	12		0.172
3	Fit back nut to tap	0.103	1/1	0.103	12		0.115
4	Fit cover and handle	0.096	1/1	0.096	12		0.107
5	Fit indice (cold)	0.129	1/1	0.129	12		0.144
6	Cleaning and polishing	0.101	1/1	0.101	12		0.113
7	Packaging	0.069	1/1	0.069	12		0.077
SBT: Selected Basic Time				TOTAL ACTUAL TIME:			0.899
RA: Rest Allowances				Contingency allowance: 4%			0.036
AT: Actual Time				STANDARD TIME: (in centi-minutes)			0.935

Figure 7.33: Time study summary sheet: Calculation of standard time

7.4 DEPARTMENTAL LAYOUTS

7.4.1 Layout of assembly department

At the time of the present study, the assembly department of Company A utilised two types of layouts, namely product layout and u-cell layouts. Stevenson (2007:237) states that layout refers to the configuration of departments, work centres and equipment, with particular emphasis on movement of work (customers and materials) through the system. Heizer and Render (2011:376) list four considerations in layout design, as layout design needs to achieve the following:

- higher utilisation of space, equipment, and people;
- improved flow of information, materials or people;
- improved employee morale and safer working conditions;
- improved customer/client interaction; and
- flexibility (whatever the layout is now, it will need to change).

The layout of the assembly department at the time of the present research was recorded and analysed. Thereafter, a new improved layout was designed. See Annexures D (present layout) and E (proposed layout). The aim was to show an effective flow of materials and employees within the assembly department in order to reduce transportation, eliminate delays and improve the overall effectiveness of the department.

7.5 CHAPTER REVIEW

In this chapter, the results and discussion of the findings of the method study and the work measurement investigations were presented.

During the method study investigation, the present method of working was charted on flow process charts. These were analysed, and an improved method of working was developed. Certain steps of the assembly procedure were improved and the comparison is shown with a list of savings (see 7.2.3).

The work measurement investigation consisted of work sampling and time studies. Work sampling was carried out to determine the percentage occurrences of three basic activities of employees in any organisation, namely working, idle and absent from workplace. The aim was to show the average percentage of time that employees of the assembly department

spent on these three activities at the time of the research. This universally accepted technique (work sampling) can also be used by organisations to sample employee activities 'quickly'. Time studies were conducted to determine the duration of processes in order to develop standard times for the operations. In this case, the duration of all elements of all the steps in the assembly process of a popular tap were determined, analysed and standard times set. This was used to develop the ERS.

The layout of the assembly at the time of the research was described , and an improved layout was developed to eliminate unnecessary transportation and delays and to display an effective working area.

This chapter showed the complete integration of theory into practice via the two work study techniques.

In the next chapter, the results and a discussion of the findings of the empirical study are presented and the ERS that was developed is introduced.

CHAPTER 8

RESULTS AND DISCUSSION OF FINDINGS

PART 2

8.1 INTRODUCTION

In the previous chapter, the results and discussion of the findings of the method study and work measurement investigations were explained. The improvement of assembly department layout to show a more effective flow of materials and employees was also discussed. In this chapter, the results and a discussion of the findings of the empirical study are presented. It comprises the analysis and interpretation of the two questionnaires.

As mentioned in Chapter 2 (see 2.4.2, the purpose of Questionnaire 1 was to elicit employee experiences, in order to identify factors that constitute stumbling blocks to improved productivity. The questionnaire consisted of a total of forty questions and was divided into eight categories.

The purpose of the Questionnaire 2 was to gather critical responses to determine whether manufacturing organisations have performance standards and measurement criteria for their manufacturing processes. The questionnaire consisted of fifteen questions.

The ERS that was developed as the output of this study is also presented in this chapter.

8.2 ANALYSIS AND INTERPRETATION OF QUESTIONNAIRE 1

The main aim of Questionnaire 1 was to elicit responses from employees of the assembly department of Company A with regard to the problems experienced and the possible reasons for poor performance. Questionnaire 1 was applied in the assembly department of Company A. A total of one hundred and fourteen (114) employees participated, and a one hundred per cent sample was used as this study was restricted to the assembly department of Company A.

As mentioned earlier, the data obtained by means of Questionnaire 1 was imported into SAS/JMP version 9.0. Data analysis included a combination of descriptive statistics of each category to look at the distribution of respondents. Only questions that were significant to this study were analysed and are explained in this section. At the request of the supervisor, descriptive statistics of only certain important points are displayed in this section.

The term **employees** represent the term **respondents** in these analyses. Full analysis of Questionnaire 2 can be found in Annexure F.

8.2.1 Category A: Personal data

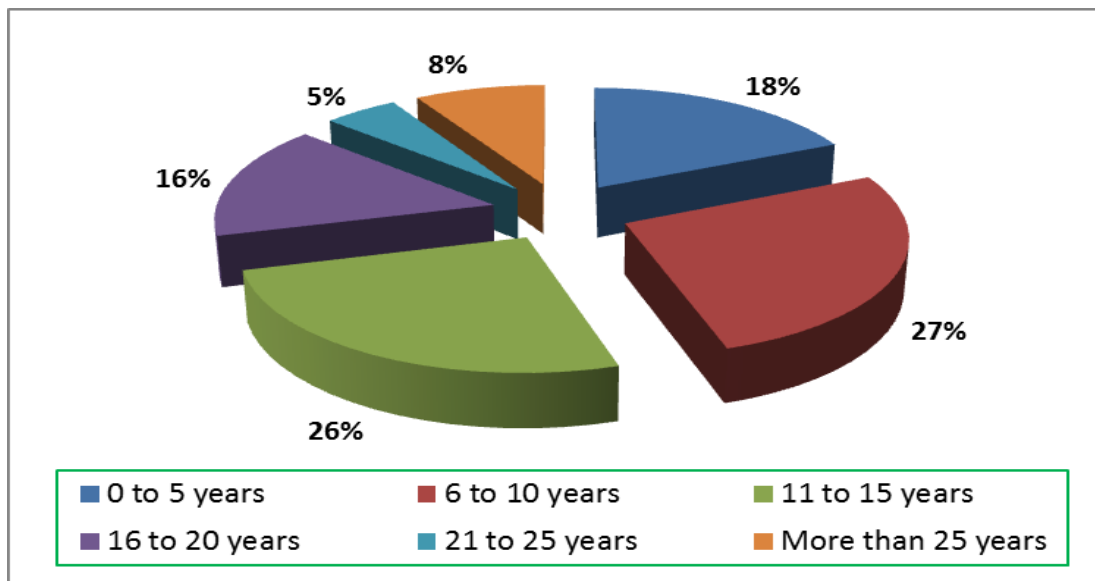
The purpose of this category was to determine the biographical information of the respondents. Information included gender, age, duration of employment and current position at Company A. Descriptive analyses were completed to show the responses of employees and the link to the study.

At the time of this research, Company A employed 56% males and 44% females. Employees' ages ranged from twenty one years old upwards. The majority of employees (38.1%) fell within the 31–40-year age group. Another 31% fell into the 41–50-year age group. Roussin (2014) states that large numbers of older workers are remaining in the global workforce, raising questions concerning age-related differences in perception and behaviour. Table 8.1 shows the employees age versus the number of problems experienced at work.

Table 8.1: Age versus mean number of problems experienced at work

Age category	N	Mean % score	Std. dev.	Significance	
				*	**
21 to 25	2	40.0	14.14	0.1363	0.0821
26 to 30	10	25.0	12.69		
31 to 40	32	20.6	17.76		
41 to 50	26	27.3	27.79		
Other	14	12.1	8.01		

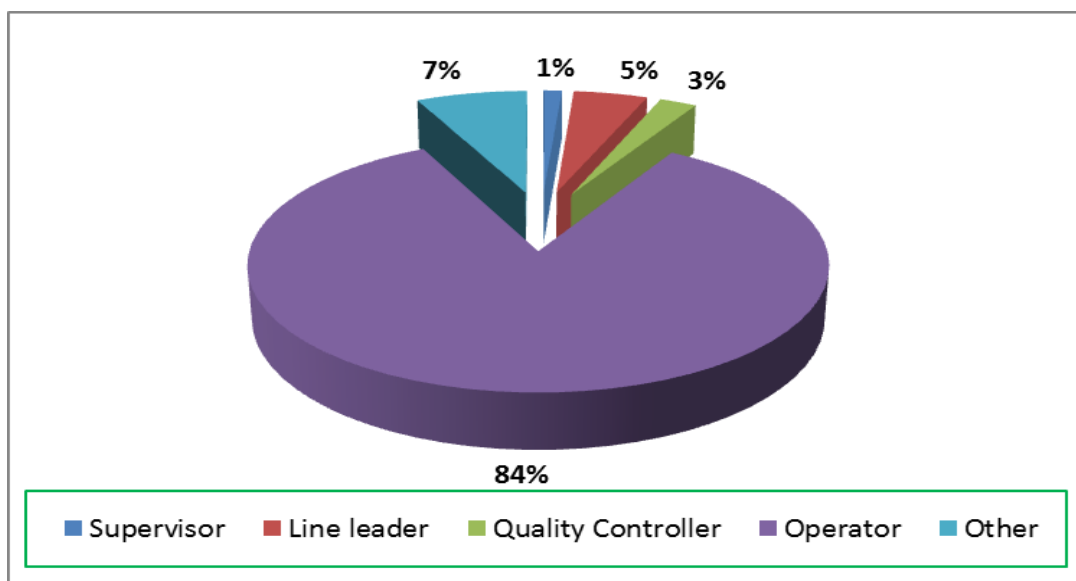
The age of employees were important as Anova tests were performed to determine the effect of employees' ages on problems experienced at work. The above results show that even though it appears as though younger employees experienced more problems at work, the differences with the other age groups were not significant.



		Per cent	Frequency	Valid Percent	Cumulative Percent
Valid	0 to 5 years	17.9	15	18.3	18.3
	6 to 10 years	26.2	22	26.8	45.1
	11 to 15 years	25.0	21	25.6	70.7
	16 to 20 years	15.5	13	15.9	86.6
	21 to 25 years	4.8	4	4.9	91.5
	More than 25 years	8.3	7	8.5	100.0
	Total:	97.6	82	100.0	
Missing:		2.4	2		
Total:		100.0	84		

Figure 8.1: Time employed at Company A

It was important to note that that the greatest percentage of 'time employed' fell in the categories of between 6 to 10 and 11 to 15 years (51.2%). This accounted for more than half of Company A's employees. Tests between the 'time employed' and the 'problems experienced at work' indicated that employees with less number of years of experience at Company A experienced significantly more problems at work. The chi-square test between time employed and contentment at work indicated that there was a significant association between employees who had shorter service at Company A and employees who had longer service. Employees who had shorter service at Company A were significantly less content than workers who had longer service.



		Per cent	Frequency	Valid Percent	Cumulative Percent
Valid	Supervisor	1.2	1	1.2	1.2
	Line leader	4.8	4	4.8	6.0
	Quality controller	2.4	2	2.4	8.4
	Operator	83.3	70	84.3	92.8
	Other	7.1	6	7.2	100.0
	Total:	98.8	83	100.0	
Missing:		1.2	1		
Total:		100.0	84		

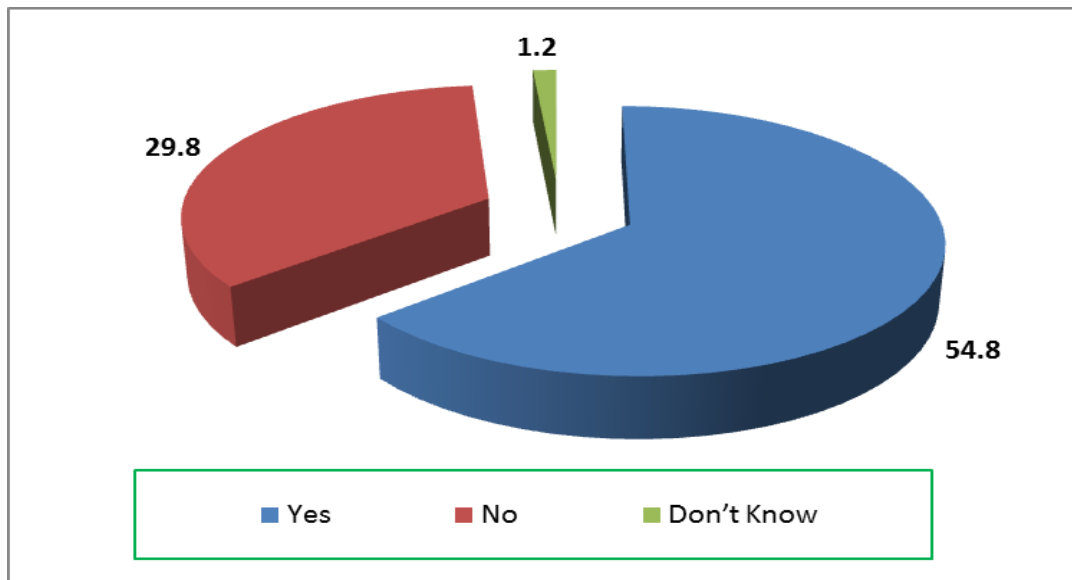
Figure 8.2: Position held at Company A

The majority of employees (83.3%) were found to be operators. A test between 'position held' and 'problems experienced' indicated that the operators seemed to experience the most problems at work. This was expected as these operators spent most of the time on the manufacturing process.

8.2.2 Category B: Psychological issues

Pryce-Jones (2012) states that a worker is simply less productive when he/she tries to balance the psychological contract between him/her and the employer. Under this category, the researcher obtained information that affected the employee at his/her workplace. Information in this regard comprised factors such as whether workers were aware of the company's mission statement, workers' feelings of working at Company A, the problems that workers encountered at work and whether these problems were resolved

timeously, their relationship with their manager and supervisory staff, the assistance which they received from Company A and whether they felt that they were recognised as an important part of the company. The aim was to ascertain the levels of employee morale. It must be noted that it is common knowledge that low employee morale affects performance. In the manufacturing sector, high employee morale is critical to the attainment of production outputs. Only 11.9% of employees at Company A indicated that they were aware of the company's mission statement.



		Per cent	Frequency	Valid Percent	Cumulative Percent
Valid	Yes	54.8	46	63.9	63.9
	No	29.8	25	34.7	98.6
	Don't know	1.2	1	1.4	100.0
	Total:	85.7	72	100.0	
Missing:		14.3	12		
Total:		100.0	84		

Figure 8.3: Employee satisfaction

Due to the literacy levels of the employees of the Company A, it was decided to ask a straight-forward 'Yes' or 'No' question regarding whether they were happy working at Company A. This was done primarily in order for the researcher to gain an indication, up front, of the satisfaction levels of employees at Company A. It is common knowledge that a happy worker performs better in the workplace. Pryce-Jones (2012) states that employees who are most productive are also the happiest workers. Happy workers help their colleagues 33% more than their least happy colleagues; raise issues that affect performance 46% more; achieve their goals 31% more and are 36% more motivated. As

many as 29.8% of employees at Company A indicated that they were unhappy. There was, however, a very large 14.3% of missing answers.

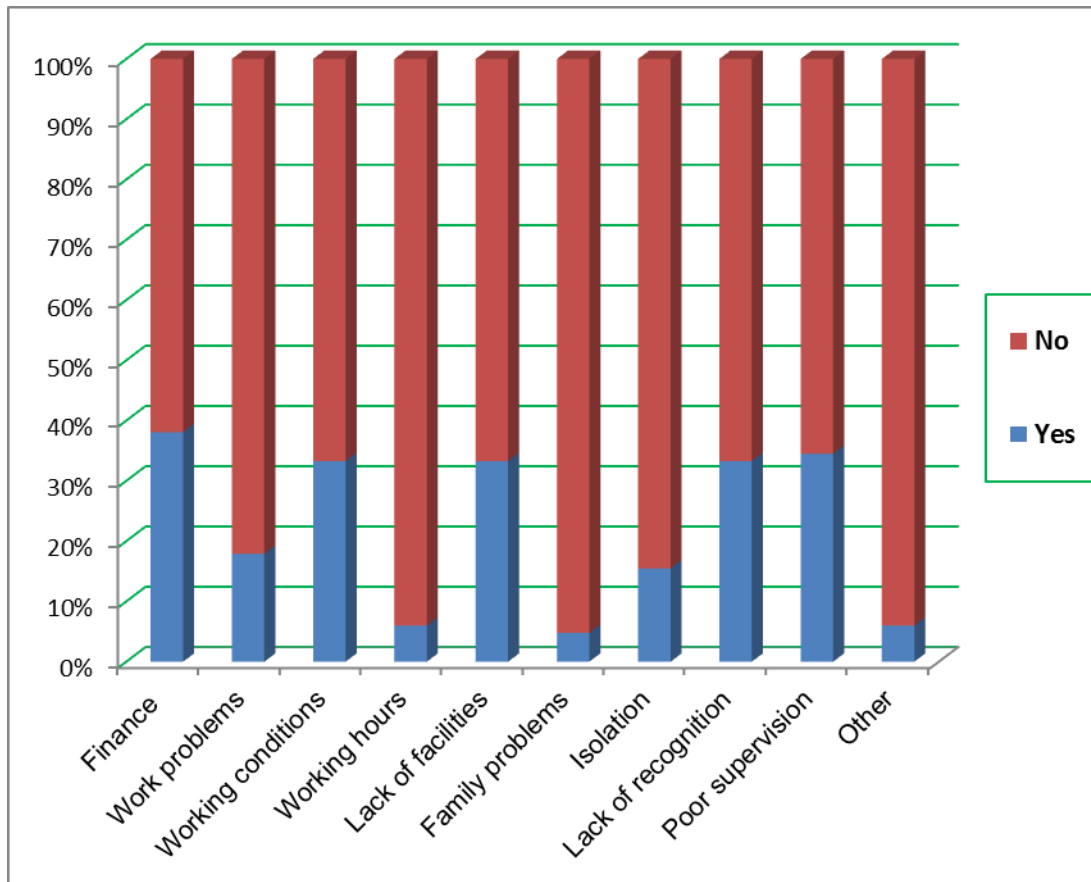


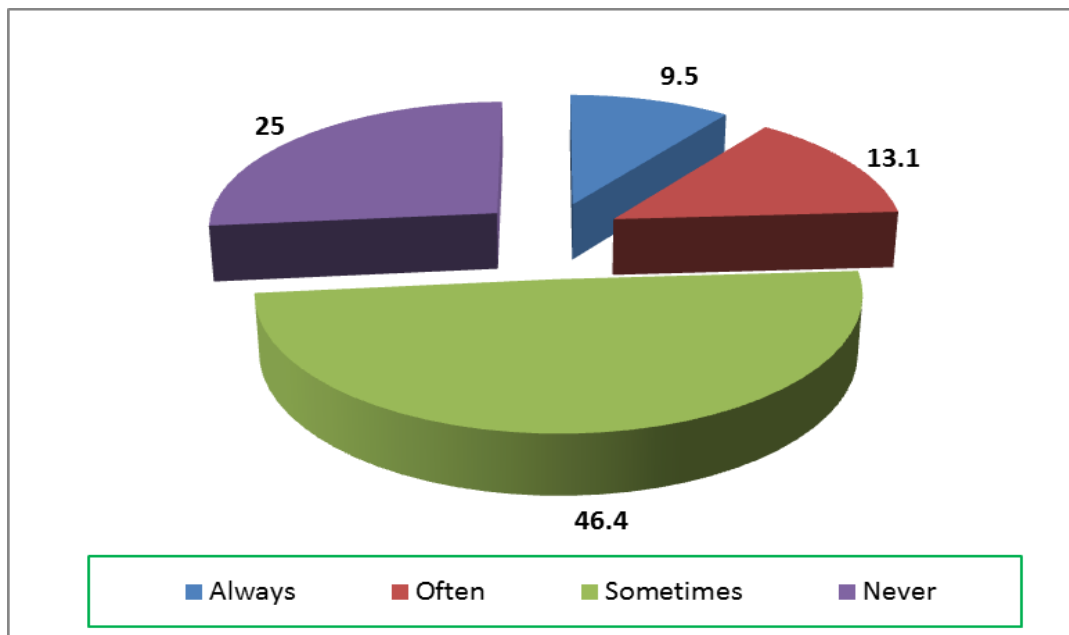
Figure 8.4: Problems experienced at work

The above ten categories of problems experienced at work were charted. Employees indicated that finance (38.1%), working conditions (33.3%), lack of facilities (33.3%), lack of recognition (33.3%) and poor supervision (34.5%) were the main problems that they experienced in the assembly department.

Table 8.2: Employee satisfaction versus mean number of problems experienced at work

Happy	N	Mean % score	Std deviation	Significance	
				*	**
Yes	46	17.3	17.18	0.0059*	0.0044*
No	25	30.8	21.96		

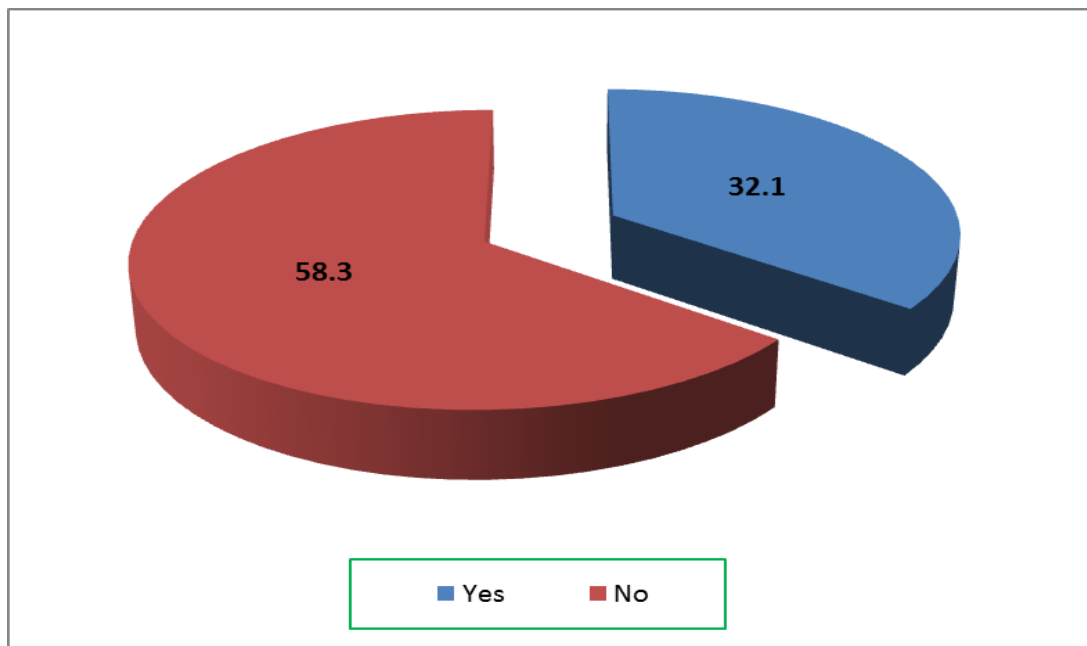
Employees who indicated that they were happy working at Company A, experienced significantly fewer problems at work than respondents who were unhappy.



		Per cent	Frequency	Valid Percent	Cumulative Percent
Valid	Always	9.5	8	10.1	10.1
	Often	13.1	11	13.9	24.1
	Sometimes	46.4	39	49.4	73.4
	Never	25.0	21	26.6	100.0
	Total	94.0	79	100.0	
Missing:		6.0	5		
Total:		100.0	84		

Figure 8.5: Problem resolution time

Employees were requested to indicate whether their problems were resolved timeously. Only 22.6% of employees indicated that their problems were resolved timeously. This had a significant effect on employee morale and performance. Chi-square tests revealed that there seemed to be an association between problem resolution time and employee satisfaction. Linked to this section, employees were requested to indicate whether management/supervisory staff were courteous towards them.



		Percent	Frequency	Valid Percent	Cumulative Percent
Valid	Yes	32.1	27	35.5	35.5
	No	58.3	49	64.5	100.0
	Total	90.5	76	100.0	
Missing	0	9.5	8		
Total		100.0	84		

Figure 8.6: Courteousness of supervisory staff towards employees

The majority of employees indicated that supervisory staff were not courteous towards them. Similar to the results of Figure 8.5, this had a significant effect on employee morale and performance. Chi-square tests between contentment at work and courteous behaviour of supervisory staff showed that a lack of courtesy by supervisory staff was associated with a lack of contentment. Workers also mentioned the following psychological issues:

- ***Assistance received from Company A:***

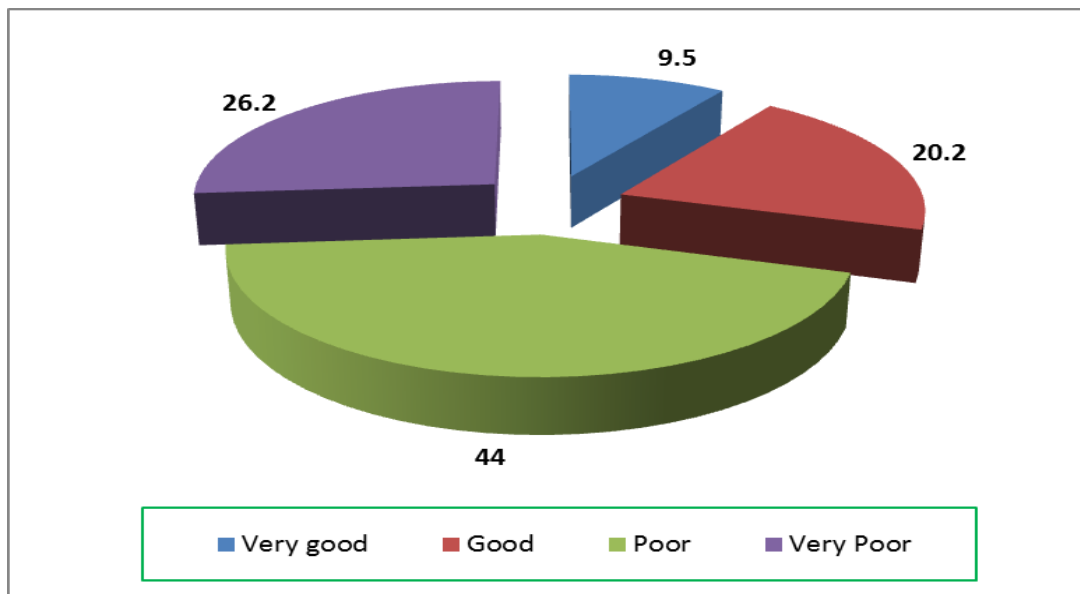
A very large percentage (44%) of employees indicated that assistance was poor.

- ***Recognition as part of Company A:***

A total of 54.8% of employees indicated that they did not feel that they were recognised as part of Company A.

- ***Being treated with respect by management:***

As many as 48.8% of employees indicated that they were not treated with respect. Chi-square tests also revealed that there was a significant association between recognition and contentment. It can therefore be concluded that the lack of recognition was a source of discontentment amongst employees at Company A.



		Percent	Frequency	Valid Percent	Cumulative Percent
Valid	Very good	9.5	8	9.5	9.5
	Good	20.2	17	20.2	29.8
	Poor	44.0	37	44.0	73.8
	Very Poor	26.2	22	26.2	100.0
	Total	100.0	84	100.0	

Figure 8.7: Rating of assistance received from Company A

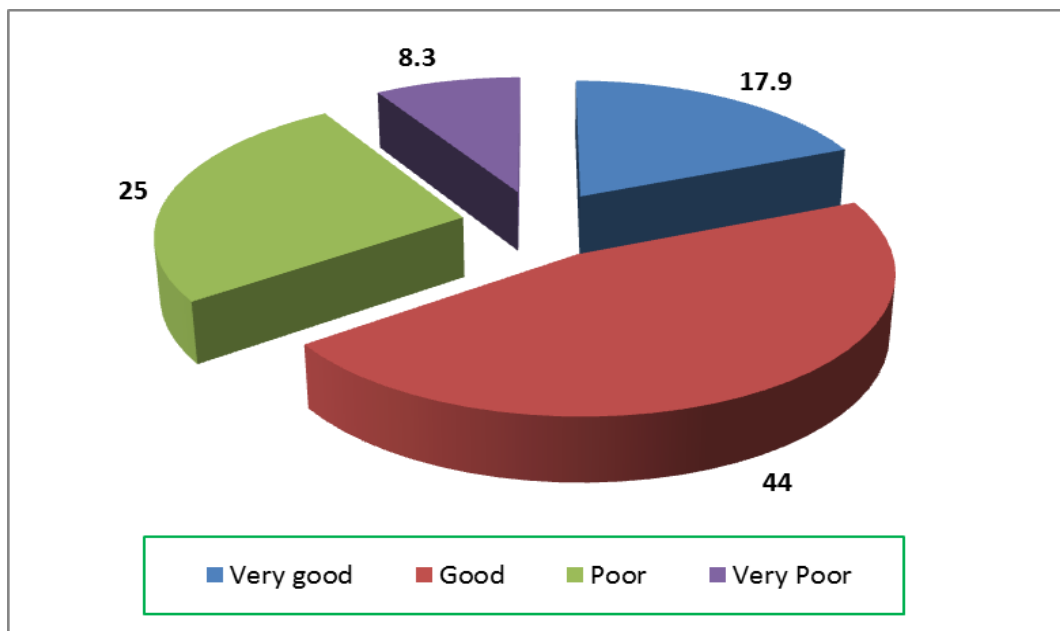
Employees were requested to rate the level of assistance which they received from Company A whenever they encountered problems. It was found that almost two thirds of employees indicated that they had received poor assistance. This could have had serious implications on employee performance as discontented employees normally do not perform to their full potential. Linked to the rating of assistance, it was found that 54.8% of employees did not feel that they were being recognised at Company A.

8.2.3 Category C: Management and supervisory issues

The aim of this category of the questionnaire was to elicit responses from employees regarding their relationships with management and supervisory staff. Issues are whether they had a job description, whether they were treated with respect by management, whether they were multi-skilled, and questions regarding their relationships with their supervisors and training.

A very large percentage (48.8%) of employees indicated that they were not treated with respect by management. General observations by the researcher indicated that this was not the case as the manager of the assembly department did not liaise or communicate directly with the employees. It was also observed that the line leaders treated the employees with respect.

An alarming statistic was that 45.2% of employees indicated that they did not have a job description. It is uncommon for a workplace, especially in manufacturing, to allow employees to work without a job description. Job descriptions are written statements that describe the duties, responsibilities and, most important, the contributions and outcomes needed from a position in an organisation. On a very positive note, the results indicated that 71.4% of employees were multi-skilled. This flexibility of employees assisted management to allocate employees to different tasks without being concerned about their skills level.



		Percent	Frequency	Valid Percent	Cumulative Percent
Valid	Very good	17.9	15	18.8	18.8
	Good	44.0	37	46.3	65.0
	Poor	25.0	21	26.3	91.3
	Very Poor	8.3	7	8.8	100.0
	Total	95.2	80	100.0	
Missing	0	4.8	4		
Total		100.0	84		

Figure 8.8: How would you rate your relationship with your supervisor?

A very high percentage (61.9%) of employees indicated that they had good relationships with their supervisors. Good employee/supervisor relations is the secret to healthy working relationships and subsequent high performance levels in an organisation.

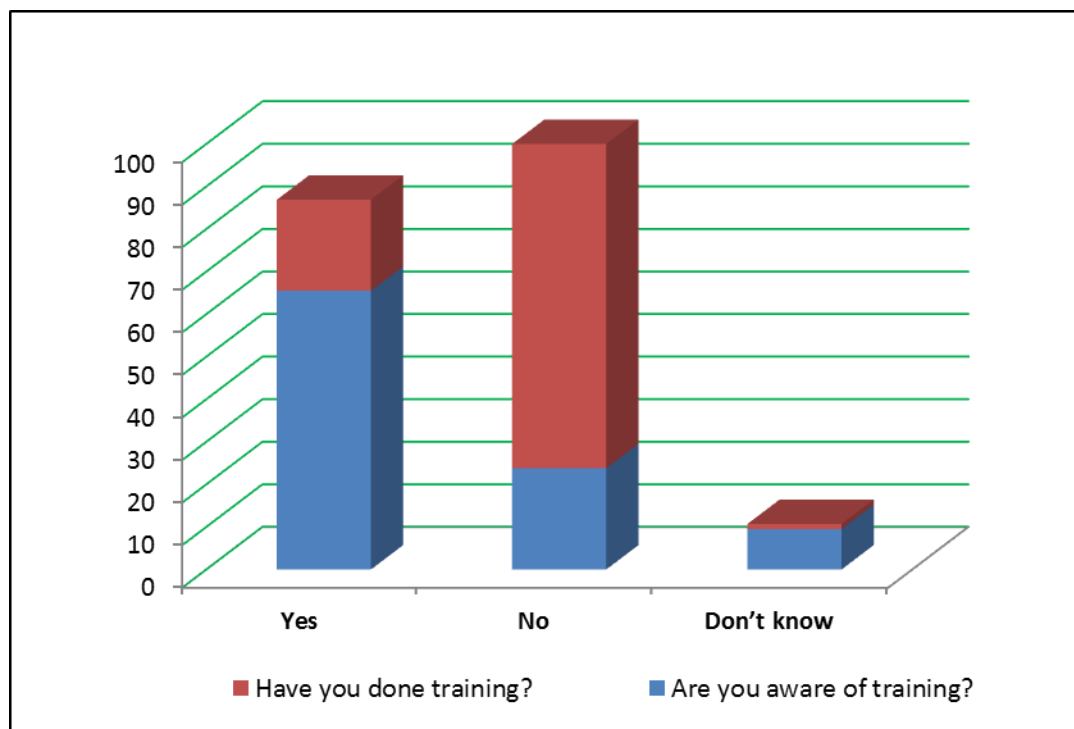


Figure 8.9: Training at Company A

There were three questions relating to training at Company A. The results indicated that 65.5% of employees were aware of training but only 21.4% had actually undergone training provided at Company A. The amount of training was dependent on the training budget that has been allocated by Company A. Due to the assembly department being highly labour-intensive, it is imperative that Company A train their employees to their full potential. The questionnaire featured one open-ended question with regard to the type of training that

employees had attended. Unfortunately, there were no responses to this question. Employees were also requested indicate what management could do to make their work better. Here again, no responses were received.

Further to the above analysis of category C, the statistician created a management and supervisory issue index. This part of the questionnaire consisted of the following questions:

- Q12. Do you feel that you are treated with respect by management?
- Q13. Do you have a job description?
- Q14. Are you multi-skilled? (Can you also work on other operations in the department?)
- Q15. How would you rate your relationship with your supervisor?
- Q16. Are you aware of any training that is offered by Company A?
- Q17. Have you undergone any training that was arranged by Company A?

All but Q15 had a response scale of 1 = Yes, 2 = No, and 3 = Don't know. The No and Don't know responses were equated to 0 and an index sum was calculated for each of the respondents for questions 12, 13, 14, 16 and 17. This index variable named Management and Supervisory Issues was expressed as a percentage, out of a maximum score of 5. Question 15 required the respondent to rate his/her relationship with his/her supervisor on a 4-point Likert-type scale that varied from 1 = Very good to 4 = Very poor.

ANOVA of Index score of Management and supervisory issues versus Rating of relationship with supervisor.

An ANOVA test was performed on the scores of the index variable Management and Supervisory Issues in an attempt to determine whether the rating of Q15 regarding respondents' relationship with the supervisor influenced the index score. The results of the ANOVA are shown below:

Table 8.3: Rating of relationship with supervisor versus index score of management and supervisory issues

Relationship with supervisor	N	Mean % score	Std deviation	Significance	
				*	**
				0.0002*	0.0007*
Very good	8	72.5	18.32		
Good	17	44.7	19.40		
Poor	37	32.4	23.26		
Very poor	22	32.7	27.97		
Level		Mean			
Very good	A	72.500000			
Good	B	44.705882			
Very poor	B	32.727273			
Poor	B	32.432432			

The levels that are not connected by the same letter are significantly different. It can be concluded from the above results that a 'Very good' relationship with the supervisor is reflected in a high index of management and supervisory perception. However, the index of management and supervisory issues is not influenced by gender, age, position, or years' service at Company A. There is a relationship between the index of management and supervisory issues and the psychological issues with regard to the following questions:

Table 8.4: Index of management and supervisory issues and the psychological issues

How would you rate the assistance that you receive from Company A when you have problems?	N	Mean	Std. dev.	Significance	
				*	**
Very good	8	72.50	18.32	0.0002*	0.0001*
Good	17	44.70	19.40		
Poor	37	32.43	23.26		
Very poor	22	32.72	27.97		
Note: Very good has a significantly larger mean than the other categories					
Are you aware of the mission statement of Company A?					
Yes	10	27.96	27.96	0.0610	0.0717
No	49	24.58	24.58		
Don't know	19	24.56	24.56		
Are you happy working at Company A?					
Yes	46	47.82	25.11	0.0002*	0.0002*
No	25	24.00	23.09		
Are problems that you encounter at work resolved timeously?					
Always	8	57.50	32.84	0.0537	0.0926
Often	11	45.45	26.96		
Sometimes	39	34.87	22.34		
Never	21	31.42	24.95		
Do you find the management/supervisory staff to be courteous towards you?					
Yes	27	51.81	26.75	0.0009*	0.0015*
No	49	31.02	24.17		
Do you feel that you are recognised as an important part of Company A?					
Yes	30	52.6	25.45	< .0001*	< .0001*
No	46	28.695	22.17		

The shaded values indicate significant differences. In all instances, an affirmative response to the psychological issue concerned has a higher management and supervisory index. This can be interpreted as follows. As management and supervisory issues include the relationship with the supervisor and training opportunities, the occurrence of good relationships and provision of training can have a direct influence on the psychological well-being of the staff at Company A. The majority of employees (60.53%) indicated that they did feel that they were recognised as an important part of the company.

8.2.4 Category D: Operational issues

Under this category, the researcher sought to determine whether employees encountered any problems with the work being carried out. Questions included, inter alia:

- whether Company A was a good company to work for;
- whether they understood the meaning of the term productivity;
- ways to measure productivity;
- the outputs of the assembly department;
- some of the problems encountered with production in the department;
- how management can improve the quality of work; and
- whether management motivates employees.

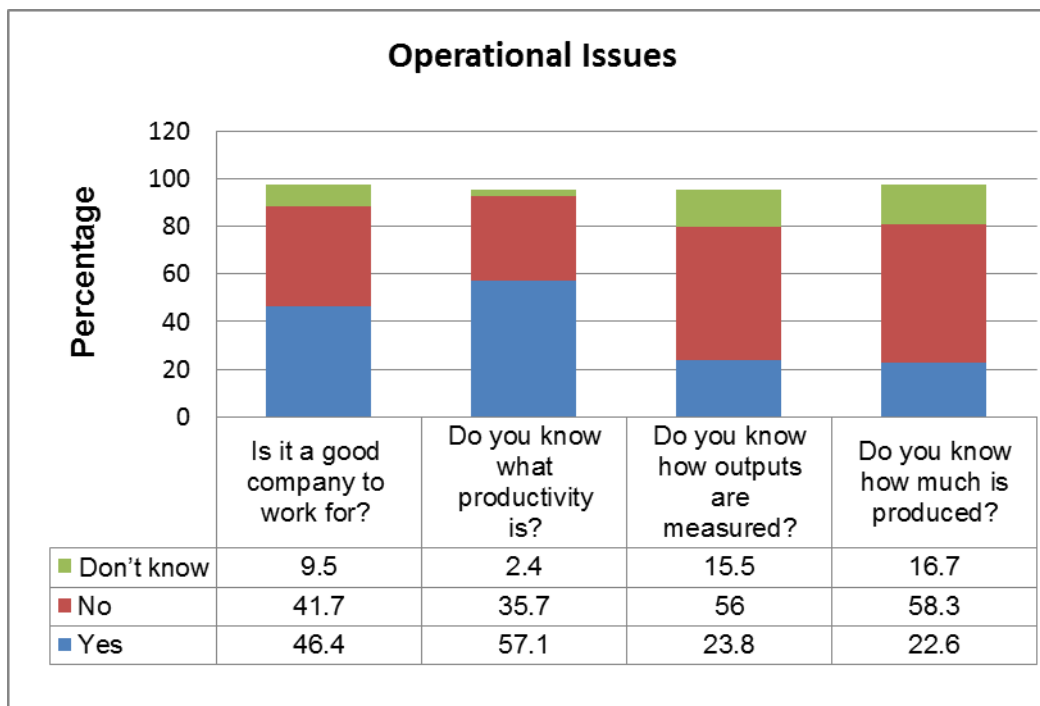


Figure 8.10: Operational issues

Employees were requested to indicate whether Company A was a good company to work for. It was found that a relatively high percentage (41.7%) answered negatively. It is very important that management take note of this issue and implement measures to address this as it is common knowledge that unhappy employees normally tend to be unproductive employees.

Very importantly, under this category, employees were asked to indicate whether they understood the term **productivity**. Heizer and Render (2014:49) define productivity as the ratio of outputs (goods and services) divided by one or more inputs (such as labour, capital or management). It was found that a total of 35.7% of employees mentioned that they did not understand the term. This begs the question how management can expect employees to perform to their maximum and to look at opportunities for productivity improvement if they do not understand the basics of productivity. It is imperative that management conduct training in the basics of productivity to inculcate a culture of productivity improvement at Company A.

Linked to the question on productivity, employees were asked whether they knew how Company A measured its outputs/productivity and whether they knew how many products were produced on a daily basis. Only 23.8% indicated that they knew how Company A measured its outputs/productivity, and only 22.6% were aware of how many products were produced daily. During observations in the assembly department and conversations with employees, it was found that employees had acquired the practical skills necessary to carry out the task at hand but lacked the theoretical knowledge of production, efficiency, productivity and performance management. This is indicative of the type of management that is output-driven without looking to develop the employee with 'soft' skills, which are a necessary and integral part of getting the best out of employees and the subsequent improvement of performance.

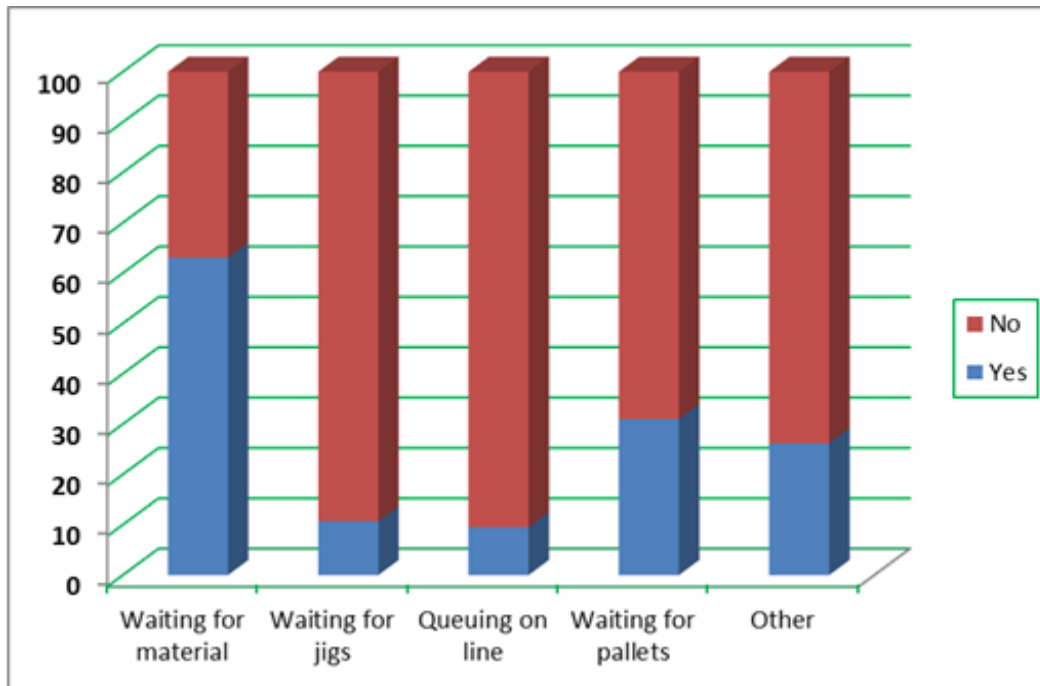


Figure 8.11: Problems encountered in production department

The researcher identified five primary problems which hindered effective production and employees were requested to indicate which of these problems they encountered the most.

- **Waiting for material.** Material refers to the components which are required in the assembly of taps. Employees sometimes had to wait for material to be delivered to them. This waiting time can be eliminated by ensuring that all components are made available before the operation begins.
- **Waiting for jigs.** Jigs are fixtures which are used to position the body of the tap, so that other components can be inserted to assemble the tap. At times, employees had to wait for a certain jig to be brought to his/her workstation.
- **Queuing on line.** This occurs when an assembly line employee leaves his/her station on the line. The taps queue up at that station until the employee returns and continues the assembly process. This also occurs when the line is not balanced and bottlenecks occur. Heizer and Render (2014:341) define a bottleneck as the limiting factor or constraint in the system. The line leader must be notified in advance so that he/she can use a substitute when an employee leaves a work station on the assembly line.
- **Waiting for pallets.** A pallet is positioned at the end of a line and the packed boxes are placed onto the pallet and then transported to the warehouse. It was observed that, at times, employees had to wait for a pallet to be delivered to their work station.

The results revealed that the major production problem was waiting for material (63.1%). This signifies that the assembly process was often held up due to non-delivery of assembly components.

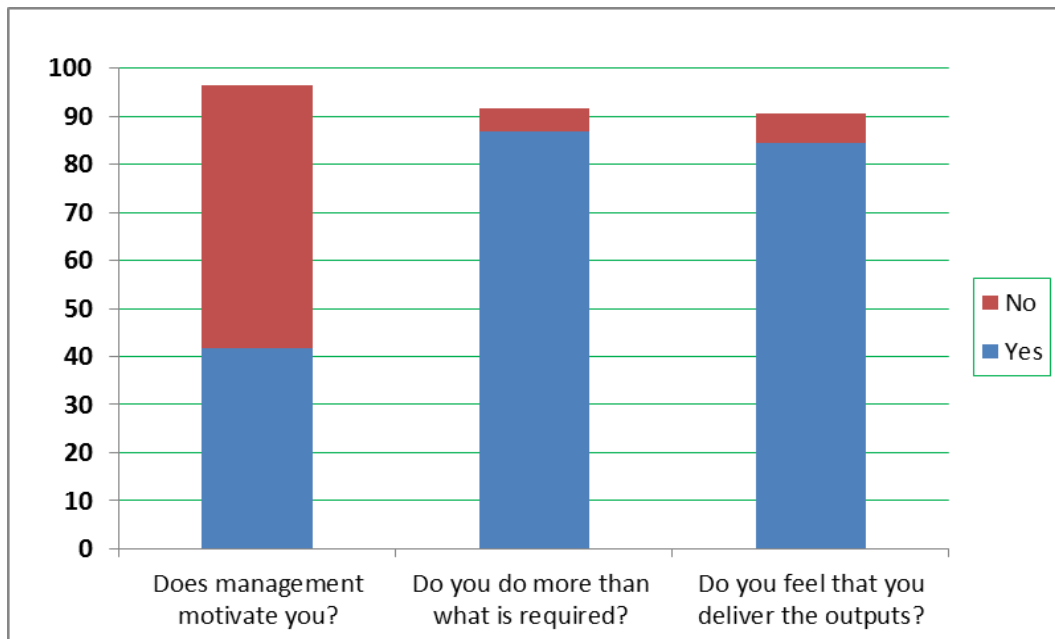


Figure 8.12: Operational issues (2)

Figure 8.12 depicts the results of three questions with regard to operational issues. A total of 54.8% of employees indicated that management does not motivate them to perform well. This was backed up by the researcher's observation that the departmental manager did not engage the employees. A very high percentage (86.9%) of employees felt that they did more than what their work required of them, and 84.5% indicated that they delivered the required outputs in terms of their work at Company A.

8.2.5 Category E: Support mechanisms and benefits

In this category, the researcher attempted to obtain responses regarding the support mechanisms and benefits that were offered by Company A. Issues included a clinic, canteen facilities, HIV counselling, study assistance schemes, on the job training, etc.

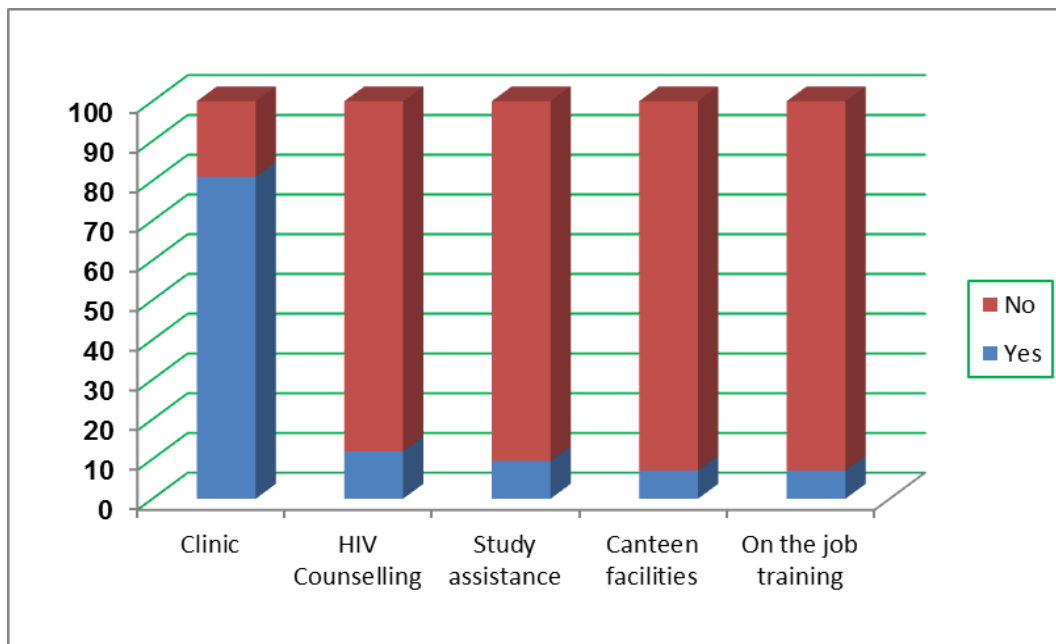


Figure 8.13: Extent of support mechanisms and benefits provided to staff

Employees indicated that support mechanisms, for example HIV counselling, study assistance, canteen facilities and training were lacking. However, 81% indicated that there was a clinic available to them. The results revealed that only 7.1% of employees indicated that there was in-service training available at Company A. However, in Figure 8.9 above, the results indicated that 65.5% of employees were aware of training and 21.4% had actually undergone training.

The assembly department employees made their own tea and coffee and consumed their meals alongside the assembly line. This is not conducive to the health and safety of employees and the organisation and is not allowed in most organisations. Proper canteen and ablution facilities are compulsory for employees of any organisation.

It was also found that Company A did not provide incentives for outstanding performance. Overtime work was the norm in the department and employees (95.2%) mentioned that they worked overtime; however, 59.5% indicated that they were not given sufficient notice when asked to work overtime. This displays poor planning as a shortcoming on the part of management.

8.2.6 Category F: Health and safety issues

It is the responsibility of any organisation to ensure a safe and healthy working environment for its employees. A safe and healthy working environment boosts employee morale and inevitably improves productivity. Under this category, the researcher attempted to elicit

responses from employees regarding the perceptions of health and safety at Company A. Questions included

- whether they felt that they were working in a safe environment;
- whether personal protective equipment (PPE) was provided;
- the existence of a safety policy; and
- whether they felt that they were working in a safe environment. A safe and healthy working environment boosts employee morale and inevitably improves productivity.

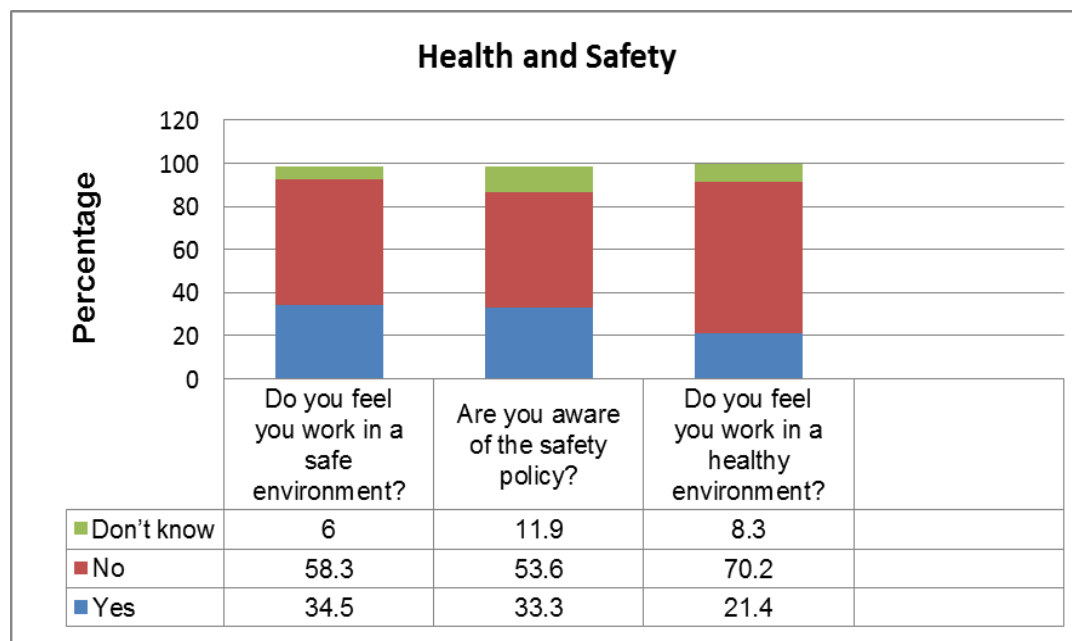


Figure 8.14: Health and safety

It was found that almost two thirds of the employees had concerns when it came to health and safety at Company A. Only 34.5% felt that Company A provided a safe working environment. As many as 65.5% were not aware of the company's safety policy, and only 21.4% felt that they worked in a healthy environment. Management needs to revisit their health and safety policy and determine to which extent they need to improve it in order to ensure a safe and healthy working environment for their employees.

8.3 ANALYSIS AND INTERPRETATION OF QUESTIONNAIRE 2

The main aim of Questionnaire 2 was to gather critical responses to determine whether manufacturing organisations have performance standards and measurement criteria for their manufacturing processes and also to gain insight into the availability of ERSs. The

questionnaire was forwarded to eight hundred (800) respondents in manufacturing organisations in South Africa.

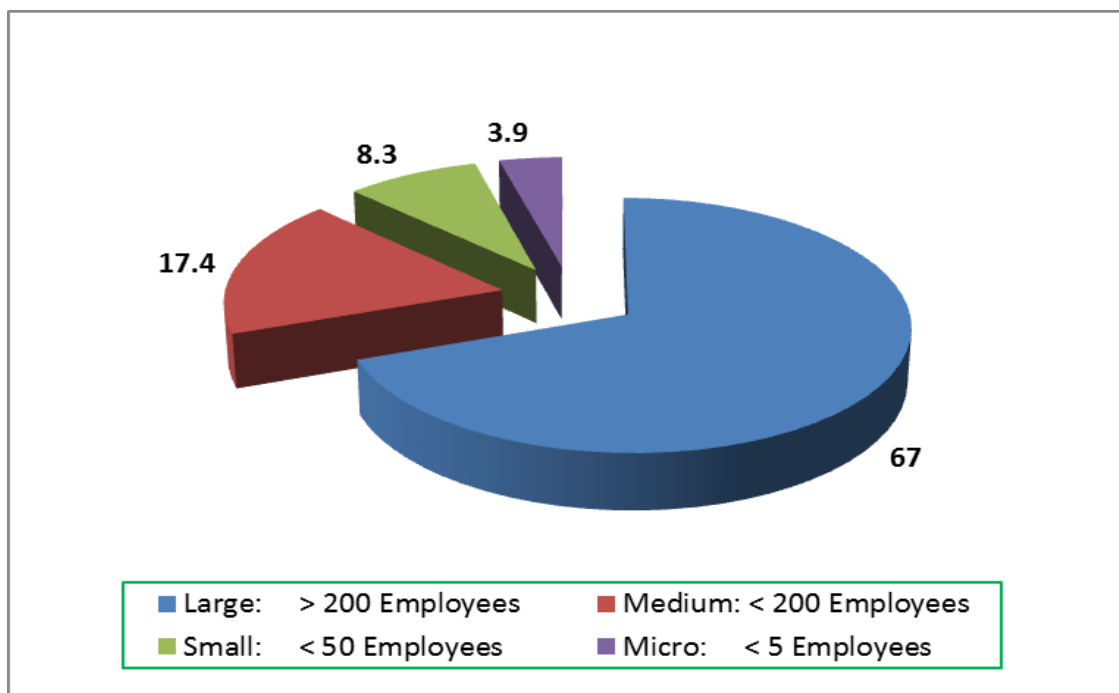
Descriptive analyses of the fifteen questions were performed to look at the distribution of the respondents. The researcher then selected certain questions that were relevant to the outcome of this study and performed cross-tabulations and chi-square tests. The aim was to see whether there were any associations between the selected questions in order to justify the need for an ERS. See Annexure G for the cross-tabulations.

8.3.1 Analysis of Questionnaire 2

The following shows the analyses of questionnaire 2. See Annexure C for Questionnaire 2 and Annexure G for the descriptive analysis.

Q01. Would you identify your organisation as?

Respondents were requested to state into which category their organisation fell, i.e. large, medium, small or micro, with the large organisations being 'greater than 200 employees' and micro being 'less than 5 employees'. There were four options.



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid:	Large: > 200 employees	154	67.0	69.4	69.4
	Medium: < 200 employees	40	17.4	18.0	87.4
	Small: < 50 employees	19	8.3	8.6	95.9
	Micro: < 5 employees	9	3.9	4.1	100.0
	Total:	222	96.5	100.0	
Missing	System	8	3.5		
Total:		230	100.0		

Figure 8.15: Number of employees

The majority of respondents indicated that their organisations were 'large' meaning that they had more than 200 employees.

Q02. The annual turnover of your organisation is:

Respondents had to choose whether their organisation's turnover was 'less than R100 000' to 'greater than R50 million'. There were six options.

Table 8.5: Annual turnover of your organisation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than R100 000	16	7.0	7.3	7.3
	R 100 000 to R500 000	9	3.9	4.1	11.4
	R 500 000 to R1 000 000	20	8.7	9.1	20.5
	R 1 000 000 to R10 million	35	15.2	15.9	36.4
	R 10 million to R50 million	44	19.1	20.0	56.4
	> R 50 million	96	41.7	43.6	100.0
	Total:	220	95.7	100.0	
Missing	System	10	4.3		
Total:		230	100.0		

Q03. How long has your organisation been in existence?

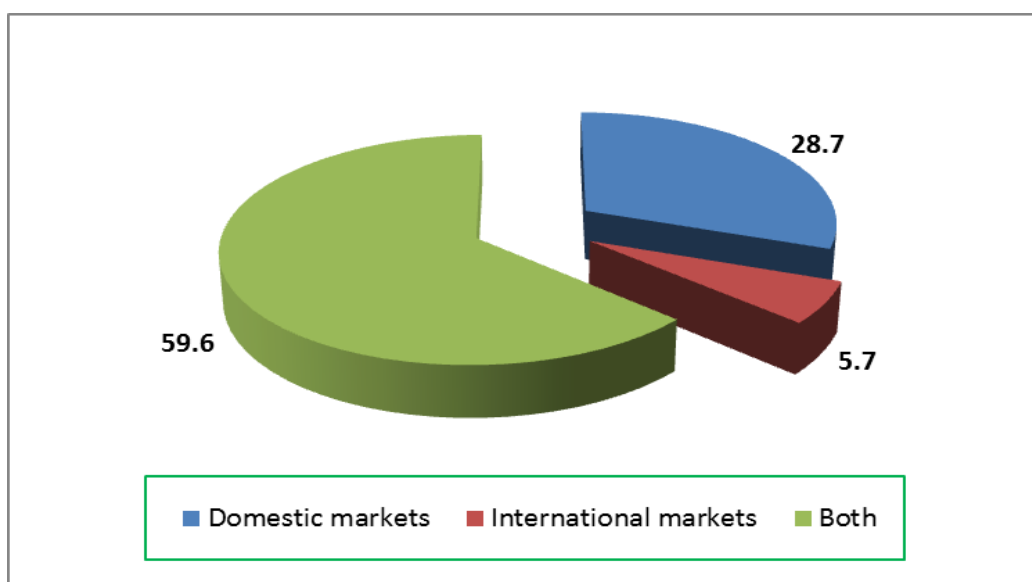
Respondents had to indicate the duration that their organisation was functioning. Choices ranged from '0–1 year' to 'greater than 5 years'. There were five options. At the time of this research, a very large percentage (77.8%) had been in existence for more than 5 years.

Q04. Which of the following sector does your organisation fit into?

This question required respondents to indicate into which sector their organisation fell. Choices ranged from 'Food and beverages' to 'Furniture'. There were eleven options with the eleventh being 'Other'. The majority of the respondents indicated 'Food and beverages' (31.75), followed by 'Petroleum, chemical products, rubber & plastic products' (19.8%) and 'Iron and steel, metal products & machinery' (14.9)%.

Q05. Your company supplies products to:

Respondents had to indicate whether their organisation supplied products to domestic markets, international markets or both markets. A total of 63.4% of organisations supplied products to both the domestic and international markets.



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Domestic markets	66	28.7	30.6	30.6
	International markets	13	5.7	6.0	36.6
	Both	137	59.6	63.4	100.0
	Total:	216	93.9	100.0	
Missing	System	14	6.1		
Total:		230	100.0		

Figure 8.16: Markets

Q06. Does your company currently have work study, industrial engineering or a productivity department?

This question requested respondents to indicate whether their organisation presently had a work study, industrial engineering or productivity department. The fourth choice was 'None of the above'. A total of 23.9% respondents indicated that they had a work study department and 19.1% indicated that they had an industrial engineering department. The above results imply that only the very small number of organisations that had a work study department, would normally have had time standards and monitoring systems for their processes.

Q07. Which of the following process types is applicable to your organisation?

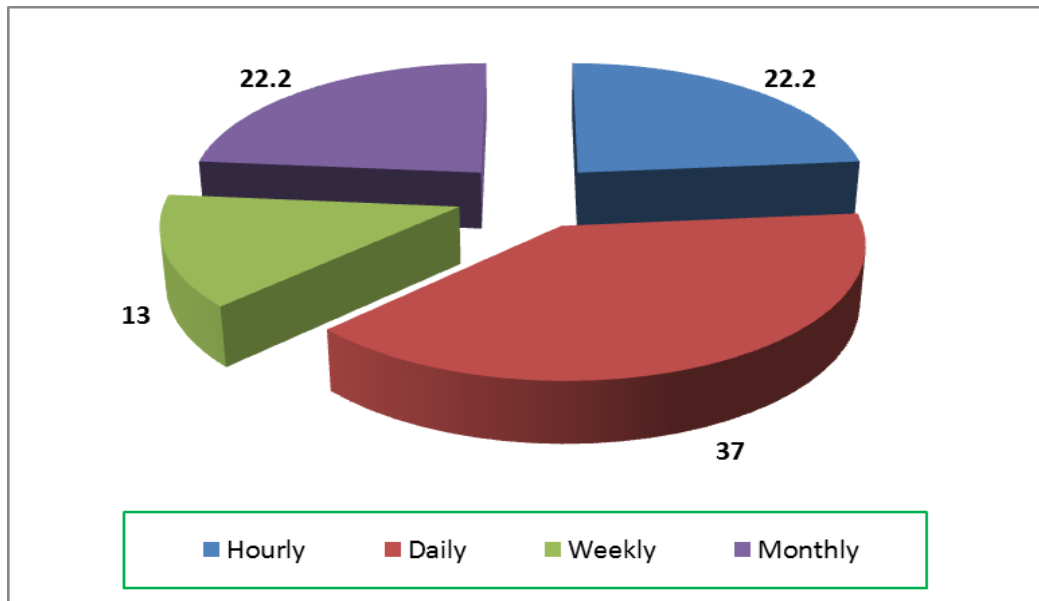
The choices here ranged from 'Job shop production' to 'Project type'. There were five choices with the fifth being 'Other'. The aim was to determine the different types of production processes of the organisations. The majority of respondents indicated that they employed the 'continuous production process'.

Q08. How do you monitor your production outputs?

Respondents were asked to indicate whether their production outputs were monitored via 'Daily production reporting', 'Rand value of outputs' or any other. There were eight choices, with the ninth choice being 'Other'. This was a very important question regarding the study as it aimed at determining how organisations monitored their production outputs. Only 28.3% of respondents indicated that they monitored their production via an ERS. This provided justification for the necessity of an ERSs for organisations in South Africa. A total of 22.6% of organisations monitored their production outputs via 'Rand value of outputs', which was similar to Company A.

Q09. When do you analyse your finished products' production?

This question merely requested respondents to indicate whether they analysed their production hourly, daily, weekly or monthly.



		Frequency	Per cent	Valid per cent	Cumulative per cent
Valid	Hourly	51	22.2	23.5	23.5
	Daily	85	37.0	39.2	62.7
	Weekly	30	13.0	13.8	76.5
	Monthly	51	22.2	23.5	100.0
	Total	217	94.3	100.0	
Missing	System	13	5.7		
Total		230	100.0		

Figure 8.17: Duration of analysis

A small percentage (23.5%) of respondents indicated that they analysed their finished products on an hourly basis. The advantage of analysing finished products on an hourly basis is simply that all non-conformances in product manufacture can be identified early (through inspection) and corrective action can be taken to eliminate the non-conformances. It is of no value to identify an error in the manufactured product at the end of a shift. All those products that were manufactured will be rejected and/or will need to be sent for rework.

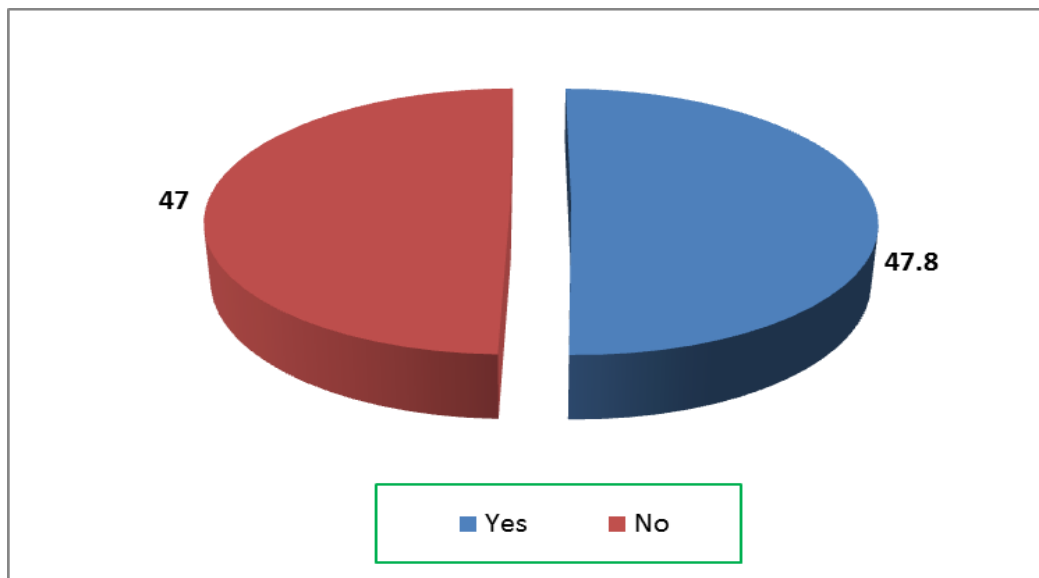
Q10. How were production targets developed?

Respondents were requested to indicate the methodology used to develop their production targets. Options ranged from 'Work measurement' to 'Work study department'. There were ten options. Production targets need to be realistic and achievable and therefore need to be compiled by qualified personnel. Work study and industrial engineering department personnel should have the skills and experience to compile such targets. Only 13.5% of

respondents indicated that their production targets were set by work study and only 10% were set by industrial engineering staff.

Q11. Does your organisation currently have time standards for processes developed by work study or industrial engineering?

Time standards are critical for measuring production outputs. Here, respondents were requested to indicate whether their time standards were set by either work study or industrial engineering staff. The researcher required a simple 'Yes' or 'No' response from the participants.



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	110	47.8	50.5	50.5
	No	108	47.0	49.5	100.0
	Total	218	94.8	100.0	
Missing	System	12	5.2		
Total		230	100.0		

Figure 8.18: Time standards

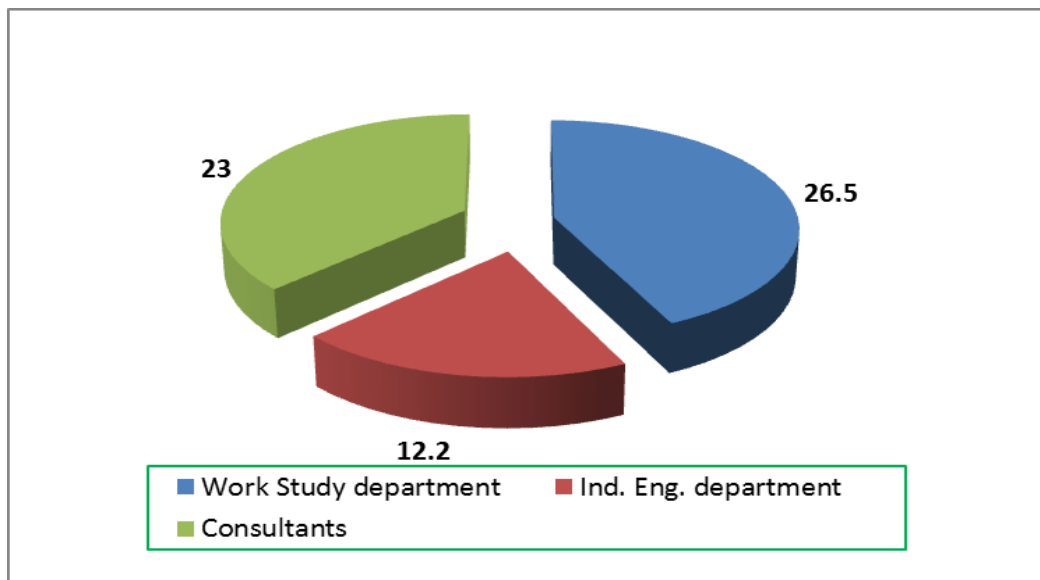
It can be seen from the above that 49.5% of respondents indicated that time standards were not set by either work study or industrial engineering. This is alarming as it was obvious that almost half of the organisations surveyed did not have proper time standards. This could lead to inaccurate production reporting and can disadvantage employees.

Q12. Does your organisation currently have an ERS?

This was probably the most important question as this formed the basis of the present study. Similar to Q11, the researcher required a simple 'Yes' or 'No' response from the respondents. A total of 78.9% of respondents indicated that their organisations did have an ERS. The quality of the system came into question as only 13.5% of respondents indicated that their production targets were set by work study and only 10% were set by industrial engineering (See Q10).

Q13. The time standards were set by which of the following:

This question required the respondents to indicate whether the time standards were set by a work study department, an industrial engineering department or whether the standards were set by consultants. The fourth option was 'Other'.



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Work study department	61	26.5	43.0	43.0
	Ind. eng. department	28	12.2	19.7	62.7
	Consultants	53	23.0	37.3	100.0
	Total	142	61.7	100.0	
Missing	System	88	38.3		
Total		230	100.0		

Figure 8.19: Time standards

In response to this question, 43% indicated that time standards were set by work study and only 19.7% were set by industrial engineering. In Q6, 23.9% respondents indicated that they

had a work study department and 19.1% indicated that they had an industrial engineering department. Contrary to this, only 13.5% of respondents indicated that their production targets were set by work study and only 10% were set by industrial engineering (see Q10) and in Q11, 50.5% of respondents indicated that time standards were set by either work study or industrial engineering.

Q14. *Who is responsible for recording and calculating the efficiency in your organisation?*

The aim of this question was to determine who in the organisation recorded and calculated the company's efficiency. The options ranged from the clerk or the supervisor to the manager. The fourth option was 'Other'. Here, 66.3% of respondents indicated that the manager was responsible for recording and calculating the efficiency in their organisation.

Q15. *What does your organisation do with the results?*

Respondents were requested to indicate for which purposes the calculated efficiencies were utilised. Options differed from being 'Discussed at production meetings' to 'Staff are notified of the results'. There were five options and respondents had to indicate their choice by (1) representing 'Agree strongly' to (5) representing 'Disagree strongly'.

The respondents indicated that the efficiency results were discussed at production meetings and it was also used to take corrective action. A total of 46.7% indicated that the results were used to show the performance of the department.

8.4 THE EFFICIENCY REPORTING SYSTEM (ERS)

The ERS is the output of this study and the following provides an explanation of the ERS.

8.4.1 Introduction

The methodology used to design and develop the ERS as the output of this study is presented below. The researcher firstly conducted method studies to improve the method of working in the assembly department of Company A, and then conducted work measurement to determine the standard times of the different processes involved in the assembly of taps. The complete assembly processes of selected taps were broken down into separate steps, and the duration of each step was determined using universally accepted timing techniques. Thereafter, rest and contingency allowances were allocated to calculate standard times. See Annexure H for a list of standard times of the other taps that were used in this study.

8.4.2 Explanation of the functioning of the ERS

The following provides an explanation of the compilation of the ERS and the procedure for determining the efficiency per hour.

Table 8.6 shows the standard time one tap (Tap A). The assembly process of Tap A consisted of seven steps. Each step was timed using a stopwatch and a rating was allocated. Thereafter, the actual time was calculated, allowances allocated and a standard time for this tap was developed. See Annexure H for the list of the analyses of the standard times of the taps that were used in this study.

Table 8.6: Time study analysis: TAP A

TAP A							
Step number	Basic time	Freq.	Selected basic time	RA %	CA %	Other allow.	Actual time
1	0.153	1/1	0.153	12	0.007	0	0.171
2	0.154	1/1	0.154	12	0.007	0	0.172
3	0.103	1/1	0.103	12	0.005	0	0.115
4	0.096	1/1	0.096	12	0.004	0	0.107
5	0.129	1/1	0.129	12	0.006	0	0.144
6	0.101	1/1	0.101	12	0.005	0	0.113
7	0.069	1/1	0.069	12	0.003	0	0.077
			0.805		0.036		
Total actual time							0.899
Contingency allowance (%)							0.036
Standard time							0.935

Table 8.7 shows a summary of the various taps that were used for the development of the ERS. Note that only five standard times of taps were used for this study. In reality, there could be a variety of products and hence, a separate standard time for each product. Therefore, irrespective of the number of products being assembled (as in the case of Company A) or manufactured by any organisation, the same principle of determining standard times will apply.

Table 8.7: Summary of standard times of various taps

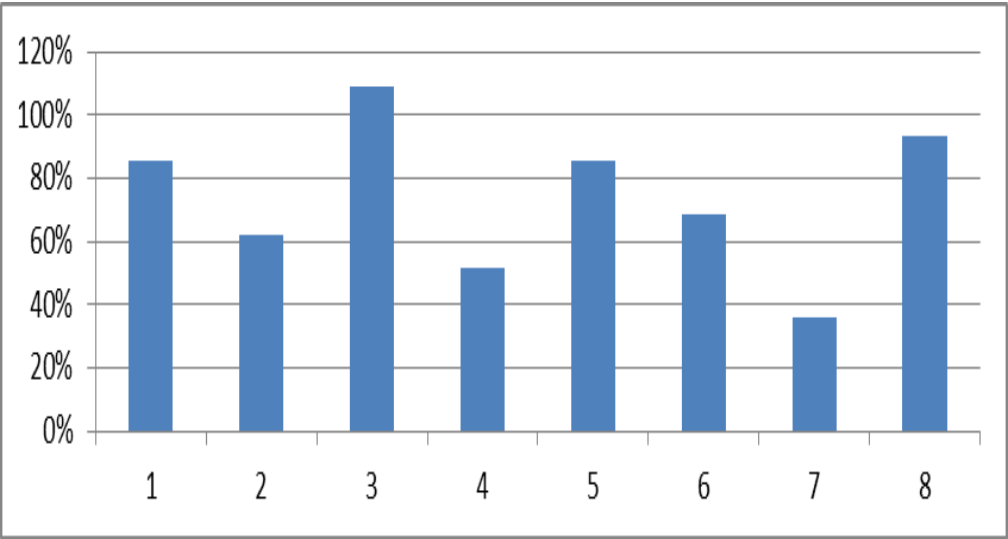
Tap number	Basic time	Allowances	Standard time
Tap A	0.899	0.036	0.935
Tap B	0.830	0.032	0.862
Tap C	0.808	0.036	0.844
Tap D	0.917	0.036	0.953
Tap E	1.045	0.036	1.081
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	0.000	0.000
12	0.000	0.000	0.000

Table 8.8: Example of the ERS: for 3 lines

Date: 01/06/2013
Captured by: B. Sookdeo

	TapA 1							
Line 1	08:00 to 09:00	09:00 to 10:00	10:00 to 11:00	11:00 to 12:00	12:00 to 13:00	13:00 to 14:00	14:00 to 15:00	15:00 to 16:00

Actual output/hours	55	40	70	33	55	44	23	60
Actual time per item	1.091	1.500	0.857	1.818	1.091	1.364	2.609	1.000
Cumulative output	1.091	2.591	3.448	5.266	6.357	7.721	10.329	11.329
Standard Output/hour	0.935	0.935	0.935	0.935	0.935	0.935	0.935	0.935
Standard Cumulative	0.935	1.87	2.805	3.74	4.675	5.61	6.545	7.48
% Efficiency / hour	86%	62%	109%	51%	86%	69%	36%	94%

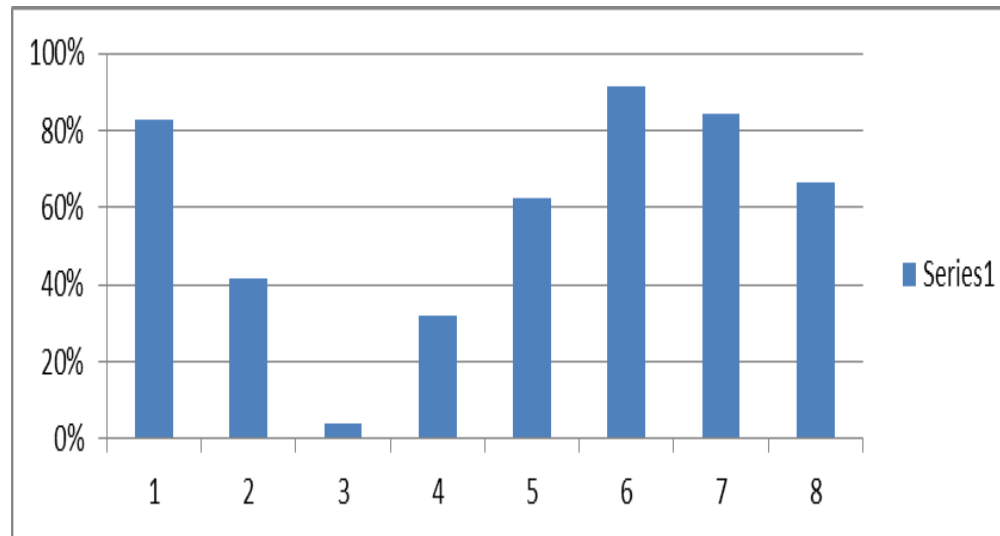


	Hours							
Line 2	1	2	3	4	5	6	7	8

TapB ▼

2

Actual output/hours	60	30	3	23	45	66	61	48
Actual time per item	1.000	2.000	20.000	2.609	1.333	0.909	0.984	1.250
Cumulative output	60	90	93	116	161	227	288	336
Standard Output/hour	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Standard Cumulative	0.83	1.66	2.49	3.32	4.15	4.98	5.81	6.64
% Efficiency / hour	83%	42%	4%	32%	62%	91%	84%	66%

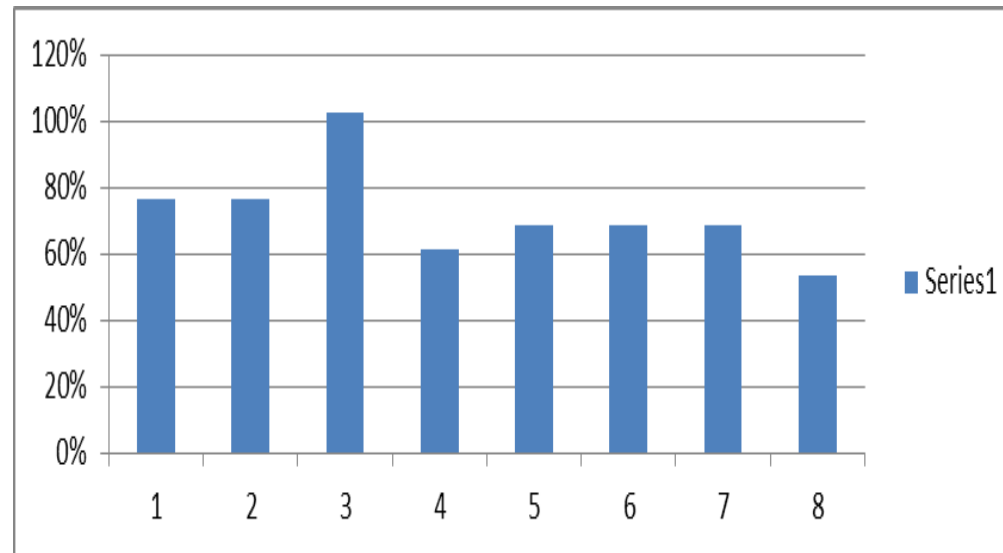


	Hours							
Line 3	1	2	3	4	5	6	7	8

TapD ▼

4

Actual output/hours	50	50	67	40	45	45	45	35
Actual time per item	1.200	1.200	0.896	1.500	1.333	1.333	1.333	1.714
Cumulative output	50	100	167	207	252	297	342	377
Standard Output/hour	0.917	0.917	0.917	0.917	0.917	0.917	0.917	0.917
Standard Cumulative	0.917	1.834	2.751	3.668	4.585	5.502	6.419	7.336
% Efficiency / hour	76%	76%	102%	61%	69%	69%	69%	53%



8.5 CHAPTER REVIEW

In this chapter, the results and discussion of the findings of the empirical study were presented. The chapter also comprised the analyses of the two questionnaires. Tables and figures outlining the analyses of the questionnaires were compiled. The ERS that was developed was also presented.

In the next chapter, the conclusions and recommendations of the study are presented.

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

9.1 INTRODUCTION

Manufacturing organisations in South Africa are annually beset by labour unrest with employees in constant demand for increased remuneration. 'Strike season' seems to have become a norm in the South African calendar year. The researcher is of the opinion that an increase in remuneration must be combined with a simultaneous increase in productivity to allow for a win-win situation between the employer and employee. It is evident from the literature that, in order to realise this improvement in productivity, it is necessary that organisations calculate their productivity. If an organisation does not measure its performance, it would not be practical to calculate its productivity. This gives credence to the necessity of an ERSs in organisations and hence, the need for this study. The research question of this study – 'Which framework can organisations use to measure their performance? – formed the main focus of this study.

This chapter presents the conclusions and recommendations drawn from the findings and addresses the aim of this study which was to develop an ERS using work study methodologies and making it available to organisations.

9.2 SYNOPSIS OF THE THESIS

A synopsis of the study thus far has Chapter 1 outlining an introduction to the thesis, the present position, the problem statement, the research questions, the aims and objectives of the study. The motivation for the study was set out as being based on the premise that organisations that do not use work study methodologies to develop ERSs face a bleak prospect of survival.

Chapter 2 focused on the research design, methodology and the research approach. Chapter 3 comprised a comprehensive literature review on the concept of productivity and related methodologies. Some of the methodologies used by organisations for effectiveness were also surveyed. Chapters 4 and 5 presented literature reviews of the main topic of this study, namely

work study and work study techniques, respectively. Chapter 6 presented the data collection and analysis procedures. This included the two work study techniques and the two research instruments. Chapter 7 (Results and discussion of findings, Part 1) presented the results and a discussion of the findings of the method study and work measurement investigations and the departmental layouts. Chapter 8 (Results and discussion of findings, Part 2) presented the analyses and interpretation of the two research instruments and the ERS. The data from the two research instruments (empirical findings) were analysed and included. Chapter 9, the final chapter, begins with a synthesis of the literature review and the gaps. The research question and the research objectives set in Chapter 1 are revisited and reviewed to determine the exact extent to which they had been answered and achieved. The limitations of the study will also be reported upon. In the recommendations, the researcher will chart the way forward and make recommendations for further research. Figure 9.1 presents an illustrative synopsis of the study:

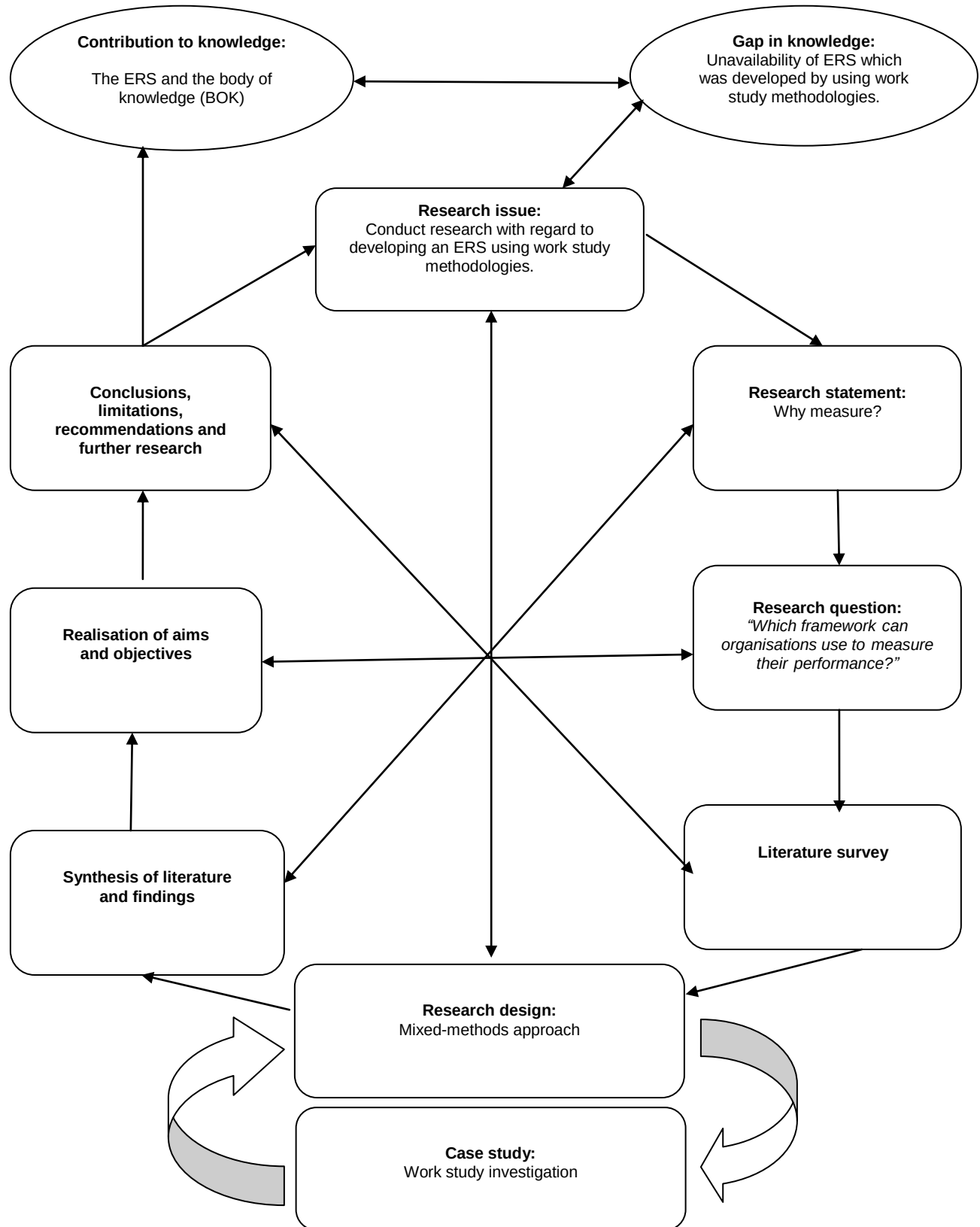


Figure 9.1: Synopsis of the study

9.3 SYNTHESIS OF LITERATURE REVIEW

In summary, the following is a synthesis of the literature that was surveyed.

9.3.1 Productivity and related methodologies

The concept of **productivity** was explained, with examples showing how productivity can be measured. This would be most beneficial to those organisations that do not measure their productivity. It must be emphasised that if organisations do not measure their productivity, they will not be able to determine whether they are profitable or not. It was therefore determined that in order to improve productivity, the ratio of outputs must be greater than the inputs (see 3.2). Management must continuously aim to achieve the most productive use of their organisational resources. They must also ensure that employees work effectively and efficiently. If the turnover of an organisation has increased, it means that the enterprise produced more of a specific product or service, compared to a previous corresponding period, providing that the increase was not as a result of a price increases.

The main responsibility of an operations manager is to ensure that productivity is improved. The sustainability of an organisation, the economy of a country and the standard of living are directly related to the capability of utilising resources optimally. Further to this, literature on various management aids that were developed through the years to assist managers in their daily functions and to ensure the efficiency and effectiveness of their organisations were surveyed (see 3.3). This was primarily done in order to create an awareness of the various aids that were available to management at the time of the present research. The literature survey on ergonomics (see 3.7) assisted to identify poor ergonomic practices in the assembly department at Company A, which subsequently lead to musculoskeletal injuries of which employees are unaware.

The efficiency criterion upon which the ERS was developed relates to how well an organisation is capable of measuring its performance. This relates back to the introduction of this study which asked the question: 'Why measure?' (see 1.1). It can be concluded that if an organisation does not set standard times for its operations, and does not know exactly how long it takes to produce an item, it would be impossible to determine whether such company has been efficient or not. It can be concluded that when standard times are not realistic and achievable, production schedules will fail and this will lead to low staff morale.

9.3.2 Work study

Literature on work study was found to be limited and the researcher made significant references to Kanawaty (1995), which as previously stated, is considered to be the 'bible' of work study. This limitation also justified the need for and the value of this study. The researcher's experience in industry and academia also assisted in the work study investigation towards the achievement of the objectives of this study. It was important to note that work study must be conducted using the set procedure and the steps must be followed in order to ensure the success of the investigation.

The concept of work study was reviewed in detail (see 4.2 as the entire study revolved around this concept. The literature review included a definition, the objectives, structure, financial implications, procedure, importance and the value of work study as a management tool. Since work study always involves the employees of an organisation the literature review included the human factor in work study (see 4.3), the reaction of groups to work study (see 4.4) and work study officers and their relations with others in the workplace 4.5. This was compulsory as one of the main obstacles in the application of work study is obtaining the co-operation of all involved in an investigation. The human factor must be considered as work study officers will often experience resistance from employees and supervisory staff, if they are not properly introduced into a department prior to an investigation. The entire scope of the investigation must be explained to all relevant people involved in the investigation. The success or failure of an investigation is dependent on how well a work study officer associates with the people involved in an investigation.

9.3.3 Work study techniques

Literature regarding the two principal techniques of work study, namely method study and work measurement, was also reviewed (see 5.1). The literature review of method study included the objectives, scope, structure and procedure (see 5.2.1). Since method study is considered a systematic investigation, a comprehensive literature review was conducted on systematic investigations (see 5.3). This included the definition, principles, objectives, advantages and systematic investigation procedures. The literature review of work measurement included the objectives, nature, scope, structure; requirements regarding work measurement, the procedure, work measurement techniques and rating (see 5.4). Further to the set procedure for work study, its two techniques also have set procedures and these must likewise be followed without omitting any step.

Certain gaps emanated from the literature review. Many organisations did not have systematic processes in place to ensure that their outputs were monitored on a regular basis (see 1.2). The current ERSs were not compiled using work study methodologies. Organisations did not develop methodological ways to measure and monitor each employee's actual production. Organisations do not measure their performance regularly, do not conduct comparisons of productivity improvements from time to time and overall, work inefficiently (see 1.2). The literature review identified the absence of ERSs in organisations as the main cause for concern (see 1.1).

9.4 SYNTHESIS OF FINDINGS

The following shows a synthesis of the findings of this study. The synthesis was categorised into five sections to show the link throughout the study. This included the findings of the work study investigation, which was conducted using the universally accepted techniques of work study, namely method study and work measurement and the two research instruments, questionnaires one and two.

9.4.1 Method study investigation

The aim of the method study investigation was to ensure that the most efficient methods of work were being used in the assembly department of Company A. The investigation consisted of process charting and an analysis of the departmental layout.

9.4.1.1 *Process charting*

The assembly operations of the selected tap were analysed, and process charts of the present method of working were compiled. These were then critically analysed and the methods of working were improved. Process charts with the improved methods of working were developed, showing a list of savings (see 7.2). Poor methods of working by employees initially hampered the researcher from carrying out the method study investigation. The human factor was considered and the researcher had to win over the employees in order to succeed with the investigation (see 4.3). It was found that the assembly department employees utilised inefficient methods of working, and there were no management interventions to improve it.

9.4.1.2 Departmental layout

During the method study investigation, it was also necessary to examine the current layout of the assembly department to determine areas of inefficiencies. The layout of the assembly department at the time of the research was drawn and critically analysed. Thereafter, an improved layout was designed to eliminate/reduce excessive movement and to show an effective flow of materials and employees within the assembly department (see Annexures D and E). It was found that there was too much unnecessary movement, bottlenecks and safety hazards, which are indicative of a poor layout. Stevenson (2007:238) states that poor layout design can adversely affect system performance.

9.4.2 Work measurement investigation

A work measurement investigation was conducted after the method study investigation to ensure that standard times for processes were not determined using inefficient methods of working. The investigation was made up of two direct work measurement techniques, namely work sampling study and time study. The aim of the work measurement investigation was to determine the duration of the various assembly processes of the selected tap. This was used to compile the ERS, which was the output of this study.

9.4.2.1 The work sampling study

A pilot work sampling study was conducted in preparation for the main study. The pilot study indicated that a total of 245 observations were needed in order to realise a true reflection of the study (see 6.2.2.1.1). The main work sampling study revealed the following:

- The percentage time that operators were found to be working = **51.93%** and;
- The percentage time that operators were found to be idle = **48.07%**.

This showed that almost 50% of employees were found to be idle (not working) at any given moment.

9.4.2.2 Time studies

Standard times for the various assembly processes of the selected tap were compiled (see 7.3.3). Time studies were conducted using a stopwatch. Rest and contingency allowances were included in the compilation of these standard times. These were used to develop the ERS. It

was found that the duration of certain elements was very short and could not be measured individually (see 7.3.2). The researcher combined these elements in order to determine the standard times. During the method study investigation, steps 1, 4 and 7 of the assembly process (see 7.2.2) were critically analysed and improvements made. This allowed the researcher to determine the duration of the improved method, which showed the value of method study during a work study investigation. Figure 9.2 shows the actual times that were determined for the seven steps of the assembly process of the selected tap. These were added to determine the standard time for the complete assembly process. The assembly process consisted of seven steps. Using this standard time, one can determine the actual output per hour.

Example:

Tap 1:

Standard time per unit = 0.935 centi-minutes

Output per hour = **64 taps**

- TIME STUDY SUMMARY SHEET							
DEPARTMENT: ASSEMBLY DEPARTMENT				STUDY NUMBER: 01/04		SHEET NO. 01 OF: 01	
DIVISION: LINE ASSEMBLY				NAME:		DATE DATUM: 13/10/2009	
DESCRIPTION OF TASK: ASSEMBLY OF TAP ERROR %:				PERSON STUDIED:			
				TEBS:		TEAS:	
STANDARD TIME CALCULATION							
Step No.	Element Description	Basic Time	Frequency	SBT per measurement	RA %	Other Allowances	Actual Time
1	Fit head part	0.153	1/1	0.153	12		0.171
2	Water pressure test	0.154	1/1	0.154	12		0.172
3	Fit back nut to tap	0.103	1/1	0.103	12		0.115
4	Fit cover and handle	0.096	1/1	0.096	12		0.107
5	Fit indice (cold)	0.129	1/1	0.129	12		0.144
6	Cleaning and polishing	0.101	1/1	0.101	12		0.113
7	Packaging	0.069	1/1	0.069	12		0.077
SBT: Selected Basic Time				TOTAL ACTUAL TIME:			0.899
RA: Rest Allowances				Contingency allowance: 4%			0.036
AT: Actual Time				STANDARD TIME: (in centiminutes)			0.935

Figure 9.2: Time study summary sheet: Calculation of standard time

9.4.3 Questionnaire 1

Questionnaire 1 was applied in the assembly department of Company A. Its aim was to elicit responses from employees regarding the problems experienced and the possible reasons for poor performance. A total of one hundred and fourteen (114) questionnaires were distributed and a response rate of 100% was achieved (see 8.2). The main findings that emanated from this research were:

- Respondents indicated that working conditions and working hours were the two main problems that they experienced in the assembly department (see 8.2.2).
- It was found that respondents with fewer years of experience at Company A experienced significantly more problems at work.
- The chi-square test between being content at work and length of service indicated that respondents who had shorter service at Company A were significantly less content.
- A very high percentage of employees (61.19%) indicated that they were unhappy at work and blamed a lack of recognition for their discontent.
- A large percentage (71.4%) of respondents indicated that they were multi-skilled and could also work on other operations in the assembly department. On the negative side, only 23.85% responded that they were aware of training that was offered by the company and 21.4% indicated that they had undergone training.
- The majority of employees (64.5%) indicated that management/supervisory staff were discourteous towards them, and 56.8% indicated that management did not regularly motivate them to perform well.
- A total of 60.53% of respondents indicated that they felt that they were recognised as an important part of the company.
- Waiting for materials was a major production problem.
- Most of the respondents indicated that they did not know what was meant by the term productivity and they were also unaware of the department's daily production.
- Respondents indicated that support mechanisms, for example HIV counselling, study assistance, canteen facilities and training were lacking.

9.4.4 Questionnaire 2

Questionnaire 2 was forwarded to respondents in manufacturing organisations in South Africa. The main aim of Questionnaire 2 was to gather critical responses to determine whether manufacturing organisations had performance standards and measurement criteria for their manufacturing processes and also to gain insight into the availability of ERSs. A total of eight hundred (800) questionnaires were distributed and yielded a response rate of 28.75%. The main findings that emanated from this research were:

- A total of 63.4% organisations supplied products to both domestic and international markets.
- A total of 43% respondents indicated that they had a work study/industrial engineering department.
- Only 28.3% of respondents indicated that they monitored their production via an ERS.
- A small percentage (23.5%) of respondents indicated that they analysed their finished products on an hourly basis.
- Regarding the development of production targets, only 23.5% of respondents indicated that their production targets were set by work study/industrial engineering.
- Almost 50% of respondents indicated that their standard times were not set by either work study or industrial engineering.
- When asked whether their standard times were set by work study, industrial engineering or consultants, 62.7% of respondents indicated that standard times were set by work study/industrial engineering.
- The question regarding availability of an ERS: formed the basis of the study. A total of 78.9% of respondents indicated that their organisations did have an ERS.
- Respondents indicated that the efficiency results were discussed at production meetings and they were also used to take corrective action. A total of 46.7% indicated that the results were used to show the performance of the department.

9.5 REALISATION OF THE AIM AND OBJECTIVES OF THE STUDY

The formulated problem statement of this study stated that organisations do not use work study methodologies to determine the standard times for their operations in order to measure their

efficiencies and monitor outputs. The problem was studied and evidence from the research instruments indicated that this problem was prevalent in most organisations. This could not be allowed to continue if organisations were to remain sustainable. Sustainable organisations ensure security of jobs and contribute to the economy of a country.

The aim of this study was to develop an ERS using work study methodologies and make it available to organisations in South Africa. The ERS was designed and developed using the standard times compiled during the work measurement investigation (see 7.3). A detailed explanation of the methodology to develop the ERS was provided (see 8.4) and examples of the spread sheet and subsequent graph depicting the efficiencies were provided (see 8.4.20). A soft copy of the ERS as a compact disk is provided. Organisations intending to use the ERS can request a copy from the researcher.

The investigation sought to achieve the following research objectives in order to realise the aim of the study, namely to –

- carry out a detailed literature survey with the goal of identifying the different techniques that would be necessary for the execution and success of the study;
- conduct a complete work study investigation using the universally accepted work study techniques and methodologies;
- carry out an intensive method study investigation using the universally accepted procedure of method study in order to ensure that the most efficient methods of work are being used;
- carry out a work measurement investigation on a selected popular tap in order to set realistic and achievable time standards;
- develop and utilise research instruments to elicit responses of employee experiences in the assembly department of Company A in order to identify factors that constitute stumbling blocks to improved productivity and to elicit responses from those in manufacturing organisations regarding the availability of an ERS at their places of work;
- develop an ERS using work study methodologies; and
- present the ERS to four organisations to elicit their responses on its suitability.

9.6 CONCLUSIONS

The conclusions of this study are divided into three sections, namely the work study investigation, the research instruments and the ERS. The following noteworthy conclusions were drawn from this study:

9.6.1 Work study investigation

The following conclusions were drawn from the work study investigation:

It is critical that organisations follow the set procedure of work study when starting an investigation. The structure of work study (Kanawaty, 1995) clearly states that method study must be conducted prior to work measurement, in order to improve the methods of working before setting time standards.

In order for an investigation to be a success, the human factor must be considered as humans do not accept change easily (resistance to change). Indeed, the success or failure of an investigation can depend on the way that the investigator handles the human factor.

Organisations must instil a culture of efficiency and this must start with senior management. Their commitment is vital as it sets an example. Management must constantly be on the lookout for inefficient operations and take immediate corrective action. Important to mention here is that during his sixteen years in industry, the researcher had observed many examples of humans working inefficiently and by conducting basic improvements using common sense, methods of working were improved.

During the present research study, it was found that the assembly department employees at Company A utilised inefficient methods of working. In order for these to be corrected, management interventions were needed. The aim should always be to work smarter; not harder.

During the present study, standard times were compiled using the universally accepted time study technique. Rest and contingency allowances had to be added to the actual observed times to cater for any other occasional elements that may occur during the operations. A standard time was compiled for only one selected tap. Under normal circumstances, there would be a variety of products and therefore standard times need to be set for all operations that are involved in the manufacturing process.

It is imperative that only trained personnel should carry out a work study investigation. This is very important as an organisation's decision-making can depend on the ERS. The standard times must be realistic and achievable as this may also lead to low employee morale which automatically hinders efficiency. The work sampling study revealed that as much as 50% of employees' time was spent being idle. The work study is therefore an easy and quick way to determine percentage occurrences of employee activities. Management needs to be aware of this as idle time affects operational outputs.

9.6.2 Research instruments

Poor working conditions and unrealistic working hours have a serious effect on morale, and management must ensure good working conditions in order to ensure job satisfaction. Employees need to be recognised for a job well done as a very high percentage of employees indicated that they were unhappy at work (see 8.2.2). Organisations must also ensure that employees have support mechanisms at their disposal (see 8.2.5). This leads to a healthy employer/employee relationship.

A large percentage of employees indicated that they were multi-skilled and could also work on other operations in the assembly department (see 8.2.3). This is very positive for an organisation as it allows for a flexible workforce. Organisations must ensure that they have training initiatives available to staff and must attempt to train their employees to their fullest and reward them equitably for their endeavours.

Efficiencies must be discussed with employees in order to make them aware of the monitoring process. This can also be used as a motivational tool, especially where incentives are present. The efficiencies must be discussed at production meetings and must be used to take corrective action. Management and supervisory staff must therefore be trained to manage employees and motivate them to perform to the best of their abilities. Good performance should be recognised, publicised and rewarded.

Management must also ensure that, in order for employees to produce outputs according to set targets, they need to be supplied with the necessary equipment and raw materials (see 8.2.6). Employees should not wait for raw materials as this causes bottlenecks in the operational processes.

Employees must be made aware of ERSs and other measurement initiatives as these directly affect them. Many respondents did not know the meaning of the term **productivity** (see 8.2.4) and they were also unaware of the department's daily production (see 8.2.4). Performance measurement and reporting must be a consultative process between employees and management.

Only a small percentage (23.5%) of organisations developed production targets using work study/industrial engineering (see 9.4.4). This was critical to the outcome as it justified the need for the study to develop an ERS. These departments are capable of setting standard times and developing ERSs; therefore it can be concluded that almost 50% of organisations did not have proper standard times for their operations. Realistic and achievable standard times are necessary for the development of an ERS. These can only be compiled by experienced personnel, for example, work study or industrial engineering personnel.

When asked whether their standard times were set by work study, industrial engineering or by consultants, 62.7% of respondents indicated that standard times were set by work study/industrial engineering. An alarmingly high number of organisations did not have proper standard times. This leads to inaccurate production reporting and can disadvantage employees.

Production monitoring is vital for organisations to measure their performance. An ERS ensures that efficiencies are calculated regularly and management informed of the progress. The advantage of measuring efficiencies on an hourly basis allows an organisation to identify non-conformances early (through inspection) and corrective action can be taken immediately. It is very costly to identify an error in the manufacturing process at the end of the shift. All those products that were manufactured will be rejected and/or will need to be sent for rework.

The question regarding the availability of an ERS formed the basis of the study. A total of 78.9% of respondents indicated that their organisations did have an ERS (see 9.4). The quality of the system comes into question as only 23.5% of respondents indicated that their production targets were set by work study/industrial engineering (see Q10). During industry liaison, the researcher identified many organisations that did not have any type of ERS. Further to this, the majority of them did not use work study methodologies to develop them.

9.6.3 The efficiency reporting system

The methodology used to design and develop the ERS was discussed in Chapter 8 (see 8.4). From the discussion of the findings, it can be confidently concluded that this study answered the research question:

Which framework can organisations use to measure their performance?

This formed the main focus of this study and was supported by the findings of the research instruments as only a small percentage of respondents (23.5%) indicated that their production targets were set by work study. This confirmed the necessity of ERSs to be developed using work study techniques.

The ERS that was developed was presented to four organisations to elicit their responses regarding its suitability for their manufacturing processes. The results indicated a resounding positive reaction. One very large organisation has already adapted the ERS and is currently utilising it.

9.7 LIMITATIONS OF THE STUDY

Literature on work study was found to be limited and the researcher made significant references to Kanaway (1995), which; as previously stated, is considered to be the 'bible' of work study. The study was further limited to the assembly of taps only and the design and development of the ERS were limited to one organisation.

9.8 RECOMMENDATIONS

The following recommendations are based on the conclusions of this study. It is recommended that:

- the set procedures of work study be followed during an investigation and that no single step be omitted;
- work measurement should not be conducted without firstly improving the method of working;
- management intervene to improve and monitor manufacturing processes if an organisation is to be successful in sustaining itself. The South African labour force needs continuous supervision in order to achieve its organisational objectives;

- managers and supervisors should undergo management training in order to improve their managerial and leadership skills;
- those organisations that cannot afford to employ work study/industrial engineering should rather look at work study consultants to develop standard times for their operations;
- the management of an organisation create a safe working environment, free from safety hazards, and that employees be given the necessary recognition for their endeavours;
- management should strive to raise the level of productivity and job performance by ensuring that their employees are adequately equipped with skills and that they provided with adequate resources;
- management consult the employees during the implementation of an ERS. They must at all times get the buy-in from employees in order to ensure its effective functioning. The majority of employees possess untapped talent, innovation, creativity and the potential to perform to their best if given an opportunity;
- realistic and achievable standard times be set for all processes and these be communicated to the employees. These standards must be reviewed on a regular basis;
- efficiencies be measured on an hourly basis;
- it is recommended that manufacturing organisations utilise this ERS and adapt it to their specific needs;
- the ERS be maintained by regular routine checks; and
- readers consult the researcher for a free computerised copy of the ERS.

9.9 FURTHER RESEARCH

Work study is not restricted to the manufacturing sector and as future research, it would be useful to extend this ERS to service industries as well, as work study can be applied any place where work is being performed.

9.10 CONTRIBUTION

The ERS, which was developed using work study methodologies, makes a unique and significant contribution to individual and organisational learning, assists organisational effectiveness and promotes growth (Adhikari, 2010).

9.11 FINAL CONCLUSIONS

The results of this study provided some important insight into the field of work study. It explained the methodology to be used in the implementation of two techniques in order to improve the method of working and the compilation of standard times for the development of an ERS. The study succeeded in providing an answer to the research question, and this study makes a significant contribution as the work study investigation and the ERS add to the body of knowledge (BOK) in the fields of work study, management services, quality and operations management. The ERS was tested at a large manufacturing organisation, adapted to their needs and subsequently implemented. The value of the ERS to organisations cannot be overemphasised as recent research shows that employing an ERS directs to better organisational results. Many organisations are inclined towards implementing new or improved performance measurement systems (De Waal et al., 2011).

The following quote from Chapter 1 is repeated here as it sums up the urgent need for ERSs:

Performance measurement allows organisations to determine whether they can remain profitable and sustainable, as the sustainability of organisations is considered to be the panacea for South Africa's unemployment problems and a stagnating economy.

(Van Scheers and Radipere, 2007)

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LIST OF ANNEXURES

- Annexure A:** Covering letter for Questionnaire 1
- Annexure B:** Questionnaire 1
- Annexure C:** Questionnaire 2 (including covering letter)
- Annexure D:** Present layout of assembly department
- Annexure E:** Proposed layout of assembly department
- Annexure F:** Graphs showing the analyses of Questionnaire 1: Category A: Personal data
- Annexure G:** Descriptive analyses of Questionnaire 2
- Annexure H:** Analysis of various taps and their standard times
- Annexure I:** Efficiency reporting system (ERS)

ANNEXURE A

COVERING LETTER FOR QUESTIONNAIRE 1

Economics & Management Sciences
University of South Africa
AJH van der Walt Building
Muckleneuk Campus
Pretoria

Dear Respondent,

Thank you for your willingness to be involved with this project and to complete the attached questionnaire.

The questionnaire forms part of a research project regarding the title in Annexure B. The questionnaire consists of 40 questions, each requiring you to indicate your answer by either supplying the information or by inserting a cross (X) in the appropriate block. It should not take you more than 15 minutes to complete. No reference to your name or address is mentioned in the questionnaire.

We wish to assure you that the information you provide will be treated with the greatest confidentiality.

Thank you for your co-operation. Your contribution and opinion forms an important part of this research project. I wish to express my sincere appreciation for your assistance.

Barnes Sookdeo (Researcher)
Senior Lecturer: Department of Business Management
University of South Africa

ANNEXURE B

QUESTIONNAIRE 1

<u>TITLE:</u> The application of work study methodologies: towards the development of an efficiency reporting system for manufacturing organisations in South Africa.

Please complete this questionnaire by indicating your answer to each question by either by inserting a cross (X) in the appropriate block or by supplying the necessary information.

A: PERSONAL DATA

1. State your gender.

<i>Male</i>	1	<i>Female</i>	2
-------------	---	---------------	---

2. State your age.

<i>Under 20</i>	1	<i>26 to 30</i>	3
<i>21 to 25</i>	2	<i>Other</i>	4

3. How long have you been employed by Company A?

<i>0 to 2 years</i>	1	<i>5 to 10 years</i>	3
<i>2 to 5 years</i>	2	<i>10 to 20 years</i>	4

4. What is your position at Company A?

<i>Supervisor</i>	1	<i>Clerk</i>	4
<i>Line leader</i>	2	<i>Operator</i>	5
<i>Quality Controller</i>	3	<i>Other</i>	6

B: PSYCHOLOGICAL ISSUES

5. Are you aware of the mission statement of Company A?

<i>Yes</i>	1	<i>Don't know</i>	3
<i>No</i>	2		

6. Are you happy working at Company A?

<i>Yes</i>	1	<i>No</i>	2
------------	---	-----------	---

7. State which are some of the problems that you experience at work:

<i>Finances</i>	1	<i>Family problems</i>	6
<i>Work problems</i>	2	<i>Isolation</i>	7
<i>Working conditions</i>	3	<i>Lack of recognition</i>	8
<i>Working hours</i>	4	<i>Poor supervision</i>	9
<i>Lack of facilities</i>	5	<i>Other</i>	10

8. Are problems that you encounter at work resolved timeously?

<i>Always</i>	<i>1</i>	<i>Sometimes</i>	<i>3</i>
<i>Often</i>	<i>2</i>	<i>Never</i>	<i>4</i>

9. Do you find the management/supervisory staff to be courteous towards you?

<i>Yes</i>	<i>1</i>	<i>No</i>	<i>2</i>
------------	----------	-----------	----------

10. How would you rate the assistance that you receive from Company A when you have problems?

<i>Very good</i>	<i>1</i>	<i>Poor</i>	<i>3</i>
<i>Good</i>	<i>2</i>	<i>Very Poor</i>	<i>4</i>

11. Do you feel that you are recognised as an important part of Company A?

<i>Yes</i>	<i>1</i>	<i>No</i>	<i>2</i>
------------	----------	-----------	----------

C.MANAGEMENT AND SUPERVISORY ISSUES

12. Do you feel that you are treated with respect by management?

<i>Yes</i>	<i>1</i>	<i>Don't know</i>	<i>3</i>
<i>No</i>	<i>2</i>		

13. Do you have a job description?

<i>Yes</i>	<i>1</i>	<i>Don't know</i>	<i>3</i>
<i>No</i>	<i>2</i>		

14. Are you multi-skilled? (*Can you also work on other operations in the department?*)

<i>Yes</i>	<i>1</i>	<i>Don't know</i>	<i>3</i>
<i>No</i>	<i>2</i>		

15. How would you rate your relationship with your supervisor?

<i>Very good</i>	<i>1</i>	<i>Poor</i>	<i>3</i>
<i>Good</i>	<i>2</i>	<i>Very Poor</i>	<i>4</i>

16. Are you aware of any training that is offered by Company A?

<i>Yes</i>	<i>1</i>	<i>Don't know</i>	<i>3</i>
<i>No</i>	<i>2</i>		

17. Have you undergone any training that was arranged by Company A?

<i>Yes</i>	<i>1</i>	<i>Don't know</i>	<i>3</i>
<i>No</i>	<i>2</i>		

18. Describe the type of training that you attended.

	<i>1</i>
	<i>2</i>
	<i>3</i>

19. What can management do to make your job better at Company A?

	1
	2
	3

D. OPERATIONAL ISSUES

20. Do you feel that Company A is a good company to work for?

Yes	1	<i>Don't know</i>	3
No	2		

21. Do you understand what is meant by the term productivity?

Yes	1	<i>Don't know</i>	3
No	2		

22. Do you know how Company A measures its output/productivity?

Yes	1	<i>Don't know</i>	3
No	2		

23. Do you know what is the amount that is produced in the assembly department daily?

Yes	1	<i>Don't know</i>	3
No	2		

24. What are some of the problems encountered with production in the department?

<i>Waiting for material</i>	1	<i>Queuing on line</i>	3
<i>Waiting for jigs</i>	2	<i>Waiting for pallets</i>	4
<i>Other:</i>			5

25. What can management do to make your job better at Company A?

	1
	2
	3

26. Does management regularly motivate you to perform well?

Yes	1	<i>Don't know</i>	3
No	2		

27. Would you do more than what your job requires you to do?

Yes	1	<i>Don't know</i>	3
No	2		

28. Do you feel that you deliver the required outputs in terms of your job?

Yes	1	<i>Don't know</i>	3
No	2		

E: SUPPORT MECHANISMS AND BENEFITS

29. What type of support mechanisms is currently available at Company A?

<i>Clinic</i>	<i>1</i>	<i>Canteen facilities</i>	<i>4</i>
<i>HIV Counselling</i>	<i>2</i>	<i>On the job training</i>	<i>5</i>
<i>Study assistance</i>	<i>3</i>	<i>Other</i>	<i>6</i>

30. Does Company A offer any incentives for outstanding performance?

<i>Yes</i>	<i>1</i>	<i>Don't know</i>	<i>3</i>
<i>No</i>	<i>2</i>		

31. Do you sometimes work overtime?

<i>Yes</i>	<i>1</i>	<i>No</i>	<i>2</i>
------------	----------	-----------	----------

32. Are you given sufficient notice when asked to work overtime?

<i>Yes</i>	<i>1</i>	<i>No</i>	<i>2</i>
------------	----------	-----------	----------

33. What benefits do you feel can be offered by Company A to you?

F: HEALTH AND SAFETY

34. Do you feel that Company A ensures a safe environment for their employees?

<i>Yes</i>	<i>1</i>	<i>Don't know</i>	<i>3</i>
<i>No</i>	<i>2</i>		

29. Does Company A provide personal protective equipment (PPE)?

<i>Always</i>	<i>1</i>	<i>Never</i>	<i>3</i>
<i>Often</i>	<i>2</i>		

36. Are you satisfied with the PPE that is supplied?

<i>Always</i>	<i>1</i>	<i>Never</i>	<i>3</i>
<i>Often</i>	<i>2</i>		

37. Are you aware of a safety policy at Company A?

<i>Yes</i>	<i>1</i>	<i>Don't know</i>	<i>3</i>
<i>No</i>	<i>2</i>		

38. Do you feel that you are working in a healthy environment?

<i>Yes</i>	<i>1</i>	<i>Don't know</i>	<i>3</i>
<i>No</i>	<i>2</i>		

39. In what ways does Company A promote the health and safety of their employees?

G. SUGGESTIONS FOR IMPROVEMENT

40. Please write down anything that you feel could make your job more satisfying and/or anything that could help to improve your job.

Thank you for your participation. Please assist by returning the completed questionnaire to the researcher.

ANNEXURE C

QUESTIONNAIRE 2

Efficiency

Hi, All,

My name is Barnes Sookdeo, a Senior Lecturer at Unisa.

Please assist by completing the attached questionnaire. It should only take you a few minutes. The purpose of this survey is to gather your critical responses to determine if organisations have performance standards/targets and measurement criteria for their manufacturing processes.

My aim is to develop an efficiency reporting system that organisations can use to measure the outputs of their manufacturing processes.

All answers will be treated with confidentiality and anonymity.

Please enter "submit" to automatically forward the questionnaire to me.

There are 15 questions in this survey.

A note on privacy

This survey is anonymous.

The record kept of your survey responses does not contain any identifying information about you unless a specific question in the survey has asked for this. If you have responded to a survey that used an identifying token to allow you to access the survey, you can rest assured that the identifying token is not kept with your responses. It is managed in a separate database, and will only be updated to indicate that you have (or haven't) completed this survey. There is no way of matching identification tokens with survey responses in this survey.

Load unfinished survey

Next >>

[\[Exit and clear survey\]](#)

Efficiency

You have completed 0% of this survey

0%

100%

General

***Would you identify your organisation as:**

Choose one of the following answers

- ☒ Large: > 200 Employees
- ☐ Medium: < 200 Employees
- ☐ Small: < 50 Employees
- ☐ Micro: < 5 Employees

***The annual turnover of your organisation is:
Choose one of the following answers**

- ☐ Less than R100 000
- ☐ R 100 000 to R500 000
- ☐ R 500 000 to R1 000 000
- ☐ R 1 000 000 to R10 million
- ☐ R 10 million to R50 million
- ☐ > R 50 million

How long has your organisation been in existence?

Choose one of the following answers

- ☐ 0-1 year
- ☐ 0-2 years
- ☐ 0-3 years
- ☐ 0-4 years

- ☐ >5 years
- ☐

*** Which of the following sector does your organisation fit into?**

Choose one of the following answers

- ☐ Food and beverages
- ☐ Textiles, clothing, leather & footwear
- ☐ Wood, paper, publishing and printing
- ☐ Petroleum, chemical products, rubber & plastic products
- ☐ Glass and non-metallic mineral products
- ☐ Iron and steel, metal products & machinery
- ☐ Electrical machinery & apparatus
- ☐ Radio, television & communication apparatus
- ☐ Automotive, parts and accessories & other transport equipment
- ☐ Furniture
- ☐ Other:

*** Your company supplies products to:**

Choose one of the following answers

- ☐ Domestic markets
- ☐ International markets

- ☐ Both

*

Does your company currently have a:

Check any that apply

- ☐ Work Study department
- ☐ Industrial Engineering (IE) department
- ☐ Productivity department
- ☐ None of the above

*

Which of the following process types is applicable to your organisation?

Check any that apply

- ☐ Job shop production
- ☐ Batch production
- ☐ Repetitive production
- ☐ Continuous production
- ☐ Project type
- ☐ Other:

*

How do you monitor your production outputs?

Check any that apply

- ☐ Daily production reporting
- ☐ Weekly production reporting
- ☐ Efficiency reporting system
- ☐ Production meetings
- ☐ Production reporting
- ☐ Improvement circles
- ☐ Recording the number of units produced
- ☐ Rand value of outputs
- ☐ Other:

***When do you analyse your finished products production?
Choose one of the following answers**

- ☐ Hourly
- ☐ Daily
- ☐ Weekly
- ☐ Monthly

How were the production targets developed?
Check any that apply**

- ☐ Thumb-suck or gut feel
- ☐ Using historical data

- ☐ Work measurement
- ☐ Work Study department
- ☐ Industrial Engineering department
- ☐ Management experience
- ☐ Motion and time study
- ☐ By conducting research studies
- ☐ Benchmarking
- ☐ By consultants

*** Does your organisation currently have time standards for processes developed by Work Study or Ind. Engineering?**

- ☐ Yes
- ☐ No

*** Does your organisation currently have an efficiency reporting system?**

- ☐ Yes
- ☐ No

*** The time standards were set by which of the following?**
Choose one of the following answers

- ☐ Work Study department
- ☐ Industrial Engineering department
- ☐ Consultants
- ☐ Other:

*

Who is responsible for recording and calculating the efficiency in your organisation?

Choose one of the following answers

- ☐ Clerk
- ☐ Supervisor
- ☐ Manager
- ☐ Other:

*

What does your organisation do with the results?

	1 Agree strongly	2	3	4	5 Disagree strongly
Discussed at production meetings	☐	☐	☐	☐	☐
Results are displayed in the department	☐	☐	☐	☐	☐
Use it to take corrective action on non-conformances	☐	☐	☐	☐	☐
Used to show performance of departments	☐	☐	☐	☐	☐

Staff are notified of the results

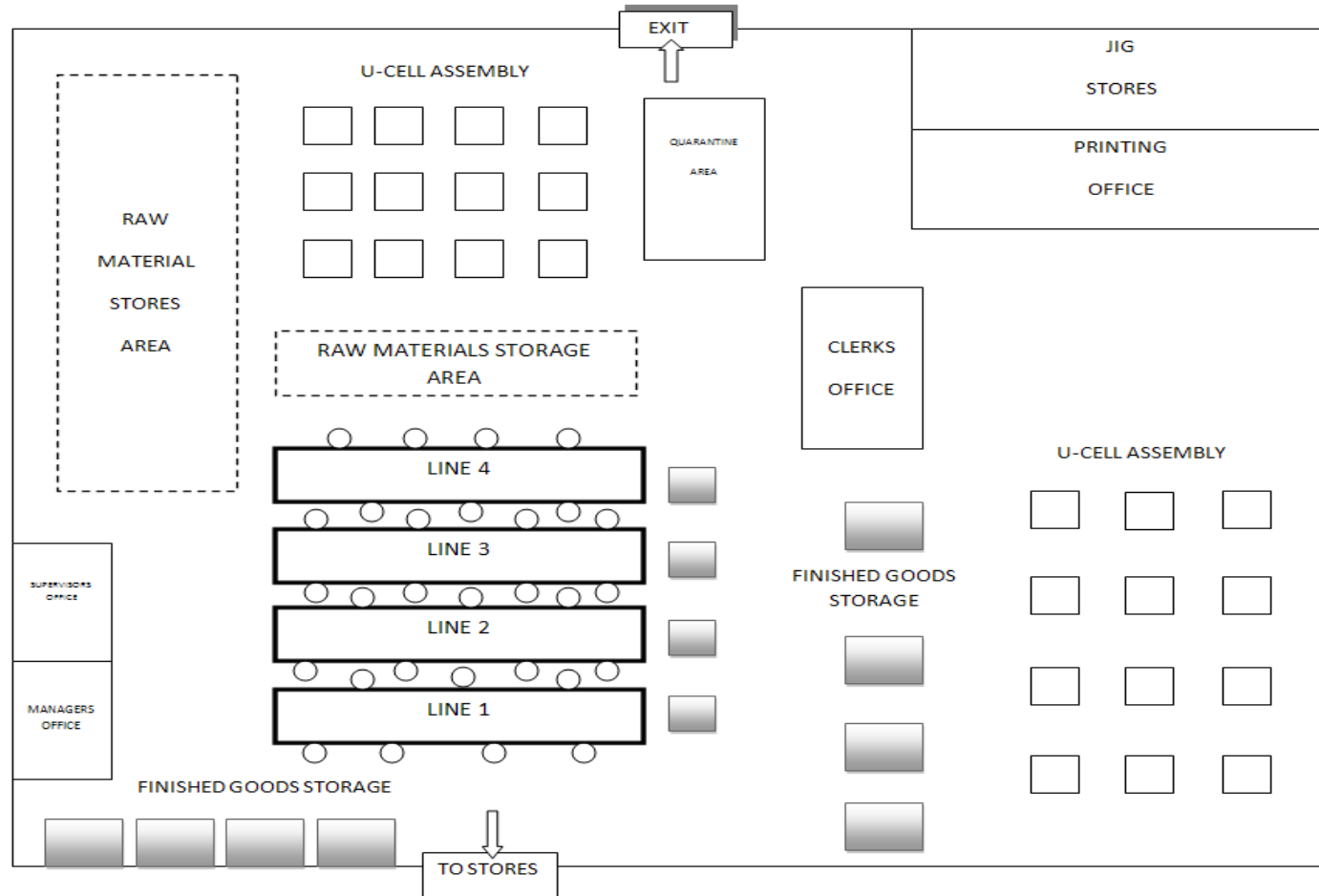


Submit

[\[Exit and clear survey\]](#)

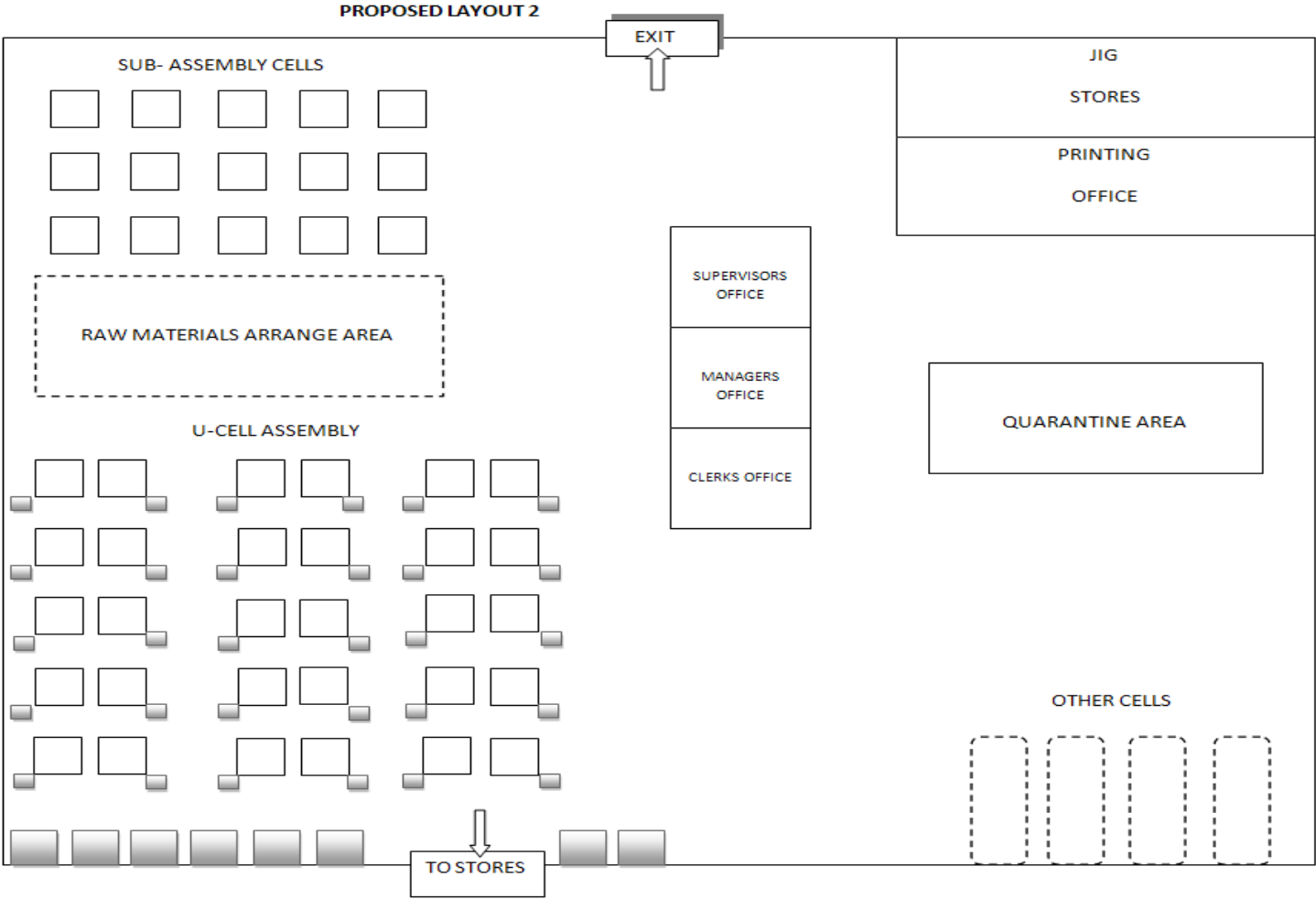
ANNEXURE D

PRESENT LAYOUT: ASSEMBLY DEPARTMENT



ANNEXURE E

PROPOSED LAYOUT: ASSEMBLY DEPARTMENT



ANNEXURE F

ANALYSES OF QUESTIONNAIRE 1

1. Category A: Personal data

The purpose of this category was to determine the biographical information of the employees. Information included the employee's gender, age, duration of employment and the current position at Company A. See Chapter 8, section 8.2.1 for details of this category.

2. Category B: Psychological issues

Under this category, the researcher obtained information that affected the employee at his/her workplace. This included information such as employee's feelings of working at Company A, problems that employees encounter at work, their relationship with their manager and supervisory staff, etc. The following graph shows the extent of various problems experienced by employees at work.

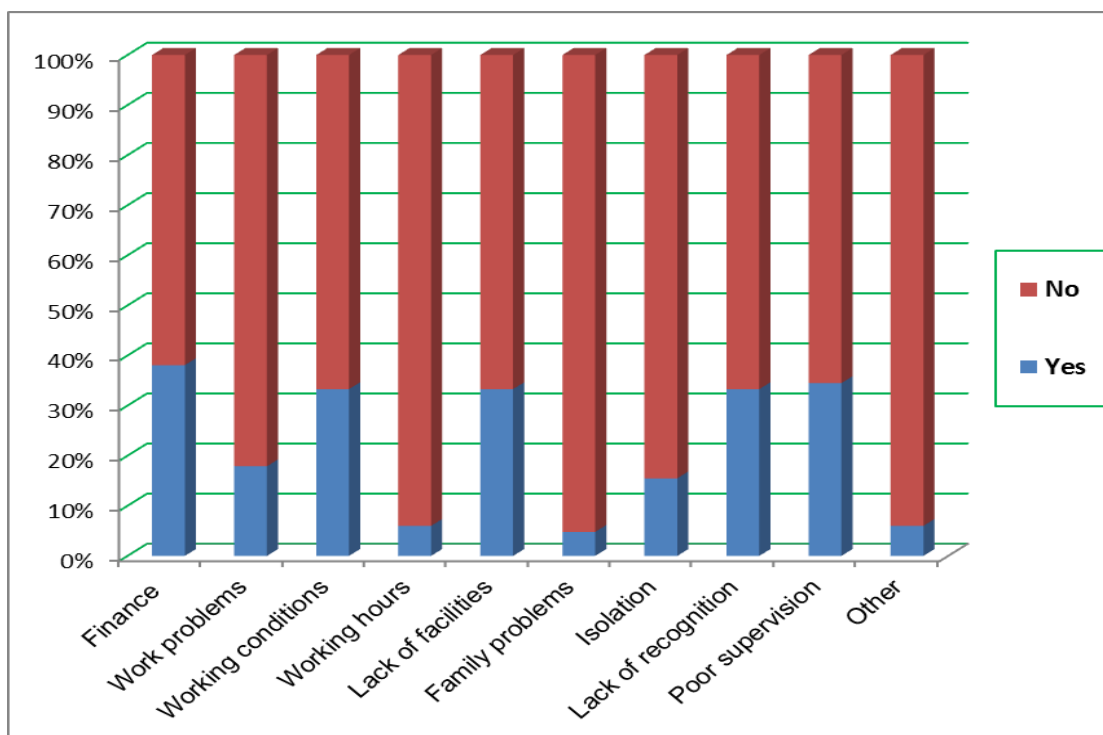


Figure 1: State which are some of the problems that you experience at work:

- The above ten categories of problems experienced at work were defined (see Figure 1). An index was calculated for each respondent by determining the percentage of all the problem items experienced by the respondent. Respondents indicated that working

conditions and working hours were the two main problems that they experienced in the assembly department.

2.1. Calculation of percentage (%) problem index

Distributions:

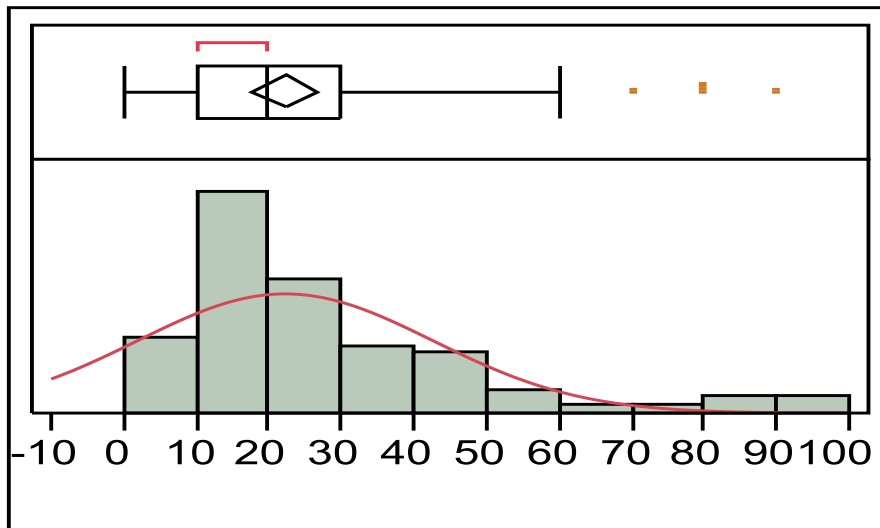


Figure 2: Mean number of problems experienced at work

Mean 22.261905
Standard deviation (Std dev.) 20.379011
Standard error (Std err) mean 2.2235324
Upper 95% mean 26.684421
Lower 95% mean 17.839388

N = 84

Goodness-of-fit test: Shapiro–Wilk W test

W	Prob<W
0.814111	<.0001*

Note:

Ho = the data is from the normal distribution. Small p-values reject Ho. There is thus a lack of normality.

2.2. ANOVA of % problem index versus biographical profile of respondents

Assumptions to perform ANOVAs are independence, normality and homogeneity of variances. ANOVAs are performed to determine whether the biographical profile of the respondent influences the extent of problems experienced at work. In all ANOVA techniques performed below, a 0.05% level of significance was applied.

Table 1: Gender vs mean number of problems experienced at work

Gender	N	Mean % score	Std dev.	Significance	
				*	**
Male	47	21.91	17.648	0.8030	0.5639
Female	36	23.06	23.888		

Note:

* indicates significance of parameter estimates at the 0.05% level of significance.

The following must be taken into consideration when viewing the significance values:

- A probability value of less than 0.05 indicates significant differences between mean scores with the assumptions of normality of distribution and homogeneity of variances.
- A probability value of less than 0.05 indicates significant differences between mean scores without any assumptions of the underlying distribution involved.

Table 2: Age vs mean number of problems experienced at work

Age category	N	Mean % score	Std dev.	Significance	
				*	**
21 to 25	2	40.0	14.14	0.1363	0.0821
26 to 30	10	25.0	12.69		
31 to 40	32	20.6	17.76		
41 to 50	26	27.3	27.79		
Other	14	12.1	8.01		

The above results show that even though it appears as though the younger respondents experienced more problems at work, the differences with the other age groups are not significant.

Note:

* indicates significance of parameter estimates at the 0.05% level of significance.

Table 3: Period of Employment vs mean number of Problems experienced at work:

Period of Employment	N	Mean % Score	Std Deviation	Significance	
				*	**
0 to 5 years	15	32.6	16.67	0.0290*	0.0039*
6 to 10 years	22	29.5	23.99		
11 to 15 years	21	17.1	20.03		
16 to 20 years	13	11.5	6.88		
21 to 25 years	4	15.0	5.77		
More than 25 years	7	20.0	27.08		

The results indicate that respondents with fewer of years of experience at Company A experienced significantly more problems at work.

Note:

* indicates significance of parameter estimates at the 0.05% level of significance.

Table 4: Position held at Company A vs mean number of problems experienced at work

Position	N	Mean % Score	Std Deviation	Significance	
				*	**
Supervisor	1	0.0	.	0.2713	0.1402
Line leader	4	12.5	5.00		
Quality controller	2	10.0	0.00		
Operator	70	24.4	21.57		
Other	6	11.6	4.08		

Even though the operators seemed to experience the most problems at work, the big variation in their attitude hides this significance.

Note:

* indicates significance of parameter estimates at the 0.05% level of significance.

Table 5: Happiness working at Company A vs mean number of problems experienced at work

Happy	N	Mean % score	Std deviation	Significance	
				*	**
Yes	46	17.3	17.18	0.0059*	0.0044*
No	25	30.8	21.96		

Respondents who responded that they were happy working at Company A, experienced significantly fewer problems at work than respondents who were unhappy.

Note:

* indicates significance of parameter estimates at the 0.05% level of significance.

Table 6: Awareness of the mission statement of Company A vs mean number of problems experienced at work

Happy	N	Mean % score	Std deviation	Significance	
				*	**
Yes	10	9.0	8.75	0.0532	0.0066*
No	49	26.3	20.58		
Don't Know	19	23.1	23.10		

Here, it was found that respondents who were aware of the mission statement of the company, experienced significantly fewer problems at work.

Note:

* indicates significance of parameter estimates at the 0.05% level of significance.

2.3. Chi-square tests between contentment at work vs biographical profile

The following chi-square tests were performed between nominal/ordinal variables:

- Chi-square tests between contentment at Company A (Are you happy working at Company A?) and gender;
- Chi-Square tests between contentment at Company A (Are you happy working at Company A?) and age provided no significant association; and
- Are you happy working at Company A? and How long have you been employed by Company A?

Table 7: Chi-square tests between contentment at work vs biographical profile

Count total % column % row %	0 to 5 years	6 to 10 years	11 to 15 years	16 years and longer	
Yes	3 4.29 25.00 6.67	11 15.71 57.89 24.44	17 24.29 85.00 37.78	14 20.00 73.68 31.11	45 64.29
No	9 12.86 75.00 36.00	8 11.43 42.11 32.00	3 4.29 15.00 12.00	5 7.14 26.32 20.00	25 35.71
	12 17.14	19 27.14	20 28.57	19 27.14	70
Test	Chi-square		Probability > chi-square		
Likelihood ratio	13.077		0.0045*		
Pearson	12.873		0.0049*		

The above chi-square test indicates that there was a significant association between respondents who had shorter service at Company A and workers who had longer service. Respondents who had shorter service at Company A were significantly less content than workers who had longer service. (Note that the service length scales 20–25 years and more than 25 years have been included into the 16 years and more category due to lack of cell density).

2.4. Chi-square tests between contentment at work and timeous resolution of work problems

- Chi-square tests between contentment at Company A (Are you happy working at Company A?) and position held provides no significant association.

- Awareness of the Company A mission statement has no significant association with the contentment of the respondent (Are you happy working at Company A?).
- Are problems that you encounter at work resolved timeously? (Are you happy working at Company A?)

Table 8: Chi-square tests between contentment at work and timeous resolution of work problems

Count total % column % row %	Yes	No	
Always	5 7.35 11.63 71.43	2 2.94 8.00 28.57	7 10.29
Often	10 14.71 23.26 90.91	1 1.47 4.00 9.09	11 16.18
Sometimes	21 30.88 48.84 65.63	11 16.18 44.00 34.38	32 47.06
Never	7 10.29 16.28 38.89	11 16.18 44.00 61.11	18 26.47
	43 63.24	25 36.76	68

Test	Chi-square	Probability > chi-square
Likelihood ratio	9.128	0.0276*
Pearson	8.494	0.0368*

Warning: 20% of cells have expected counts less than 5, (chi-square suspect). It must be noted that there seems to be an association between timeous resolution of problems encountered and contentment (Are you happy working at Company A?).

2.5. Chi-square tests between contentment at work and courteous behaviour of management/supervisors

- Do you find the management/supervisory staff to be courteous towards you? (Are you happy working at Company A?)

Table 9: Chi-square tests between contentment at work and courteous behaviour of management/supervisors

Count total % column % row %	Yes	No	
Yes	19 28.79 45.24 79.17	5 7.58 20.83 20.83	24 36.36
No	23 34.85 54.76 54.76	19 28.79 79.17 45.24	42 63.64
	42 63.64	24 36.36	66
Test	Chi-square	Probability > chi-square	
Likelihood ratio	4.117	0.0424*	
Pearson	3.931	0.0474*	

The results show that a lack of courtesy by management is associated with lack of contentment.

2.6. Chi-square tests between contentment at work and rating of assistance received at work

- How would you rate the assistance that you receive from Company A when you have problems? (Are you happy working at Company A?)

Table 10: Chi-square tests between contentment at work and rating of assistance received at work

Count total % column % row %	Yes	No	
Very good	8 11.27 17.39 100.00	0 0.00 0.00 0.00	8 11.27
Good	12 16.90 26.09 92.31	1 1.41 4.00 7.69	13 18.31
Poor	19 26.76 41.30 61.29	12 16.90 48.00 38.71	31 43.66
Very poor	7 9.86 15.22 36.84	12 16.90 48.00 63.16	19 26.76
	46 64.79	25 35.21	71
Test	Chi-square	Probability > chi-square	
Likelihood ratio	18.682	0.0003*	
Pearson	15.334	0.0016*	

Warning: 20% of cells have expected counts less than 5, chi-square suspect. Due to a lack of cell density, the following conclusion can be drawn:

- it seems as though unhappiness is associated with poor to very poor assistance received from supervisors/management.

2.7. Chi-square tests between contentment at work and recognition received

- Do you feel that you are recognised as an important part of Company A? (Are you happy working at Company A?)

Table 11: Chi-square tests between contentment at work and recognition received.

Count total % column % row %	Yes	No	
Yes	24 35.82 57.14 92.31	2 2.99 8.00 7.69	26 38.81
No	18 26.87 42.86 43.90	23 34.33 92.00 56.10	41 61.19
	42 62.69	25 37.31	67
Test	Chi-square	Probability > chi-square	
Likelihood ratio	18.192	<.0001*	
Pearson	15.938	<.0001*	

It can be seen from the above results that there was a significant association between recognition and happiness. It can be concluded that a lack of recognition was a source of unhappiness among workers at Company A.

3. Category C: Management and supervisory issues

Under this category, the aim was to elicit responses from employees regarding their relationships with management and supervisory staff. Issues included whether they had a job description, their relationship with their supervisor and the quality of supervision in the department.

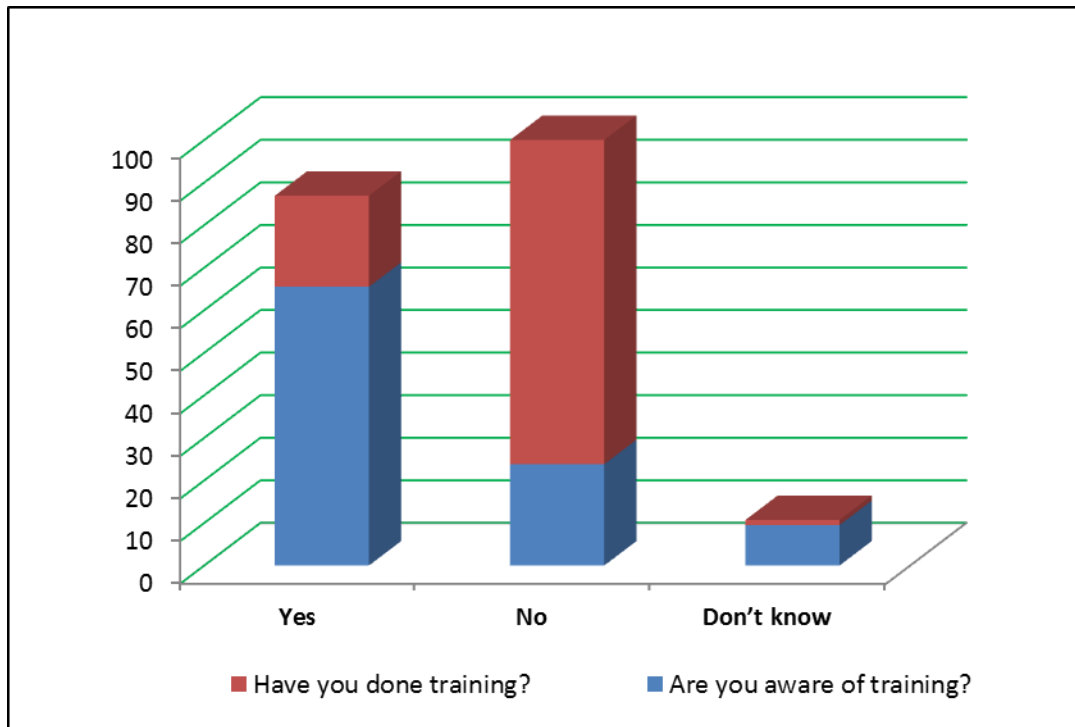


Figure 3: Training at Company A

There were three questions relating to training at Company A. The results indicated that 65.5% of employees were aware of training but only 21.4% had actually undergone training that was provided at Company A. The amount of training was dependent on the training budget that had been allocated by Company A. Due to the assembly department being highly labour-intensive, it is imperative that Company A train their employees to their full potential. The questionnaire featured one open-ended question with regard to the type of training that employees had attended. Unfortunately, there were no responses to this question. Employees were also requested to indicate what management can do to make their work better. Here again, no responses were received.

A large percentage (71.4%) of respondents indicated that they were multi-skilled and could also work on other operations in the assembly department.

3.1. Creation of a management and supervisory issue index

Management and supervisory Issues were covered by the following questions/statements:

- Q12. Do you feel that you are treated with respect by management?
- Q13. Do you have a job description?
- Q14. Are you multi-skilled? (Can you also work on other operations in the department?)
- Q15. How would you rate your relationship with your supervisor?

Q16. Are you aware of any training that is offered by Company A?

Q17. Have you undergone any training that was arranged by Company A?

All but Q15 had a response scale of 1 = Yes, 2 = No. And 3 = Don't know. The 'No' and 'Don't know' responses were equated to 0 and an index sum was calculated for each of the respondents for questions Q12, Q13, Q14, Q16 and Q17. This index variable named 'Management and Supervisory Issues' was expressed as a percentage out of a maximum score of 5. Question 15 required the respondent to rate his/her relationship with his/her supervisor on a 4-point Likert-type scale that varied from 1 = Very good to 4 = Very poor.

A distribution of this index score:

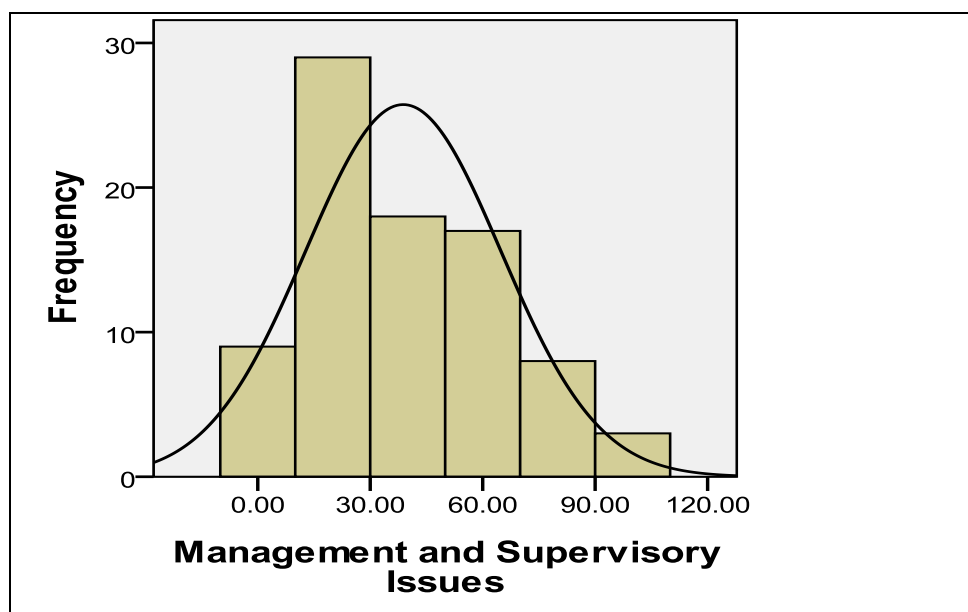


Figure 4: Distribution parameters of the management and supervisory issue index

Descriptive statistics:

Type	Parameter estimates	Estimate
Location	μ	38.809524
Dispersion	σ	26.040042

Goodness-of-fit test

Shapiro–Wilk W test

W	Prob<W
0.911879	<.0001*

Note:

Ho = the data is from the normal distribution. Small p-values reject Ho.

3.2. ANOVA of index score of management and supervisory issues vs rating of relationship with supervisor

An ANOVA was performed on the scores of the index variable management and supervisory issues in an attempt to determine whether the rating of Q15 regarding the respondent's relationship with the supervisor influenced the index score. The results of the ANOVA are shown below:

Table 12: Rating of relationship with supervisor vs index score of management and supervisory issues

Relationship with supervisor	N	Mean % score	Std deviation	Significance	
				*	**
Very good	8	72.5	18.32	0.0002*	0.0007*
Good	17	44.7	19.40		
Poor	37	32.4	23.26		
Very poor	22	32.7	27.97		

Level		Mean
Very good	A	72.500000
Good	B	44.705882
Very poor	B	32.727273
Poor	B	32.432432

Note:

* indicates significance of parameter estimates at the 0.05% level of significance.

The levels that are not connected by same letter are significantly different. It can be concluded from the above results that a very good relationship with the supervisor is reflected in a high index of management and supervisory perception. However, the index of management and supervisory issues is not influenced by gender, age, position or years' service at Company A. There is a relationship between the index of management and supervisory issues and the psychological issues with regard to the following questions:

Table 13: Index of management and supervisory issues and the psychological issues

How would you rate the assistance that you receive from Company A when you have problems?	N	Mean	Std dev.	Significance	
				*	**
Very good	8	72.50	18.32	0.0002*	0.0001*
Good	17	44.70	19.40		
Poor	37	32.43	23.26		
Very poor	22	32.72	27.97		
Note: Very good has a significantly larger mean than the other categories					
Are you aware of the mission statement of Company A?					
Yes	10	27.96	27.96	0.0610	0.0717
No	49	24.58	24.58		
Don't know	19	24.56	24.56		
Are you happy working at Company A?					
Yes	46	47.82	25.11	0.0002*	0.0002*
No	25	24.00	23.09		
Are problems that you encounter at work resolved timeously?					
Always	8	57.50	32.84	0.0537	0.0926
Often	11	45.45	26.96		
Sometimes	39	34.87	22.34		
Never	21	31.42	24.95		
Do you find the management/supervisory staff to be courteous towards you?					
Yes	27	51.81	26.75	0.0009*	0.0015*
No	49	31.02	24.17		
Do you feel that you are recognised as an important part of Company A?					
Yes	30	52.6	25.45	<.0001*	<.0001*
No	46	28.695	22.17		

The highlighted values indicate significant differences. In all instances, an affirmative response to the psychological issue concerned had a higher management and supervisory index. This can be interpreted as follows:

As management and supervisory issues include the relationship with the supervisor and training opportunities, the occurrence of good relationships and provision of training can have a direct influence on the psychological well-being of the staff at Company A. The majority of employees (60.53%) indicated that they did feel that they were recognised as an important part of the company.

4. Category D: Operational issues

Under this category, the researcher aimed to determine whether employees encountered any problems with the work being carried out. Questions included asking whether Company A was a good company to work for, whether they understood the meaning of the term **productivity**, some of the problems encountered with production in the department, etc.

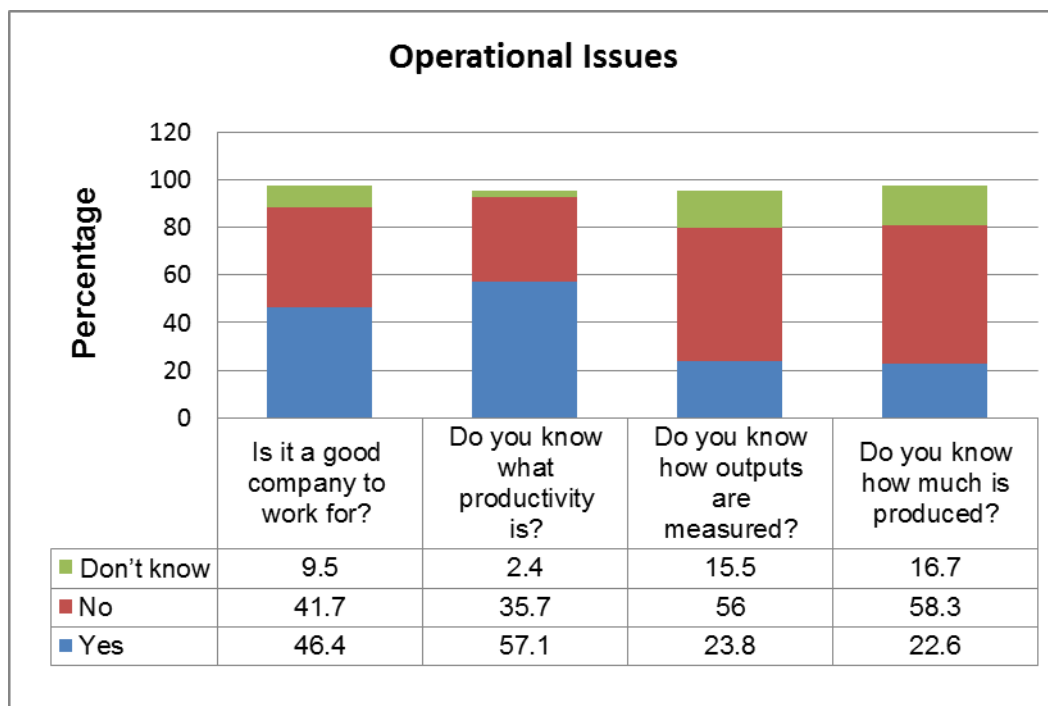


Figure 5: Operational issues

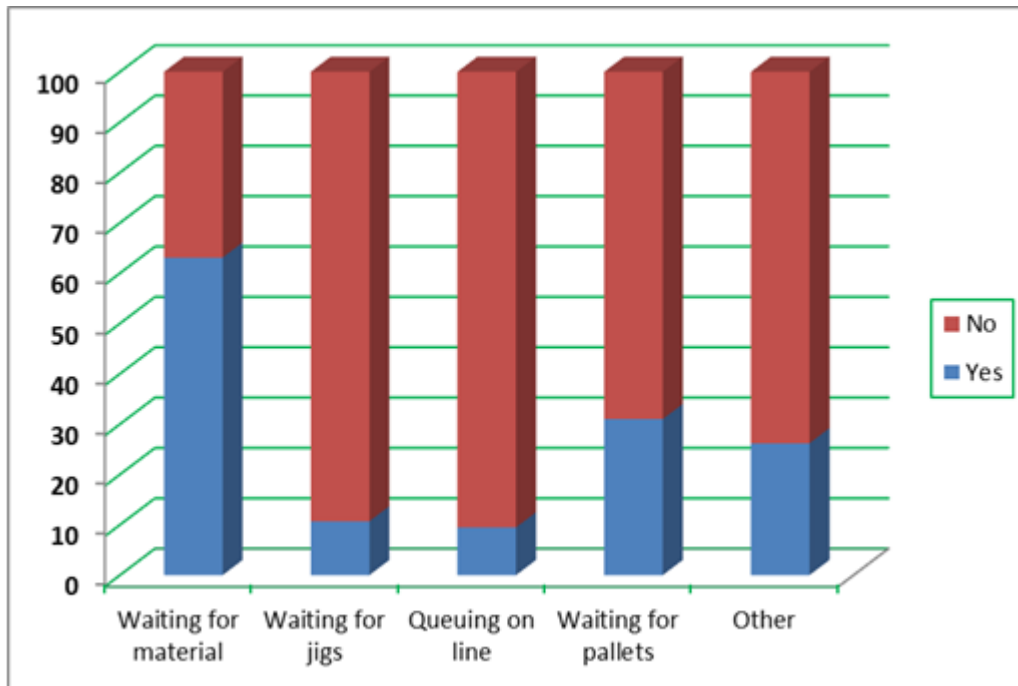


Figure 6: The graph presents the extent of production problems experienced by respondents

As many as 63.1% of employees indicated that the major production problem was waiting for material. This indicates that the assembly process was often held up due to non-delivery of assembly parts.

4.1. An index of production problems experienced created from the production issues experienced: Question 25

An Index of production problems experienced was also created from the production issues experienced: Question 25. This index was calculated by adding up the problems experienced by each respondent and then presenting this value as a percentage out of 5. This was done to create a scale or continuous variables from these problem issues. The following histogram presents a distribution of these indexes:

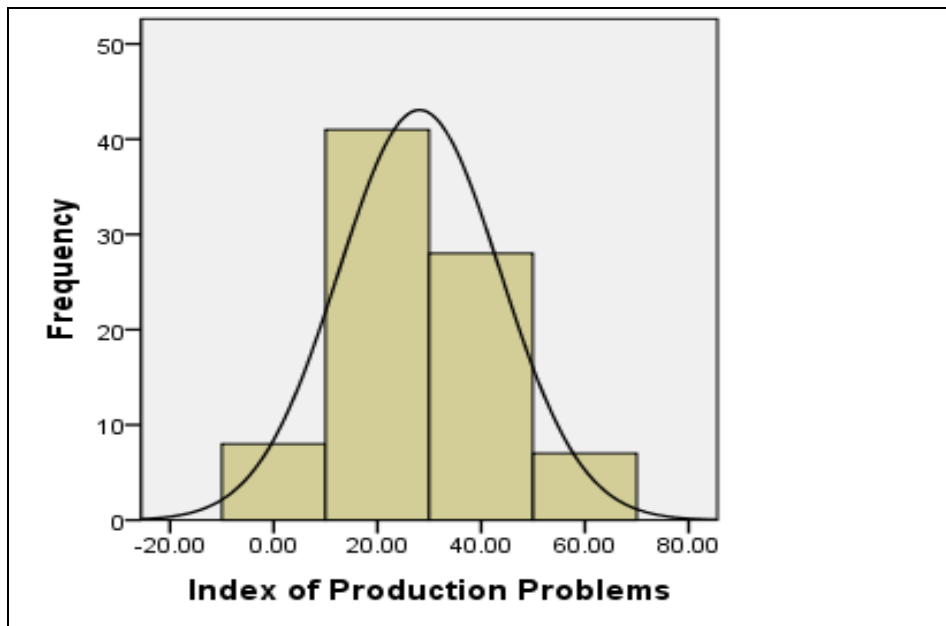


Figure 7: A distribution of the index of production problems

Descriptive statistics of this Index:

Parameter estimates		
Type	Parameter	Estimate
Location	μ	28.095238

Normality test:

Shapiro–Wilk W test

W	Prob<W
0.850183	<.0001*

Note:

Ho = The data is from the normal distribution. Small p-values reject Ho.

4.2. ANOVA test to determine whether biographical profile of respondents influenced the index of production problems

ANOVA tests revealed no influence of the biographical variables of gender, age, position held and years of service of respondents at Company A upon the production problem index.

A reliability analysis was conducted on the following items regarding:

- Q21. Do you understand what is meant by the term **productivity**?
- Q22. Do you know how Company A measures its output/productivity?
- Q23. Do know what the amount is that is produced in the assembly department daily?

A factor was created, called 'Knowledge of Production' from the 3 items above. Distribution

details of the variable 'Knowledge of Production', the investigation into the relationship between the index of production problems and the factor knowledge of production.

ANOVA test to determine the influence of the biographical profile of respondent upon the factor Knowledge of Production.

The following questions refer to production:

- Q21.* Do you understand what is meant by the term productivity?
- Q22.* Do you know how Company A measures its output/productivity?
- Q23.* Do know what is the amount that is produced in the assembly department daily?

These questions were considered as a single factor and the reliability (internal consistency) of these items were determined. The following table presents Cronbach's alpha values of internal consistency.

Table 14: Cronbach's alpha

Cronbach's α	
Entire set:	0.7606
Excluded α values:	
Do you understand what is meant by the term productivity?	0.6654
Do you know how Company A measures its output/productivity?	0.6620
Do know what is the amount that is produced in the assembly department daily?	0.7074
Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Based on Cronbach's alpha in Table 14 above, the value of 0.7606 indicates an acceptable internal consistency.

A single value to measure respondents' knowledge of production was calculated by determining the means of the 3 items Q21, Q22 and Q23. Note that the original response values of these questions were recoded as follows: (1 = No, 2 = Don't know, and 3 = Yes.)

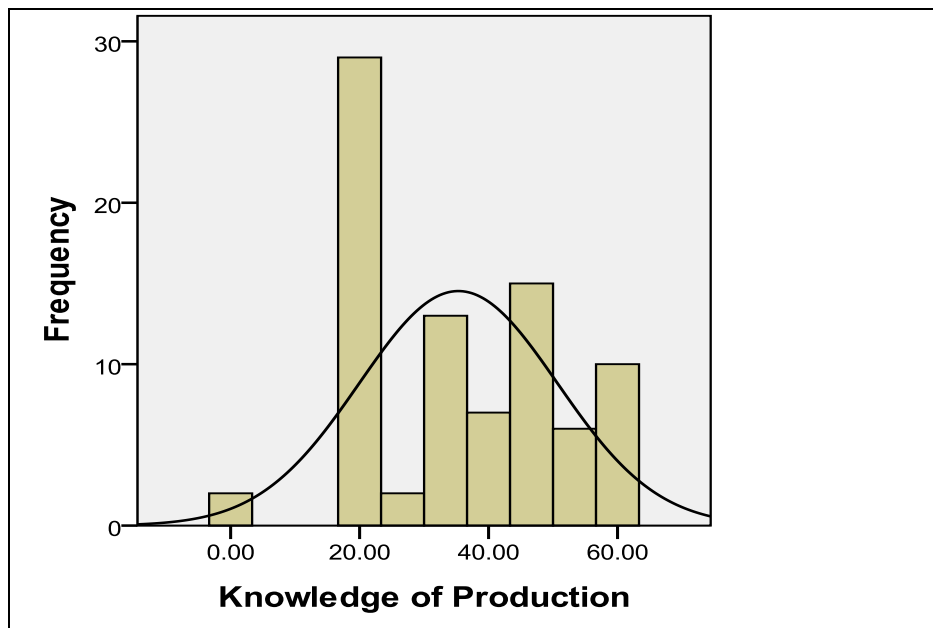


Figure 8: Distribution of the factor: knowledge of production:

Type	Parameter	Parameter estimates		
		Estimate	Lower 95%	Upper 95%
Location	μ	35.31746	31.980503	38.654418
Dispersion	σ	15.376742	13.351466	18.132021

Normality test:
Shapiro--Wilk W test

W	Prob<W
0.900732	<.0001*

Note:

Ho = The data is from the normal distribution. Small p-values reject Ho.

The following relationship existed between the production problem index and the knowledge of production factor.

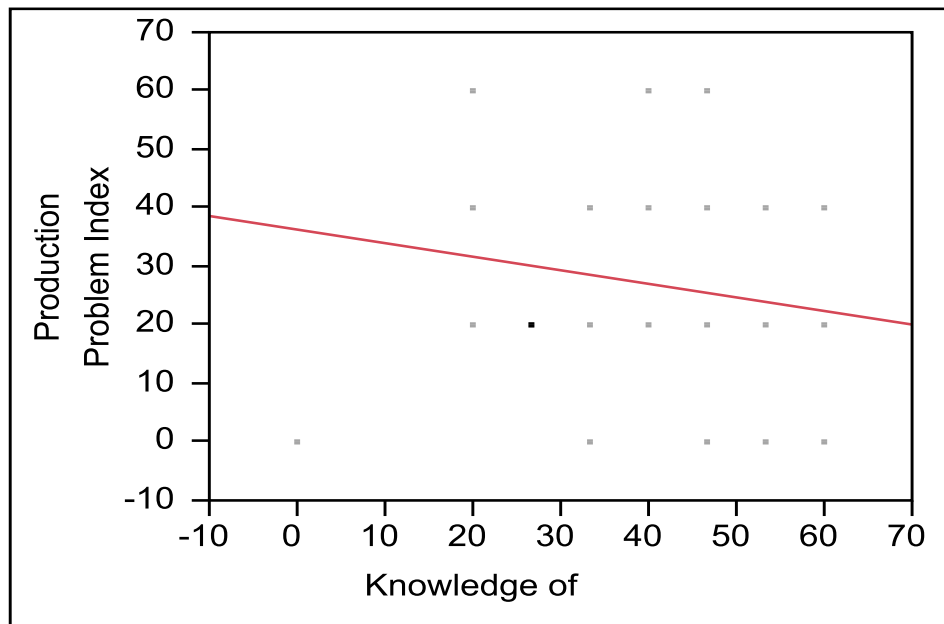


Figure 9: Production problem index and the knowledge of production factor

Linear fit:

Production problem index = 36.282117 - 0.2318083*knowledge of production

Term	Parameter estimates		t ratio	Prob> t
	Estimate	Std error		
Intercept	36.282117	4.186023	8.67	<.0001*
Knowledge of production	-0.231808	0.108776	-2.13	0.0361*

Note:

* indicates significance of parameter estimates at the 0.05% level of significance.

The above results can be interpreted as follows. The greater the knowledge of production factor value, the smaller the production problem index. Of the biographical factors: gender, age, years of service and position, only position held at Company A influenced the knowledge of production factor. This is indicated in the following table following an ANOVA test:

Table 15: ANOVA test

What is your position at Company A?	N	Mean	Std dev.	Significance	
				*	**
Supervisor	1	60.00	.	0.0192*	0.0189*
Line leader	4	51.66	6.38		
Quality controller	2	46.66	0.00		
Operator	70	32.95	15.22		
Other	6	43.33	12.47		

Note:

* indicates significance of parameter estimates at the 0.05% level of significance.

The results indicate that the operators displayed a significantly lesser knowledge of production than the other respondents.

An ANOVA test of knowledge of production vs the performance issues of:

- Q26. Does management regularly motivate you to perform well?
- Q27. Would you do more than what your job requires you to do?
- Q28. Do you feel that you deliver the required outputs in terms of your job?

The following table indicates that only motivation by management influences knowledge of production.

Table 16: ANOVA test

Does management regularly motivate you to perform well?	N	Mean	Std dev	Significance	
				*	**
No	46	30.57	12.61	<.0001*	<.0001*
Yes	35	44.00	13.35		

Note:

* indicates significance of parameter estimates at the 0.05% level of significance.

From the results of the ANOVA test it can be concluded that respondents who were motivated by management had a significant higher knowledge of production issues. ANOVA tests revealed no influence of performance issues (Q26, Q27 and Q28) on the production problem index.

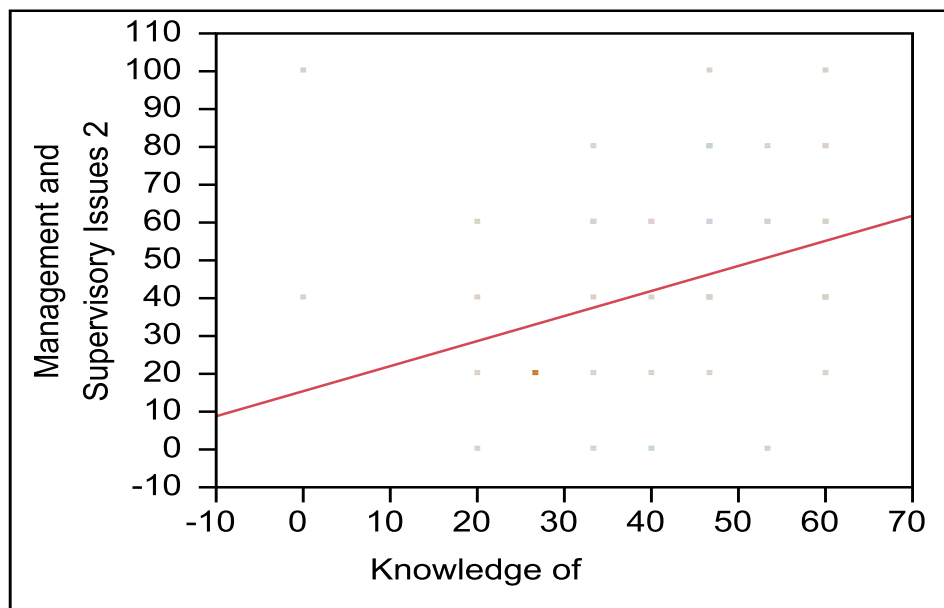


Figure 10: Relationship between management and supervisory issues and knowledge of production

Linear fit:

Management and supervisory issues 2 = 15.417217 + 0.662344*Knowledge of production

Term	Parameter estimates		t ratio	Prob> t
	Estimate	Std error		
Intercept	15.417217	6.623535	2.33	0.0224*
Knowledge of production	0.662344	0.172115	3.85	0.0002*

Note that the estimates are significant. This positive relationship indicates that an increase in knowledge of production results in an increase in the perception of a good relationship with management and supervisor and the provision of training.

5. Category E: Support mechanisms and benefits

In this category, the researcher attempted to obtain responses regarding the support and benefits that were offered by Company A at the time of this research. Issues included a clinic, canteen facilities, HIV counselling, study assistance schemes, on the job training, etc.

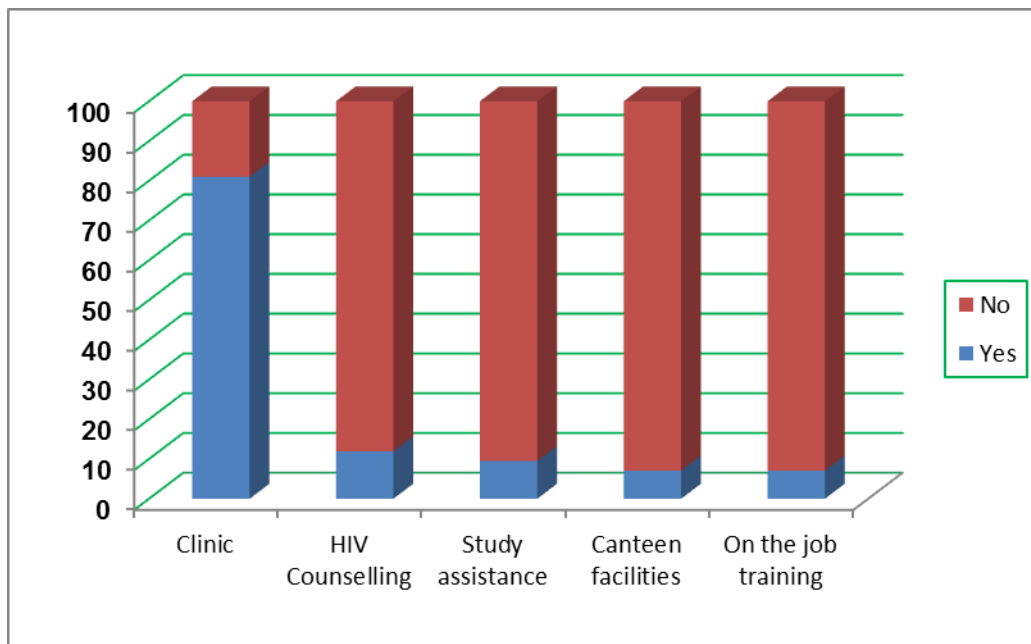


Figure 11: Extent of support mechanisms and benefits provided to staff

Respondents indicated that support mechanisms, for example, HIV counselling, study assistance, canteen facilities and training were lacking. The extent of support mechanisms and benefits was calculated as a percentage of all possible support mechanisms and benefits available. This is however only the perception or knowledge of facilities of workers at Company A. The distribution of the percentage of support mechanisms and benefits is provided below:

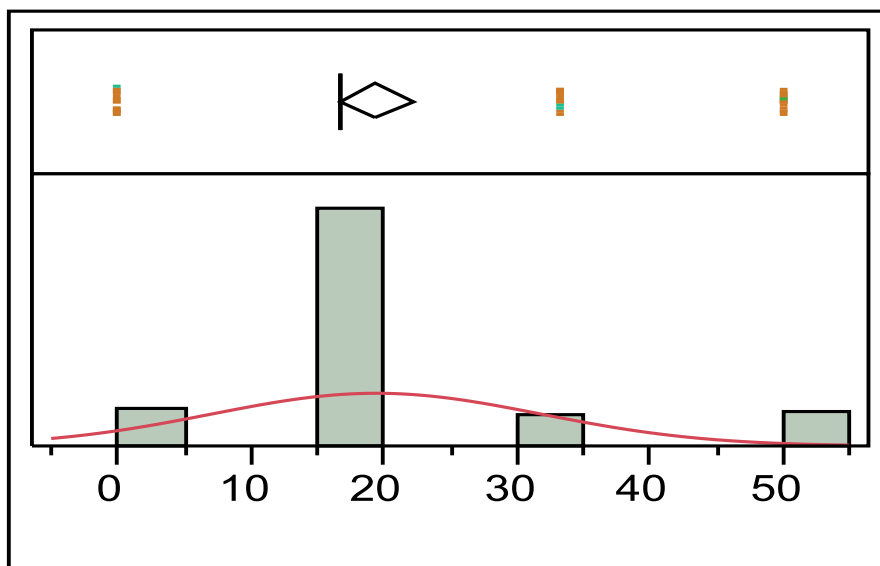


Figure 12: Number of support mechanisms and benefits

Mean	19.444444
Standard deviation	12.362587
Standard error mean	1.3488688
Upper 95% mean	22.12729
Lower 95% mean	16.761599
N	84

Goodness-of-fit test

Shapiro–Wilk W test

W	Prob<W
0.695967	<.0001*

ANOVA tests to determine whether the percentage mean score for the factor support mechanisms and benefits was influenced by:

- biographical profile of the respondents;
- awareness of mission statements;
- contentment of workers;
- chi-square tests between the biographical profile and the question/statement; and
- the question, “Does Company A offer any incentives for outstanding performance?”

Note:

Ho = The data is from the normal distribution. Small p-values reject Ho. (This distribution is not normal). ANOVA tests show that the % mean score for the factor support mechanisms and benefits is not influenced by the biographical profile of the respondents.

The % mean score calculated for the provision of support mechanisms and benefits was also not influenced by the awareness of mission statements or the contentment of workers at Company A.

Chi-square tests between the biographical profile and the question/statement, “Does Company A offer any incentives for outstanding performance?” did not reveal any significant association.

6. Category F: Health and safety issues

It is a moral responsibility of organisations to ensure a safe and healthy working environment for their employees. Under this category, the researcher attempted to obtain responses from employees regarding the perceptions of health and safety at Company A. Questions included

whether they felt that they were working in a safe environment, the provision of personal protective equipment (PPE), the safety policy, etc. A safe and healthy working environment boosts employee morale and inevitably improves productivity. A reliability analysis was performed upon the following three questions:

- Q34. Do you feel that Company A ensures a safe working environment for their employees?
- Q37. Are you aware of a safety policy at Company A?
- Q39. In what ways does Company A promote the health and safety of their employees?

A health and safety factor was created from the above 3 items. To achieve this, the response scale was recoded into an ordinal type as follows: No = 1, Don't know = 2 and Yes = 3.

Table 13: Health and safety factor

Overall Cronbach's alpha value = 0.799

Question	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Squared multiple correlation	Cronbach's alpha if item deleted
Q34. Do you feel that Company A ensures a safe working environment for their employees?	3.30	2.387	.648	.437	.724
Q37. Are you aware of a safety policy at Company A?	3.27	2.544	.607	.373	.767
Q38. Do you feel that you are working in a healthy environment?	3.57	2.667	.687	.474	.690

The Cronbach's Alpha value of 0.799 indicates a good internal consistency. A single continuous variable was created from these ordinal responses by calculating the mean score of Q34, Q37 and Q38.

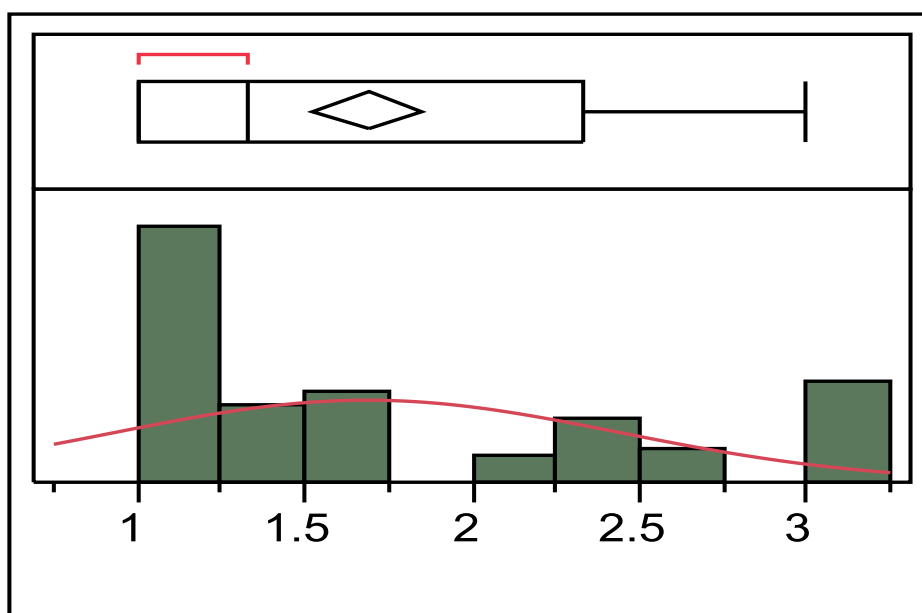


Figure 14: Distributions: Health and safety

Mean	1.6864286
Standard deviation	0.7541302
Standard error mean	0.0822824
Upper 95% mean	1.8500849
Lower 95% mean	1.5227723
N	84

Goodness-of-fit test

Shapiro–Wilk W test

W	Prob<W
0.803423	<.0001*

Note:

Ho = The data is from the normal distribution. Small p-values reject Ho (lack of normality)

The influence of the biographical profile of the respondent upon the health and safety factor was investigated. ANOVA tests were conducted to establish the influence of the biographical profile of respondents upon the health and safety factor. Gender and age did not influence the respondent's perception of health and safety issues. The perception of health and safety, however, were influenced by the period of service and position held at Company A:

6.1. Period of service

Tests between the 'time employed' and the 'problems experienced at work' indicated that employees with less number of years of experience at Company A experienced significantly

more problems at work.

Table 18: Period employed at Company A vs mean number of problems experienced at work

Period	N	Mean % score	Std deviation	Significance	
				*	**
0 to 5 years	15	1.35	0.387	0.0045*	0.0027*
6 to 10 years	22	1.45	0.679		
11 to 15 years	21	2.12	0.819		
16 Years and longer	24	1.63	0.747		

Even though the Operators seemed to experience the most problems at work, the big variation in their attitude hid this significance. The differences can be viewed below:

Level		Mean
Supervisor	A B	3.0000000
Line leader	A	2.9175000
Quality controller	A B	2.5000000
Operator	B	1.6092857
Other	B	1.3900000

Levels not connected by same letter are significantly different.

6.2. Position held at Company A

A test between 'position held' and 'problems experienced' indicated that the operators seemed to experience the most problems at work. This was expected as these operators spent most of the time on the manufacturing process.

Table 19: Position held

Position	N	Mean % score	Std. deviation	Significance	
				*	**
Supervisor	1	3.00	.	0.0007*	0.0057*
Line leader	4	2.91	0.165		
Quality controller	2	2.50	0.707		
Operator	70	1.60	0.699		
Other	6	1.39	0.681		

Level		Mean
Supervisor	A B	3.0000000
Line leader	A	2.9175000
Quality controller	A B	2.5000000
Operator	B	1.6092857
Other	B	1.3900000

Levels not connected by same letter are significantly different. The provision and effectiveness of PPE was also investigated with regard to the health and safety factor as calculated above. ANOVA tests were conducted to determine the influence of the provision and effectiveness of PPE upon the health and safety factor.

For this question, the response scale was first recoded as follows:

1 = Never, 2 = Often and 3 = Always.

6.3. Provision of PPE

It was found that almost two thirds of the employees had concerns when it came to health and safety at Company A.

Table 20: Provision of PPE

Provision of PPE	N	Mean % score	Std. deviation	Significance	
				*	**
Never	19	1.21	0.354	<.0001*	<.0001*
Often	48	1.57	0.640		
Always	14	2.71	0.624		

Level		Mean
Always	A	2.7142857
Often	B	1.5764583
Never	B	1.2100000

Levels not connected by same letter are significantly different.

There was a significant difference between the health and safety factor scores between respondents who replied that they always get PPE and respondents who replied that they often or never received PPE. This means that workers who were always provided with PPE are significantly more satisfied with the working environment, safety policy and the way that Company A promotes health and safety.

6.4. Effectiveness of PPE

There is a significant difference between the health and safety factor scores between respondents who reply that they were satisfied with their PPE and respondents who replied that they were often or never satisfied with their PPE. This means that workers who were satisfied with their PPE were significantly more satisfied with the working environment, safety policy and the way that Company A promotes health and safety.

Table 21: Effectiveness of PPE

Provision of PPE	N	Mean % score	Std. deviation	Significance	
				*	**
Never	42	1.48	0.603	<.0001*	0.0011*
Often	24	1.61	0.700		
Always	16	2.41	0.802		

Level		Mean
Always	A	2.4162500
Often	B	1.6116667
Never	B	1.4838095

Levels not connected by same letter are significantly different.

ANNEXURE G

DESCRIPTIVE ANALYSIS OF QUESTIONNAIRE 2

1. Would you identify your organisation as:

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Large: > 200 Employees	154	67.0	69.4	69.4
	Medium: < 200 Employees	40	17.4	18.0	87.4
	Small: < 50 Employees	19	8.3	8.6	95.9
	Micro: < 5 Employees	9	3.9	4.1	100.0
	Total	222	96.5	100.0	
Missing	System	8	3.5		
Total		230	100.0		

2. The annual turnover of your organisation is:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than R100 000	16	7.0	7.3	7.3
	R 100 000 to R500 000	9	3.9	4.1	11.4
	R 500 000 to R1 000 000	20	8.7	9.1	20.5
	R 1 000 000 to R10 million	35	15.2	15.9	36.4
	R 10 million to R50 million	44	19.1	20.0	56.4
	> R 50 million	96	41.7	43.6	100.0
	Total	220	95.7	100.0	
Missing	System	10	4.3		
Total		230	100.0		

3. How long has your organisation been in existence?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-1 year	7	3.0	3.2	3.2
	0-2 years	9	3.9	4.1	7.2
	0-3 years	5	2.2	2.3	9.5
	0-4 years	4	1.7	1.8	11.3
	>5 years	172	74.8	77.8	89.1
	6	24	10.4	10.9	100.0
	Total	221	96.1	100.0	
Missing	System	9	3.9		
Total		230	100.0		

4. Which of the following sector does your organisation fit into?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Food and beverages	32	13.9	31.7	31.7
	Textiles, clothing, leather & Footwear	8	3.5	7.9	39.6
	Wood, paper, publishing and Printing	8	3.5	7.9	47.5
	Petroleum, chemical products, Rubber & plastic products	20	8.7	19.8	67.3
	Glass and non-metallic mineral Products	4	1.7	4.0	71.3
	Iron and steel, metal products & machinery	15	6.5	14.9	86.1
	Total				

	Electrical machinery & Apparatus	1	.4	1.0	87.1
	Radio, television & Communication apparatus	3	1.3	3.0	90.1
	Automotive, parts and Accessories & other transport Equipment	10	4.3	9.9	100.0
	Total	101	43.9	100.0	
Missing	System	129	56.1		
Total		230	100.0		

Which of the following sector does your organisation fit into?[Other]

		Frequency	Percent	Valid Percent	Cumulative Percent
		118	51.3	51.3	51.3
	Academic	1	.4	.4	51.7
	Agricultural	1	.4	.4	52.2
	Agricultural Research	1	.4	.4	52.6
	Agriculture	2	.9	.9	53.5
	Airline	1	.4	.4	53.9
	Arms and Defence	1	.4	.4	54.3
	Aviation	1	.4	.4	54.8
	Banking	1	.4	.4	55.2
	Banking services	1	.4	.4	55.7
Valid	Building	2	.9	.9	56.5
	CAR -G.M	1	.4	.4	57.0
	Cement Manufacturing	1	.4	.4	57.4
	Cement manufacturing.	1	.4	.4	57.8
	Central bank	1	.4	.4	58.3
	Ceramics	1	.4	.4	58.7
	Civil	1	.4	.4	59.1
	Coal	1	.4	.4	59.6
	Construction	1	.4	.4	60.0
	Construction	2	.9	.9	60.9
	Cosmetics and perfumes	1	.4	.4	61.3
Valid	Defence	1	.4	.4	61.7
	Education	4	1.7	1.7	63.5
	Education	3	1.3	1.3	64.8
	Electrical engineering	1	.4	.4	65.2
	Electricity	1	.4	.4	65.7
	Electricity Generation	1	.4	.4	66.1
	Electricity supply	1	.4	.4	66.5
	Emergencies	1	.4	.4	67.0
	Energy sector	1	.4	.4	67.4
	Engineering	1	.4	.4	67.8
	Energy supplier	1	.4	.4	68.3
	Finance	2	.9	.9	69.1
	Finance and tax	1	.4	.4	69.6
	Financial	1	.4	.4	70.0
	Financial Services	1	.4	.4	70.4
	Government department	1	.4	.4	70.9
	Government	3	1.3	1.3	72.2
	Health	2	.9	.9	73.0
	Health care	1	.4	.4	73.5
	Hospital	1	.4	.4	73.9
	Hotel accommodation	1	.4	.4	74.3
Valid	HOUSING	1	.4	.4	74.8
	ICT Industry	1	.4	.4	75.2
	Industrial Diamond	1	.4	.4	75.7

	Inspection	1	.4	.4	76.1
	Inspection services	1	.4	.4	76.5
	Institution	1	.4	.4	77.0
	Insurance	1	.4	.4	77.4
	Insurance	1	.4	.4	77.8
	Insurance industry	1	.4	.4	78.3
	Insurance industry	1	.4	.4	78.7
	Internet Service Provider	1	.4	.4	79.1
	Local Government	2	.9	.9	80.0
	Maintenance	1	.4	.4	80.4
	Manufacturing	1	.4	.4	80.9
	Manufacturing-hospitality	1	.4	.4	81.3
	Medical	1	.4	.4	81.7
	Medical research	1	.4	.4	82.2
	Mineral Processing	1	.4	.4	82.6
	Mining	2	.9	.9	83.5
	Mining	4	1.7	1.7	85.2
	MINING SECTOR	1	.4	.4	85.7
Valid	Mining, Cement Industry	1	.4	.4	86.1
	Mining(Minerals)	1	.4	.4	86.5
	Municipality	1	.4	.4	87.0
	Municipality	1	.4	.4	87.4
	Non-profit organisation	1	.4	.4	87.8
	Painting	1	.4	.4	88.3
	Pension Administration	1	.4	.4	88.7
	Pharmaceutical	1	.4	.4	89.1
	Pharmaceutical	1	.4	.4	89.6
	Pharmacy	1	.4	.4	90.0
	Police	1	.4	.4	90.4
	Prosecutions	1	.4	.4	90.9
	Public sector	2	.9	.9	91.7
	PUBLIC SECTOR	1	.4	.4	92.2
	Retail	1	.4	.4	92.6
	Safety, defence & security	1	.4	.4	93.0
	Science and Technology	1	.4	.4	93.5
	Service delivery	2	.9	.9	94.3
	Services sector	1	.4	.4	94.8
	Statistics	1	.4	.4	95.2
	Technical	1	.4	.4	95.7
Valid	Training	2	.9	.9	96.5
	Transport	3	1.3	1.3	97.8
	Travel	1	.4	.4	98.3
	University	1	.4	.4	98.7
	Vehicle manufacturing	1	.4	.4	99.1
	Water treatment	1	.4	.4	99.6
	Youth centre	1	.4	.4	100.0
	Total	230	100.0	100.0	

5. Your company supplies products to:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Domestic markets	66	28.7	30.6	30.6
	International markets	13	5.7	6.0	36.6
	Both	137	59.6	63.4	100.0
	Total	216	93.9	100.0	
Missing	System	14	6.1		
Total		230	100.0		

6. Does your company currently have a:[Work Study department]

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	175	76.1	76.1	76.1
	Yes	55	23.9	23.9	100.0
	Total	230	100.0	100.0	
[Industrial Engineering (IE) department]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	186	80.9	80.9	80.9
	Yes	44	19.1	19.1	100.0
	Total	230	100.0	100.0	
[Productivity department]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	137	59.6	59.6	59.6
	Yes	93	40.4	40.4	100.0
	Total	230	100.0	100.0	
[None of the above]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	146	63.5	63.5	63.5
	Yes	84	36.5	36.5	100.0
	Total	230	100.0	100.0	

7. Which of the following process types is applicable to your organisation?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	198	86.1	86.1	86.1
	Yes	32	13.9	13.9	100.0
	Total	230	100.0	100.0	
[Job shop production]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	176	76.5	76.5	76.5
	Yes	54	23.5	23.5	100.0
	Total	230	100.0	100.0	
[Batch production]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	187	81.3	81.3	81.3
	Yes	43	18.7	18.7	100.0
	Total	230	100.0	100.0	
[Repetitive production]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	126	54.8	54.8	54.8
	Yes	104	45.2	45.2	100.0
	Total	230	100.0	100.0	
[Continuous production]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	182	79.1	79.1	79.1
	Yes	48	20.9	20.9	100.0
	Total	230	100.0	100.0	
[Project type]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	182	79.1	79.1	79.1
	Yes	48	20.9	20.9	100.0
	Total	230	100.0	100.0	

[Other]

		Frequency	Percent	Valid Percent	Cumulative Percent
		204	88.7	88.7	88.7
	Bargaining council	1	.4	.4	89.1
	Business Process Modelling	1	.4	.4	89.6
	Call centre operation	1	.4	.4	90.0
	Continuous performance	1	.4	.4	90.4
	Conveyance of goods	1	.4	.4	90.9
	Customer service	3	1.3	1.3	92.2
	Distribution process	1	.4	.4	92.6
	Education	1	.4	.4	93.0
Valid	Financial markets	1	.4	.4	93.5
	Health services	1	.4	.4	93.9
	Healthcare	1	.4	.4	94.3
	Inspection	1	.4	.4	94.8
	Institution	1	.4	.4	95.2
	JIT	1	.4	.4	95.7
	Mining	1	.4	.4	96.1
	None	1	.4	.4	96.5
	Paying of members pension	1	.4	.4	97.0
	Prosecution service	1	.4	.4	97.4
Valid	Selling life policies & investment	1	.4	.4	97.8
	Service	1	.4	.4	98.3
	Service delivery	1	.4	.4	98.7
	Service Delivery	1	.4	.4	99.1
	Service sector	1	.4	.4	99.6
	Various	1	.4	.4	100.0
	Total	230	100.0	100.0	

8. How do you monitor your production outputs?[Daily production reporting]

		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	112	48.7	48.7	48.7
Valid	Yes	118	51.3	51.3	100.0
	Total	230	100.0	100.0	
[Weekly production reporting]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	158	68.7	68.7	68.7
Valid	Yes	72	31.3	31.3	100.0
	Total	230	100.0	100.0	
[Efficiency reporting system]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	165	71.7	71.7	71.7
Valid	Yes	65	28.3	28.3	100.0
	Total	230	100.0	100.0	
[Production meetings]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	145	63.0	63.0	63.0
Valid	Yes	85	37.0	37.0	100.0
	Total	230	100.0	100.0	
[Production reporting]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	173	75.2	75.2	75.2
Valid	Yes	57	24.8	24.8	100.0
	Total	230	100.0	100.0	
[Improvement circles]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	203	88.3	88.3	88.3

	Yes	27	11.7	11.7	100.0
	Total	230	100.0	100.0	
[Recording the number of units produced]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	177	77.0	77.0	77.0
Valid	Yes	53	23.0	23.0	100.0
	Total	230	100.0	100.0	
[Rand value of outputs]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	178	77.4	77.4	77.4
Valid	Yes	52	22.6	22.6	100.0
	Total	230	100.0	100.0	
[Other]					
		Frequency	Percent	Valid Percent	Cumulative Percent
		220	95.7	95.7	95.7
	Average handling time of calls	1	.4	.4	96.1
	How many services was rendered	1	.4	.4	96.5
	Education	2	.9	.9	97.4
	Inspection appointments	1	.4	.4	97.8
Valid	Monitor the quality and labelling of the product	1	.4	.4	98.3
	Monthly project review	1	.4	.4	98.7
	Meetings	1	.4	.4	99.6
	Monthly reports	2	.9	.9	100.0
	SDBIP	1	.4	.4	
	Total	230	100.0	100.0	

9. When do you analyse your finished products production?

		Frequency	Percent	Valid Percent	Cumulative Percent
	Hourly	51	22.2	23.5	23.5
	Daily	85	37.0	39.2	62.7
Valid	Weekly	30	13.0	13.8	76.5
	Monthly	51	22.2	23.5	100.0
	Total	217	94.3	100.0	
Missing	System	13	5.7		
Total		230	100.0		

10. How were the production targets developed?

[Thumb-suck or gut feel]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	220	95.7	95.7	95.7
Valid	Yes	10	4.3	4.3	100.0
	Total	230	100.0	100.0	
[Using historical data]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	157	68.3	68.3	68.3
Valid	Yes	73	31.7	31.7	100.0
	Total	230	100.0	100.0	
[Work measurement]					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not selected	148	64.3	64.3	64.3

	Yes	82	35.7	35.7	100.0
	Total	230	100.0	100.0	
[Work Study department]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	199	86.5	86.5	86.5
Valid	Yes	31	13.5	13.5	100.0
	Total	230	100.0	100.0	
[Industrial Engineering department]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	207	90.0	90.0	90.0
Valid	Yes	23	10.0	10.0	100.0
	Total	230	100.0	100.0	
[Management experience]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	170	73.9	73.9	73.9
Valid	Yes	60	26.1	26.1	100.0
	Total	230	100.0	100.0	
[Motion and time study]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	206	89.6	89.6	89.6
Valid	Yes	24	10.4	10.4	100.0
	Total	230	100.0	100.0	
[By conducting research studies]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	200	87.0	87.0	87.0
Valid	Yes	30	13.0	13.0	100.0
	Total	230	100.0	100.0	
[Benchmarking]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	178	77.4	77.4	77.4
Valid	Yes	52	22.6	22.6	100.0
	Total	230	100.0	100.0	
[By consultants]					
		Frequency	Percent	Valid Percent	Cumulative Percent
	Not selected	206	89.6	89.6	89.6
Valid	Yes	24	10.4	10.4	100.0
	Total	230	100.0	100.0	

11. Does your organization currently have time standards for processes developed by Work Study or Ind. Engineering?

		Frequency	Percent	Valid Percent	Cumulative Percent
	Yes	110	47.8	50.5	50.5
Valid	No	108	47.0	49.5	100.0
	Total	218	94.8	100.0	
Missing	System	12	5.2		
Total		230	100.0		

12. Does your organisation currently have an efficiency reporting system?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	172	74.8	78.9	78.9

No	46	20.0	21.1	100.0
Total	218	94.8	100.0	
Missing	12	5.2		
Total	230	100.0		

13. The time standards were set by which of the following?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Work Study department	61	26.5	43.0	43.0
Valid Industrial Engineering department	28	12.2	19.7	62.7
Valid Consultants	53	23.0	37.3	100.0
Valid Total	142	61.7	100.0	
Missing System	88	38.3		
Total	230	100.0		

[Other]

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Based on process requirements	181	78.7	78.7	78.7
Valid By comparison of previous records	1	.4	.4	79.1
Valid By management	1	.4	.4	79.6
Valid Client	1	.4	.4	80.0
Valid Clients	1	.4	.4	80.4
Valid Daily reports	1	.4	.4	80.9
Valid Don't know	1	.4	.4	81.3
Valid Food Quality Safety	2	.9	.9	82.2
Valid Generated from Australia	1	.4	.4	82.6
Valid In House	1	.4	.4	83.0
Valid Internal consultants through Capability studies	1	.4	.4	83.5
Valid Machine manufactures	1	.4	.4	83.9
Valid Management	1	.4	.4	84.3
Valid Management	2	.9	.9	85.2
Valid Managers	2	.9	.9	86.1
Valid Managers	1	.4	.4	86.5
Valid Managers	1	.4	.4	87.0
Valid Myself (WIP)	1	.4	.4	87.4
Valid No time standards	1	.4	.4	87.8
Valid No time standards set	2	.9	.9	88.3
Valid None	1	.4	.4	88.7
Valid None	3	1.3	1.3	90.0
Valid Not sure who did it	1	.4	.4	90.4
Valid Not that I know of	1	.4	.4	90.9
Valid Not yet aware	1	.4	.4	91.3
Valid Observations on previous jobs	1	.4	.4	91.7
Valid Planning Department	1	.4	.4	92.2
Valid Plant suppliers	1	.4	.4	92.6
Valid Political	2	.9	.9	93.0
Valid production manager	1	.4	.4	93.5
Valid Production manager	1	.4	.4	93.9
Valid Production Manager	1	.4	.4	94.3
Valid Programme manager	1	.4	.4	94.8
Valid Project managers	1	.4	.4	95.2
Valid Project managers - (project based work)	1	.4	.4	95.7
Valid Quality dept. & management	1	.4	.4	96.1
Valid Research & development	1	.4	.4	96.5

	Safety Reporting Office	1	.4	.4	97.8
Valid	Sole Prop	1	.4	.4	98.3
	Standards set by equipment efficiency.	1	.4	.4	98.7
	System development and testing	1	.4	.4	99.1
	TECHNICAL DIRECTOR	1	.4	.4	99.6
	Volumes set by customer	1	.4	.4	100.0
	Total	230	100.0	100.0	

14. Who is responsible for recording and calculating the efficiency in your organisation?

		Frequency	Percent	Valid Percent	Cumulative Percent
	Clerk	18	7.8	9.9	9.9
Valid	Supervisor	43	18.7	23.8	33.7
	Manager	120	52.2	66.3	100.0
	Total	181	78.7	100.0	
Missing	System	49	21.3		
Total		230	100.0		

[Other]

		Frequency	Percent	Valid Percent	Cumulative Percent
	All of the above on different levels	205	89.1	89.1	89.1
	Automatically by MIS system	1	.4	.4	89.6
	BARCO SYSTEM	1	.4	.4	90.0
	Business resource department	1	.4	.4	90.4
	By SAP system	1	.4	.4	90.9
	CEO	2	.9	.9	91.3
	Coordinator	1	.4	.4	92.2
	Exco	1	.4	.4	92.6
Valid	Factory Accountant	1	.4	.4	93.0
	For production -IE are responsible	1	.4	.4	93.5
	Industrial engineer	1	.4	.4	93.9
	Industrial engineering	1	.4	.4	94.3
	manager and owner	1	.4	.4	94.8
	Masthead	1	.4	.4	95.2
	Me	1	.4	.4	95.7
	Metallurgists	1	.4	.4	96.1
	Myself	1	.4	.4	96.5
Valid	None	1	.4	.4	97.0
	Principal	1	.4	.4	97.4
	Process Department (Metallurgist)	1	.4	.4	97.8
	Production co-ordinator	1	.4	.4	98.3
	Project Managers	1	.4	.4	98.7
	Secretary	1	.4	.4	99.1
	Senior technician	1	.4	.4	99.6
	Total	230	100.0	100.0	100.0

15. What does your organisation do with the results?[Discussed at production meetings]

		Frequency	Percent	Valid Percent	Cumulative Percent
	1 Agree strongly	119	51.7	55.6	55.6
	2	42	18.3	19.6	75.2
Valid	3	26	11.3	12.1	87.4
	4	12	5.2	5.6	93.0
	5 Disagree strongly	15	6.5	7.0	100.0
	Total	214	93.0	100.0	
Missing	System	16	7.0		

Total	230	100.0	
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[Results are displayed in the department]

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1 Agree strongly	83	36.1	39.0	39.0
2	40	17.4	18.8	57.7
3	33	14.3	15.5	73.2
4	19	8.3	8.9	82.2
5 Disagree strongly	38	16.5	17.8	100.0
Total	213	92.6	100.0	
Missing System	17	7.4		
Total	230	100.0		

[Use it to take corrective action on non-conformances]

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1 Agree strongly	94	40.9	44.1	44.1
2	45	19.6	21.1	65.3
3	34	14.8	16.0	81.2
4	22	9.6	10.3	91.5
5 Disagree strongly	18	7.8	8.5	100.0
Total	213	92.6	100.0	
Missing System	17	7.4		
Total	230	100.0		

[Used to show performance of departments]

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1 Agree strongly	100	43.5	46.7	46.7
2	42	18.3	19.6	66.4
3	27	11.7	12.6	79.0
4	22	9.6	10.3	89.3
5 Disagree strongly	23	10.0	10.7	100.0
Total	214	93.0	100.0	
Missing System	16	7.0		
Total	230	100.0		

[Staff are notified of the results]

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1 Agree strongly	93	40.4	43.3	43.3
2	32	13.9	14.9	58.1
3	30	13.0	14.0	72.1
4	25	10.9	11.6	83.7
5 Disagree strongly	35	15.2	16.3	100.0
Total	215	93.5	100.0	
Missing System	15	6.5		
Total	230	100.0		

ANNEXURE H

ANALYSIS OF VARIOUS TAPS AND THEIR STANDARD TIMES

TAP A:								
Step no.	Description	Basic time	Frequency	Selected basic time	RA %	Cont. allowance	Other allowance	Actual time
1		0.153	1/1	0.153	12	0.007	0	0.171
2		0.154	1/1	0.154	12	0.007	0	0.172
3		0.103	1/1	0.103	12	0.005	0	0.115
4		0.096	1/1	0.096	12	0.004	0	0.107
5		0.129	1/1	0.129	12	0.006	0	0.144
6		0.101	1/1	0.101	12	0.005	0	0.113
7		0.069	1/1	0.069	12	0.003	0	0.077
Total actual time:								0.899
Contingency allowance:								0.036
Standard time:								0.935
TAP B:								
Step no.	Description	Basic time	Frequency	Selected basic time	RA %	Cont. allowance	Other allowance	Actual time
1		0.153	1/1	0.069	12	0.003	0	0.102
2		0.154	1/1	0.154	12	0.007	0	0.172
3		0.103	1/1	0.103	12	0.005	0	0.115
4		0.096	1/1	0.096	12	0.004	0	0.107
5		0.129	1/1	0.129	12	0.006	0	0.144
6		0.101	1/1	0.101	12	0.005	0	0.113
7		0.069	1/1	0.069	12	0.003	0	0.077
Total actual time:								0.830
Contingency allowance:								0.032
Standard time:								0.862
TAP C:								
Step no.	Description	Basic time	Frequency	Selected basic time	RA %	Cont. allowance	Other allowance	Actual time
1		0.153	1/1	0.153	12	0.007	0	0.080
2		0.154	1/1	0.154	12	0.007	0	0.172
3		0.103	1/1	0.103	12	0.005	0	0.115
4		0.096	1/1	0.096	12	0.004	0	0.107
5		0.129	1/1	0.129	12	0.006	0	0.144
6		0.101	1/1	0.101	12	0.005	0	0.113
7		0.069	1/1	0.069	12	0.003	0	0.077
Total actual time:								0.808

Contingency allowance:								0.036
Standard time:								0.844
TAP D:								
Step no.	Description	Basic time	Frequency	Selected basic time	RA %	Cont. allowance	Other allowance	Actual time
1		0.153	1/1	0.153	12	0.007	0	0.189
2		0.154	1/1	0.154	12	0.007	0	0.172
3		0.103	1/1	0.103	12	0.005	0	0.115
4		0.096	1/1	0.096	12	0.004	0	0.107
5		0.129	1/1	0.129	12	0.006	0	0.144
6		0.101	1/1	0.101	12	0.005	0	0.113
7		0.069	1/1	0.069	12	0.003	0	0.077
Total actual time:								0.917
Contingency allowance:								0.036
Standard time:								0.953
TAP E:								
Step no.	Description	Basic time	Frequency	Selected basic time	RA %	Cont. allowance	Other allowance	Actual time
1		0.153	1/1	0.153	12	0.007	0	0.199
2		0.154	1/1	0.154	12	0.007	0	0.180
3		0.103	1/1	0.103	12	0.005	0	0.165
4		0.096	1/1	0.096	12	0.004	0	0.167
5		0.129	1/1	0.129	12	0.006	0	0.144
6		0.101	1/1	0.101	12	0.005	0	0.113
7		0.069	1/1	0.069	12	0.003	0	0.077
Total actual time:								1.045
Contingency allowance:								0.036
Standard time:								1.081

JOURNAL ARTICLES

ANNEXURE I

EFFICIENCY REPORTING SYSTEM

(COMPACT DISK)