Factors contributing to productivity in the South African Electronic Manufacturing Industry

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1545613

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ABSTRACT

Electronic manufacturing services companies play an important role in the South African economy and society. They contribute to the growth of the country and provides sustainable jobs to the community.

The purpose of this reseach was to identify the perceived factors that contributed to productivity, either negative or positive, within the electronic manufacturing industry in South Africa. By identifying these factors and making it known, leaders in the industry can make use of the information to improve their levels of productivity within their organisations.

A quantitative approach was taken in this research and data was gathered through a Likert scale survey on the electronic manufacturing services industry within South Africa. From the literature review, 12 broad variables were identified as contributing factors to productivity. The research concluded that six of the 12 variables contributed to productivity negatively. These six variables were grouped broadly into three factor categories, namely Skills, Process and Preventative measures.

The outcome of this study highlights the main contributors to poor productivity and the industry will now be aware of these factors. This gives management within this sector the opportunity to focus on these factors to improve the levels of productivity within their organisations.

DECLARATION

I, Vinay Ramhari, declare that this research article is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the Graduate School of Business Administration, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Vinay Ramhari

Signed at ……………………………………………………

On the …………………………… day of ………………………… 2018

DEDICATION

To my wife Katharina Ramhari, thank you for all the love and support that you have given to me throughout this journey. Thank you for believing in me and pushing me to challenge my limits. You have been my pillar of strength and a huge source of motivation and encouragement. I would not have achieved all that I have without your continuous love and support.

To my brothers Lawrence, Terence and Sudesh, thank you for all the encouragement and support that you all have given to me. To my late parents Heeraman and Sushila Devi Ramhari, thank you for instilling in me the values that I have today. To have continuously pushed me to further my studies and for teaching me the importance of education. I will not have become the person I am today without the guidance, belief and love that you have given to me.

I would like to dedicate this achievement to my son Tristan Vinay Ramhari. I hope that I can provide you with all the opportunities to pursue your education and dreams. You are the reason I want to do and be more.

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1 INTRODUCTION

The global electronics industry should make up roughly R16.31 trillion (1.5%) of global gross domestic product (GDP), assuming the global economy makes an estimated GDP of R1087.2 Trillion (Ross, 2015). According to Statistics South Africa (Stats S.A.), the average South African household spends around R107.5 billion on information and communication technology (ICT) products which contributes 4.6% of total household expenditure (Stats S.A., 2017). This means that for every R100 spent by households, R4.60 is spent on ICT products.

ICT's contribution was at 2.7% (R93 billion) to GDP which was larger than the contribution from agriculture by 0.3% (Stats S.A., 2017). In other words, for every R100 produced by the economy, R2.70 was due to ICT activities with almost two thirds being generated from telecommunication activities, and the other third combined with activities from the computer services and manufacturing of ICT equipment, such as electronic components and devices (Stats S.A., 2017).

ICT imports in 2014 was valued at R130.983 billion compared to its exports valued at R33.794 billion leaving South Africa with a trade deficit of R97.189 billion (Stats S.A., 2017). The trade deficit in South Africa from ICT activities has grown from R42 billion in 2011 to R97 billion in 2014 (Stats S.A., 2017). It can be surmised that with inflation, the contribution in percentage to GDP is about the same and that the trade deficit has since increased in respect to the present date.

It can be seen that there is a great demand for ICT products globally and locally. Thus, there is a great demand for the manufacturing services to produce these goods. By increasing ICT productivity, this can decrease costs and increase product output which will contribute positively towards a greater demand for the service locally. Not only will this make companies more competitive (Hamel, 2017), but it will also increase contributions towards GDP and also assist in reducing the trade deficit locally within South Africa.

According to the South African Electrotechnical Export Council (SAEEC), South Africa has a critical mass of experienced well-established electronic manufacturing firms that have been in existence for over 40 years in the country and can offer a complete electronics value chain (SAEEC, 2017). South African electronic manufacturing firms' value proposition focuses on specialisation, high quality, high technology, customisation and flexibility (SAEEC, 2017).

The industry has developed a competitive advantage by being flexible and adaptable in its manufacturing approach with a higher production capacity than most mid-sized European firms (SAEEC, 2017). The electronic manufacturing industry in South Africa serves the high-tech and mixed technology markets by utilising a wide variety of technological platforms (SAEEC, 2017).

1.1 Purpose of the study

The purpose of this research is to better understand the electronic manufacturing service (EMS) industry through an in-depth investigation and to identify and evaluate the perceived factors that contribute to productivity. The research also aids in identifying factors contributing to poor productivity and that of higher productivity. By identifying these factors, it can help EMS providers to improve productivity to be able to deliver on time at the right quality and at the right price, making them more competitive. Information was gathered through an industry survey. Through this research, a better understanding can be achieved to whether this industry is or is not performing to its maximum potential. The literature review highlights the factors that contribute to productivity. The research identifies the perceived factors that need to be improved to contribute towards higher productivity levels.

1.2 Context of the study

Managing the production of electronics manufacturing is challenging and companies must be proactive to counter market uncertainties in a productive way (Helo, 2004). In addition, factors such as more demanding customers, advancing technology, increasing labour cost and shortening product lifecycles is putting more challenges on electronic manufacturers (Wang, Hsu, Wang, & Pham, 2017).

With all operations having an interest in keeping costs as low as possible and still maintaining the levels of quality, speed, dependability and flexibility as required by customers (Pycraft et al., 2010), the main focus for EMS providers is on-time delivery at the right quality, and at the right price. A limiting factor that can prevent an EMS provider from achieving this could be due to low levels of productivity (product throughput) due to various reasons.

Productivity has a direct impact on a company’s profitability, costs, quality and on-time deliveries which ultimately determines its survival and growth in the market place as more productive businesses displace less productive ones (Stanfield, Haltiwanger, & Syverson, 2008). Global competition among organisations has led to higher demands on the manufacturing organisations as a result of a dynamic and constantly changing environment (Miyake, 1999). This requires improvements in organisational performance through cost reductions, improving productivity levels, quality and ensuring customer deliveries are met to satisfy the customers (Raouf, 1994).

With global competition constantly on the rise in the industry as well as within South Africa, product throughput at the highest quality and at the lowest cost delivered to the customer when required is a major point of focus to ensure competitiveness. Those companies that can effectively achieve this will gain competitive advantage and ensure future survival. Those companies that fall behind, risk being put out of business. The more products that are produced with the same resources ensures that the product variable costs are decreased. This, combined with a high level of quality and a low reject rate, will contribute towards industry competitiveness.

Thus, there is a need to explore what are the contributing factors of productivity. Then to understand the reasons for it and improve on those that contribute to productivity and to reduce or eliminate those factors that are preventing EMS providers from achieving maximum productivity.

1.3 Problem statement

1.3.1 Main Problem

To evaluate the perceived factors that most influence productivity in the South African electronic manufacturing industry.

1.3.2 Sub-problem 1

Determine what manufacturing process techniques contribute to productivity?

1.3.3 Sub-problem 2

Determine how employees contribute to productivity?

1.4 Research Objectives

The research objectives for this research is to get a better understanding of:

- The perceived factors contributing to productivity in the EMS industry in South Africa.
- Determining what manufacturing process techniques contribute to productivity.
- Determining the manufacturing process techniques used within the industry and that are implemented by the employees.
- Determining how employees contribute to productivity, and to
- Determine the inhibitors of the manufacturing process and of employees from reaching high levels of productivity.

By gathering data through a survey and performing analysis on the data, challenges faced by the EMS industry in achieving maximum productivity levels are highlighted. The main outcome of the research is to provide the industry with a better understanding of these factors. Recommendations are provided to aid the industry to improve productivity levels.

1.5 Significance of the study

Operations have an interest in keeping costs as low as possible and still maintaining the levels of quality, speed, dependability and flexibility as required by customers (Pycraft et al., 2010), and this means that they have to maintain high levels of productivity. As more productive businesses displace less productive ones (Stanfield et al., 2008), EMS companies need to be geared to be competitive or must face the possibility of closure.

There is a strong stress on productivity improvement in a competitive business environment with productivity closely linked with quality, technology and profitability (Kumar & Suresh, 2009). The more productive a company is, the less expensive are their product costs and services. All operations are increasingly concerned with cutting out waste, whether it is from wastage of material, staff time or underutilised facilities (Pycraft et al., 2010). This means that the costs of transformed and transforming resource inputs must decrease to contribute to an increase in productivity (Pycraft et al., 2010).

According to EMS Solutions, electronic manufacturing services and small and mid-sized contract manufacturers are facing their greatest challenges (EMS Solutions, 2017). This is due to manufacturing innovations and global competition driving prices down, a complex global supply chain where material is being sourced from all over the world, consumer’s tastes and preferences changing rapidly, resulting in shortened product lifecycles, uncertain consumer demands, and sustainability to maintain corporate responsibility and environmental requirements (EMS Solutions, 2017). Therefore, these increasing challenges require EMS companies to be more capable, adaptable and responsive in the industry (Wang et al., 2017).

1.6 Delimitations of the study

- The study was limited around six EMS companies in South Africa.
- The survey was limited to only employees in the EMS industry.
- The study is limited to factors affecting productivity.
- Not all employees have access to email and Internet, therefore some of the surveys were manually completed.

1.7 Definition of terms

Productivity - Rogers and Rogers (1998) define productivity as the ratio of output to input for a specific production situation. The measure of the level of productivity for a single firm that produces one output (y) using a single input (x), is the ratio of these two (y/x) (Rogers & Rogers, 1998).

Value Stream Mapping (VSM) – A value stream is a collection of all actions including information and materials in the supply chain that are required to bring a product or group of products, using the same resources through the main flows from raw materials to the end customer, with the main aim of identifying and eliminating all types of waste in the value chain (Rother & Shook, 1999).

Continuous Improvement (CI) – can be defined as incremental improvement of products, processes, or services over time, with the goal of reducing waste to improve workplace functionality, customer service, or product performance (Marin-Garcia & Bonavia, 2011).

Root Cause Analysis (RCA) - Mahto and Kumar (2008) define RCA as using a structured methodology or technique to solve problems by identifying the causal factors.

1.8 Assumptions

The following assumptions were made:

1. Respondents answered the survey at their own free will.
2. Respondents were not coerced when answering the survey.
3. Responds answered the survey honestly and as accurately as they could.
4. There were more than 50 required responses to render the descriptive analysis study valid.
5. Respondents understood the questions in the survey clearly and without any ambiguity.

2 APPLICATION OF PRIOR RESEARCH

The literature review is to provide guidance in identifying the possible factors that contribute to productivity and best practices. Management theories that are applicable to the problem are determined through the literature review and are interpreted in the context of the problem statement. Trans-disciplinary management theories that are applicable to the problem statement are applied and integrated. Research questions are determined from the literature review. There is an introduction to the literature review with a brief description of the structure and contents of the review, some background and definition of the problem, factors contributing to the problem are identified and discussed and finally, the literature reviewed is summarised and concluded.

2.1 Introduction

"Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker" (Krugman, 1994).

The concept of productivity is a widely discussed subject matter, but it is often vaguely defined and poorly understood (Tangen, 2002). In practice, this lack of knowledge results in productivity being ignored by those who influence the production processes (Tangen, 2002). It is argued that productivity is one of the most important basic variables governing economic production activities and productivity is seen as one of the most vital factors affecting a manufacturing company's competitiveness (Tangen, 2002). Productivity of employees is also an important consideration for businesses, as much of the success of any organisation relies upon the productivity of its workforce (Rouse, 2017).

Productivity is closely connected to the use and availability of resources and will be reduced if a company's resources are not properly used or if there is a lack of them (Tangen, 2002). There is a strong link between productivity and value creation (Tangen, 2002). High productivity is achieved when activities and resources within production add value to products (Tangen, 2002). Waste within production negatively impacts on productivity, and by reducing waste, this can increase productivity levels (Tangen, 2002).

The objectives of productivity measurement include technology, efficiency, real cost savings, benchmarking production processes and living standards (Co-operation & Development, 2001). High productivity spill-overs and greater incentives for capital improvement are a result of the combined effect of higher skills and the technology component of manufacturing production (Dabla-Norris, Ho, Kochhar, Kyobe, & Tchaidze, 2014).

2.2 Definition of topic or background discussion

Productivity is the measure of how successful an organisation is at keeping their costs as low as possible while maintaining the customers' required level of quality, speed, dependability and flexibility (Pycraft et al., 2010). It is the ratio of the output of an operation or process to its inputs (Pycraft et al., 2010).

Productivity can be defined in terms of utilisation of resources, like material and labour where productivity is the ratio of output to input and productivity of labour can be measured as units produced per labour hour worked (Kumar & Suresh, 2009). Productivity is closely linked with quality, technology and profitability and can be improved by controlling inputs, improved technology, and improving process so that the same input yields higher output (Kumar & Suresh, 2009).

Productivity in Industrial Engineering is defined as the relation of output (i.e. produced goods) to input (i.e. consumed resources) in the manufacturing transformation process (Tangen, 2002).

Productivity measures how efficiently production inputs, such as labour and capital, are being used in an economy to produce a given level of output and it is the basic statistical information for many international comparisons and country performance assessments and is considered a key resource of economic growth and competitiveness (Krugman, 1994).

Above are different definitions of productivity. The different authors talk about productivity in terms of costs, utilisation of resources, relationship of output to input, and the efficient use of production inputs. Ultimately, they all are referring to ways in which output can be increased from the use of the same available resources/inputs.

2.3 What are the factors contributing to productivity?

2.3.1 Continuous Improvement (CI)

Manufacturing companies all over the world experience increased competition, by improving productivity, ensuring quality and increasing delivery reliability through continuous improvement which is a commonly used method to increase the competitive edge (Hyland, Mellor, & Sloan, 2007). To the operational staff, CI is to improve the activities and functions in which they are involved (Bititci & Nudurupati, 2002).

Larsson, Strand, Persson, and Syberfeldt (2017) cite Bititci and Nudurupati (2002)'s important activities to succeed with CI in manufacturing companies which are:
1) To define the performance measures for all departments;
2) To clarify the relationship between the different types of performance measures;
3) To define improvement targets and to align them with the company targets; and
4) To communicate the performance measures throughout the organisation.

An integration of control indicators and improvement indicators could lead to continuous improvement results and increased business performance (Larsson et al., 2017). Continuous improvement actions, measures, and communication are vital to productivity improvements and are a vital contributing factor to productivity.

2.3.2 Overall Equipment Effectiveness (OEE)

Another contributing factor to productivity is to have machines running free of breakdowns and downtime. This contributes towards achieving high levels of overall equipment effectiveness (OEE). OEE is a measure of the value added to production through equipment with the goal to increase OEE so each part of the equipment can be operated to its full potential and maintained at that level (Dulange, Pundir, & Ganapathy, 2014). This can be achieved through total productive maintenance (TPM). This means that machines produce for longer with less downtime, thus contributing to the overall productivity.

2.3.3 Total Productive Maintenance (TPM)

TPM is an innovative approach to maintenance through day-to-day activities involving the total workforce (Singh, Gohil, Shah, & Desai, 2013). By performing this maintenance, equipment effectiveness can be optimised and breakdowns can be reduced or eliminated (Singh et al., 2013). TPM has been adopted in many industries across the world to address the above problem with the goal of improving productivity and quality along with increased employee morale and job satisfaction (Singh et al., 2013).

According to Ahuja and Khamba (2008), by putting priority on maintenance, this can improve productivity and reduce maintenance costs by up to a third. More machine uptime results in higher levels of productivity and downtime results in lower levels of productivity, hence TPM is a contributing factor to productivity.

2.3.4 Root Cause Analysis (RCA)

RCA is the cause that, if corrected, would prevent recurrence of a specific problem and similar occurrences (Mahto & Kumar, 2008). RCA can be implemented in each and every individual set up of manufacturing to improve product quality and productivity (Mahto & Kumar, 2008). If there are recurring failures creating downtime such as machine breakdowns, supply of material, etc., this would have a direct negative impact on productivity. Finding the root cause of the recurring problem and resolving it, allows for more machine uptime, quicker supply of materials, prevention of material losses, etc. and higher levels of OEE, resulting in a higher level of productivity.

2.3.5 Man power

Labour productivity is a crucial organisational outcome (Datta, Guthrie, & Wright, 2005). Employee turnover plays an important role in organisational productivity and employees in an organisation can bring about a competitive advantage that can be difficult to replicate by competitors (Huselid, 1995). Employees who are present at work can produce goods and supply services as opposed to those that are not at work. If there are employees who are not present at work, it could mean that a production operation or service unit would not run at full capacity. This could result in a reduced output which directly impacts the organisation's overall productivity.

2.3.6 Skills

Black and Lynch (1996) cite Bishop (1994) who states employer provided training raises employee productivity by almost sixteen percent. Black and Lynch (1996) also cite the findings of Bartel (1994) who states that lagged training investments rather than current training yield positive effects on productivity. Black and Lynch (1996)'s research shows that human capital is an important determinant of establishment productivity and that education has a positive and significant effect on productivity. Education can be both academic and hands-on training. It makes sense that the more familiar an employee is with a process or service, the better they can perform that task. The more output that can be achieved through the same employee is a contributing factor to productivity.

2.3.7 Line Balancing

Unbalanced production lines lead to bottlenecks which bring about many types of wastes such as waiting time, work in progress, overproduction, etc. which leads to low levels of productivity (Lam, Toi, & Tuyen, 2016). By balancing the line, this creates a smooth flow of production, making full use of the machine and man hours in respect to capacity. This means that no man or machine is idling or waiting for a process to be completed before they can start adding value to the process. Eliminating the different types of wastes associated with an unbalance line contributes to higher levels of productivity.

2.3.8 Total Quality Management (TQM)

TQM is an approach to the management of quality that emphasises the role of all parts of the business and all the employees within the business to influence and improve quality (Pycraft et al., 2010). If the overall quality is improved, the reject rate, loss of time and scraps will be reduced. If this is reduced, there will be an expected increase in output, therefore reducing waste and contributing to productivity.

2.3.9 Material Availability

Inaccurate inventory records result in shortages of material, disrupted schedules, late deliveries, lost sales, low productivity and excess inventory of wrong items having a negative impact on productivity levels (Matsebatlela & Mpofu, 2015). Having incorrect stock quantities, no stock or wrong stock will lead to low levels of productivity. Stock availability will determine the continuous flow of production. If there are stock discrepancies, it will lead to line stoppages, possibly incorrect builds from wrong material and possible reworks and/or scrap. Stock availability is a contributing factor to productivity as it can lead to wastages due to rework, line stoppages and possible scraps.

2.3.10 Supply Chain Management (SCM)

SCM has been a major component of competitive strategy to enhance organisational productivity and profitability (Gunasekaran, Patel, & McGaughey, 2004). SCM represents the most advanced state in the evolutionary development of procurements, purchasing and other supply chain activities (Thomas & Griffin, 1996). SCM is a vital factor to productivity. If the materials are not purchased and procured on time, this will affect lead times which will create delays in the arrival and availability of the materials to be used on the production lines. This will result in line stoppages and delays, thus leading towards less output which leads to lower levels of productivity.

2.3.11 Agility and Flexibility

Agility is the ability to respond quickly to market changes (Pycraft et al., 2010). Gunasekaran (1998), cites an anonymous author who wrote in 1995 that to be agile is to master change and uncertainty, and to integrate the employees of the organisation and information systems into all aspects of the business. Maintaining good productivity under the pressure of uncertainty is a concept of agile manufacturing (Helo, 2004). Flexibility refers to the capability to adapt to a changing environment and is seen as a close concept to agility (Helo, 2004). To be agile is to be able to perform quick change-overs to line setups, reallocating manpower to different processes and tasks when needed and having people multi-skilled, etc. thereby reducing waste to produce a higher output. Therefore, being agile and flexible is a contributor to productivity.

2.3.12 Human Resource Management

Huselid (1995) cites Cutcher-Gershenfeld (1991) in his article, stating that firms using "transformational" labour practices, emphasising cooperation and dispute resolution-had lower costs, less scrap, higher productivity, and a greater return to direct labour hours compared to firms using "traditional" labour relations practices. Quality of work life increases productivity (Huselid, 1995). If the employee is happy and stress free, they can perform better in their duties. When they are unhappy and stressed, this could lead to unwanted pressure, resulting in poor productivity levels and unforced errors.

2.3.13 Summary of factors affecting Productivity

There are various and multiple detailed factors that can contribute directly and/or indirectly to productivity. Above are the common factors that can influence productivity which is broadly grouped below:

1. **Process**

   Continuous Improvement (CI)
   Line Balancing
   Overall Equipment Effectiveness
   Material Availability

2. **Preventative Measures:**

   Total Productive Maintenance (TPM)
   Root Cause Analysis (RCA)
   Total Quality Management (TQM)

3. **Workforce / Labour**

   Manpower

4. **Skills**

   Skills

5. **Managerial factors:**

   Human Resource Management

   Supply Chain Management (SCM)

6. **Culture:**
   Agility and Flexibility

2.4 Models to mitigate the factors

In this section, models are used to ground the factors contributing towards productivity that were discussed in the previous section. All the factors are not found in one model as there are various and multiple detailed factors that can contribute directly and/or indirectly to productivity. The models below however cover the most common known factors to productivity.

2.4.1 An integrated model of enterprise productivity factors

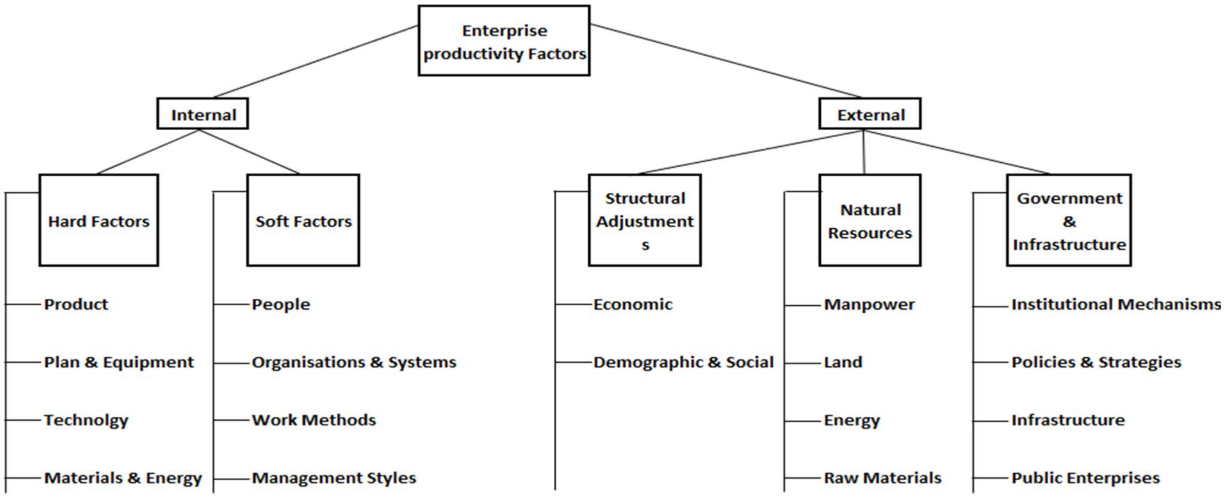

Figure 01: An integrated model of enterprise productivity factors

Source: Adapted from Mukherjee and Singh (1975, p. 93). Retrieved from Prokopenko (1987).

Prokopenko (1987), makes mention of many factors that can contribute to productivity. He separates them into the two major categories namely, external factors which is not controllable, and internal factors which are controllable. The first step towards improving productivity is to identify problem areas within these factor groups (Prokopenko, 1987).

2.4.2 Worker Productivity Factors

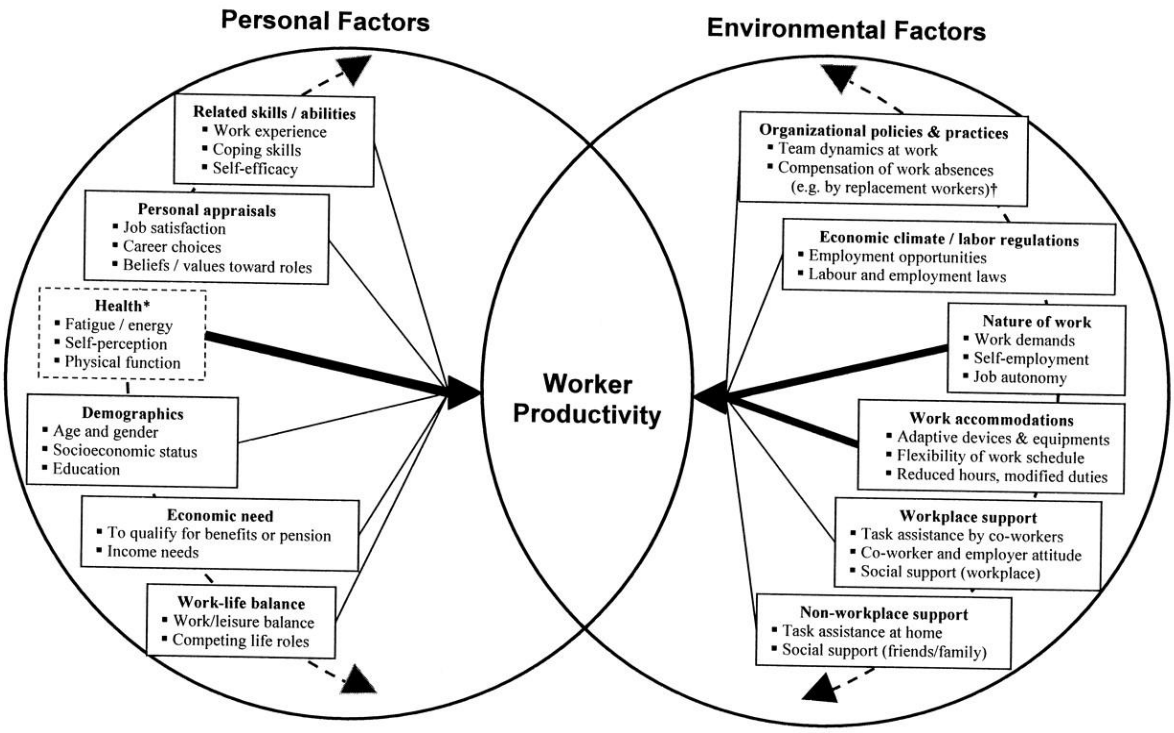

Figure 02: Conceptual representation of the interaction between contextual factors that contribute to the person-environment "fit".

Source Tang et al. (2011).

The model depicts the two categories that can affect.t worker productivity. Tang et al. (2011)'s research on all factors was organised into a proposed 2-tiered classification as either personal factors or environmental factors. Each category can be broken down into the finer factors that contribute to worker productivity that ultimately contribute towards the organisational overall quality.

The above two diagrams were chosen specifically because figure 01 depicts the organisational factors and figure 02 depicts the factors related to the person (employee). These two diagrams links to sub-problem 1 and sub-problem 2.

2.5 Conclusion of Literature Review

The literature review performed represent the factors contributing towards productivity. From the literature review, each factor can contribute both negatively or positively to productivity. The factors can occur individually or there can be a combination of factors affecting productivity.

<u>Proposition 1:</u> The factors contributing to productivity in the electronic manufacturing industry can be grouped as below:

1. Process
2. Preventative Measures
3. Workforce / Labour
4. Skills
5. Managerial factors
6. Culture

3 RESEARCH METHODOLOGY

This research is based on the understanding of perceived factors affecting productivity in the electronic manufacturing industry. The research methodology selected for the research is quantitative. The following sections explain the methodology in more detail in terms of the approach taken and the method used for data collection and analysis.

3.1 Research methodology / paradigm

A quantitative approach was taken in this research and data were gathered through a Likert scale survey. Quantitative research can be defined as explaining some phenomena by collecting numerical data that are analysed using mathematically based methods (Creswell, 2013). According to Borg (1989), quantitative research falls into two areas, namely studies that describe events and studies that are aimed at discovering inferences or causal relationships. This study aimed to discover inferences (a conclusion reached on the evidence or reasoning).

3.2 Research Design

A survey was developed to collect quantitative descriptive data through an online survey tool. Observational and survey methods are frequently used to collect descriptive data as descriptive studies are aimed at finding out "what is" (Borg, 1989). Survey research measures characteristics of the population with statistical precision by using scientific sampling and questionnaire design (Sukamolson, 2007). It provides estimates from a sample that can be related to the entire population with a degree of certainty (Sukamolson, 2007).

The questions in the survey were mainly derived from the literature review performed. An email with a cover letter was sent to potential respondents explaining the purpose of the survey and requesting their participation. They had an option to choose to participate or not in the survey. See Appendix A and B for more information on the letter and survey questionnaire.

3.3 Population and sample

3.3.1 Population

The population for this study included six electronic manufacturing companies in South Africa. There were no limitations regarding age, gender, race, education or experience in the industry. Four companies from Gauteng, one from the North-West province (Brits) and one from Cape Town were chosen for this study. The population included all levels within the organisation, namely top management, middle and junior management, support functions and direct employees.

3.3.2 Sample and sampling method

The random sampling method was used through a survey. Each member of the population has an equal and known chance of being selected (StatPac, 2017). An email with the survey link was sent to a lead contact at each of the six electronic manufacturing companies. They distributed the email to all staff members within their respective organisations ensuring that managers and direct employees in the organisation had a chance to choose to participate or not in the survey. A minimum sample quantity of fifty respondents was targeted.

3.4 The research instruments

A self-designed questionnaire was derived from the literature review to obtain the required data for the descriptive analysis. The questionnaire was developed from the literature review around the topics of Processes, Preventative Measures, Workforce/Labour, Skills, Managerial factors and Culture. The link to the survey was sent out on an email with a cover letter attached.

The cover letter contained the title of the research and explained the reason, purpose and value of the survey. All who received the survey had a choice when entering the survey at the beginning to accept and proceed with the survey or to decline participation in the survey. No person was forced to participate. The respondents of the survey remained anonymous.

The survey was a five-point Likert-type scale survey structured in three sections to obtain the required information for the research. The first section was the introduction, and this is where the respondent gave consent to proceed or leave the survey. The second part of the survey addressed demographic questions. The third part of the survey consisted of questions derived from the literature review on the perceived factors affecting productivity. The respondent had a choice in the Likert scale to choose one of the following options for each question:

1. Strongly Disagree
2. Disagree
3. Neither Agree or Disagree
4. Agree
5. Strongly Agree

3.5 Procedure for data collection

Data were gathered through the Likert-type survey questionnaire completed by respondents from the six chosen electronic manufacturing companies. A copy of the questionnaire was submitted to the WITS Business School committee for an ethical clearance and validation. The survey was distributed to the relevant chosen electronic manufacturing companies only after permission had been granted by the university committee giving clearance for the survey.

Discussions had already been undertaken with the chosen companies in respect to the survey, its purpose, reason for the survey, expected outcomes and how the research could benefit their organisations and the industry at large. Permission had been requested from the HR executive / relevant decision maker. Verbal permission had been obtained by these companies.

Email communication was sent specifically to these individuals to distribute the email within their organisations. The email included both the cover letter and the link to the survey. The cover letter introduced the researcher and covered the purpose, reason and benefits that would be obtained from their participation and explained to them that they are under no obligation to complete the survey and would remain completely anonymous.

The questionnaire was opened for two weeks after releasing it to the chosen companies to give them enough time to distribute the survey and to give enough time for the respondents to decide on participation and to complete the survey. This was to not put pressure on any individual to complete it within a short time frame. With this timeframe and the fact that the survey was anonymous, it was expected that questions would be answered honestly and as accurately as possible.

3.6 Data analysis and interpretation

Employees of the chosen six companies were asked to answer thirty open-ended questions related to the perceived factors affecting productivity in their respective organisations. The results were traceable via the organisations' Internet Protocol (IP) address that would retrieved through the software platform used to create the survey. Open-ended questions are designed to encourage a full, meaningful answer using the subject's own knowledge and/or feelings (Media College.com, 2017).

The data from the questionnaire were interpreted through descriptive statistics. Descriptive statistics are brief descriptive coefficients that summarise a given data set and are broken down into measures of central tendency and measures of variability or spread that help describe and understand the features of a specific data (Investopedia, 2017). Through the analysis, the common factors were extracted and evaluated further.

3.7 Limitations of the study

- A limitation was that not all respondents may have access to email. Therefore, there were some hard copies of the questionnaire that were distributed to respondents only to the companies in the Gauteng region due to accessibility.
- The questionnaire might not have covered all aspects of the business operations that could affect productivity.
- There is limited access to companies in the electronic manufacturing industry in South Africa.
- Only companies with which the researcher had direct contact were asked to participate due to convenience.

3.8 Validity and reliability

Validity is a key requirement for effective research and is thus a requirement for both qualitative and quantitative research (Cohen, Manion, & Morrison, 2013). Quantitative data validity might be improved through careful sampling, appropriate instrumentation and appropriate statistical treatments of the data (Cohen et al., 2013).

Threats to validity can be minimised by choosing an appropriate time scale, ensuring that there are adequate resources to undertake the research, selecting an appropriate methodology and instrument for answering the questions and gathering data, using an appropriate sample size, and to demonstrate internal and external validity, and to ensure reliability (Cohen et al., 2013).

This research has a time plan that must be followed with a two-week cut-off time to get the survey questions answered after approval of the survey. There are enough resources to undertake the research. There are six companies with a total staff complement of almost one and a half thousand employees. The targeted minimum sample size is fifty respondents. A survey instrument was selected to get questions answered and to collect required and relevant data.

3.8.1 External validity

External validity refers to the degree to which the results can be generalised to the wider population, cases or situations (Cohen et al., 2013). A sample size of no less than fifty respondents is being targeted. Six companies have been included in the research and a minimum of fifty respondents has been targeted to mitigate the risk of having a low external validity.

3.8.2 Internal validity

Internal validity seeks to demonstrate that the explanation of an event, issue or set of data which a piece of research provides can be sustained by the data (Cohen et al., 2013). A survey was derived from an in-depth literature review and was validated by the WITS Business School committee, as well an external supervisor to help increase the internal validity.

3.8.3 Reliability

Reliability in quantitative research is based on dependability, consistency and replicability over time and must provide trustworthy information from respondents (Cohen et al., 2013). For a research to be reliable, it must demonstrate that similar results would be achieved if it were to be carried out with a new set of similar respondents (Cohen et al., 2013).

Reliability was increased through validation of the questionnaire by the WITS Business School committee, as well as by an external supervisor. The reliability was also increased by the fact that all included in the research received the exact same questionnaire to answer.

3.9 Conclusion

A Likert-scale survey was sent out to six companies with the aim of targeting a minimum population of fifty respondents with ten respondents from each company, based on random sampling. A quantitative research methodology was used to gather descriptive data that were analysed. From this data, factors that affect productivity were determine and further examined.

4 PRESENTATION OF THE RESULTS

Here will be a brief discussion on the approach and methodology of the descriptive analysis applied as well as a brief discussion on the results from the survey that was obtained.

4.1 Introduction

A survey was conducted to assess and evaluate perceptions of factors that most influence productivity in the South African electronic manufacturing Industry. There was a total of 92 respondents. From the 92 respondents there was a total of 72 respondents who completed the survey in totality. There were 20 incomplete surveys.

The first part of the survey required respondents to provide some demographic information about themselves. The next part was directed towards factors contributing to productivity. Respondents were then asked to indicate the level to which they agree/disagree from a Likert scale (1 = “Strongly Disagree”, 2 = “Disagree”, 3 = “Neither Agree or Disagree”, 4 = “Agree”, 5 = “Strongly Agree”) around the identified factor variables.

Quantitative analysis of the data was performed through descriptive statistics to describe the basic features of the study with simple summaries about the sample and measures. Central tendency, and measures of variability, or spread will be analysed.

4.2 Demographic profile of respondents

Below are the demographic statistics in tabulated form with a brief description only of the respondents that completed the survey.

Table 1 - Gender

Gender				
	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Male	43	59.72	43	59.72
Female	26	36.11	69	95.83
No Response	3	4.17	72	100

From the total of 72 respondents there were 43 (approximately 60%) male, 26 (approximately 36%) female and 3 (approximately 4%) chose to not respond.

Table 2 - Organisational Role

Organisational Role				
	Frequency	Percent	Cumulative Frequency	Cumulative Percent
High level Management	1	1.39	1	1.39
Senior management	5	6.94	6	8.33
Middle management	12	16.67	18	25
Support Role	8	11.11	26	36.11
Direct operations	45	62.5	71	98.61
No Response	1	1.39	72	100

Most of the respondents (45) were from direct operations with 18 from management, 8 from support roles and one with no response.

Table 3 - Age Group

Age Group				
	Frequency	Percent	Cumulative Frequency	Cumulative Percent
29 or below	17	23.61	17	23.61
30 - 39	26	36.11	43	59.72
40 - 49	14	19.44	57	79.16
50 or above	15	20.83	72	100

There is a good distribution in age group amongst the respondents. There are 43 respondents below the age of 40. There are 29 respondents above the age of 39.

Table 4 - Employment Status

Employment Status				
	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Temporary	0	0	0	0
Contractor	6	8.33	6	8.33
Part Time	0	0	6	8.33
Permanent	66	91.67	72	100
Other	0	0	72	100

Most of the respondents (66) are employed permanently with 6 employed on contract.

Table 5 - Qualifications

Qualifications				
	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Yes	50	69.44	50	69.44
No	21	29.17	71	98.61
No Response	1	1.39	72	100

Most of the respondents (50, approximately 70%) have a formal qualification, 21 respondents do not have a qualification and 1 with no response.

Table 6 - On-the-job training

On-the-job training				
	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Yes	56	77.78	56	77.78
No	16	22.22	72	100

Most of the respondents (56, approximately 78%) have been through a formal on-the-job training. There were 16 (approximately 23%) of the respondents that have not been for on-the-job training.

Table 7 - Organisational Productivity

Organisational Productivity				
	Frequency	Percent	Cumulative Frequency	Cumulative Percent
less than 50%	5	6.94	5	6.94
50% to 69%	11	15.28	16	22.22
70% to 79%	23	31.94	39	54.16
80% to 89%	20	27.78	59	81.94
90% to 100%	13	18.06	72	100

Most of the respondents (43) are between 70% to 89% productivity within their organisation. 16 respondents are below 70% organisational productivity and 13 respondents are above 89% organisational productivity.

4.3 Descriptive Analysis

Table 8 - Gaussian distribution fit algorithm

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Overall
Observed frequencies																															
1	23	42	21	15	16	16	19	19	28	35	19	10	15	6	21	13	18	6	14	8	7	14	13	17	9	10	9	15	7	21	486
2	44	25	25	37	36	47	30	36	32	32	29	25	31	30	35	31	33	34	21	29	23	31	30	36	30	25	22	28	23	28	918
3	7	3	13	15	17	9	18	16	10	7	15	21	19	18	16	20	14	15	25	23	26	18	15	11	20	19	16	17	25	5	473
4	5	9	16	11	8	5	12	7	8	3	8	17	9	22	4	8	6	13	10	11	9	5	9	4	4	9	17	7	8	12	276
5	1	1	5	1	3	3	1	0	1	2	2	5	4	2	1	3	6	8	5	6	6	4	5	3	8	7	8	4	9	6	120
n =	80	80	80	79	80	80	80	78	79	79	73	78	78	78	77	75	77	76	75	77	71	72	72	71	71	70	72	71	72	72	2273
Distribution parameters																															
μ =	-0,36	-0,78	0,03	-0,04	-0,05	-0,16	-0,05	-0,19	-0,40	-0,66	-0,15	0,33	0,04	0,40	-0,27	0,05	-0,07	0,34	0,18	0,30	0,36	0,00	0,07	-0,19	0,25	0,26	0,43	-0,01	0,43	-0,10	
σ^2 =	0,64	1,74	1,37	0,72	0,78	0,69	0,90	0,69	1,02	1,07	0,92	0,83	0,87	0,63	0,69	0,75	1,10	0,81	0,92	0,74	0,70	0,84	0,95	0,82	0,90	0,96	1,02	0,93	0,83	1,49	
Expected frequencies																															
1	23,7	39,8	19,3	14,7	16,2	17,9	17,4	18,2	27,6	35,4	18,4	8,6	14,6	5,1	20,3	12,4	18,9	8,0	11,6	7,9	6,0	14,0	13,5	18,0	9,7	9,9	8,2	14,8	6,5	20,6	
2	39,3	23,4	27,3	36,2	35,4	38,2	33,3	37,4	31,5	29,1	30,7	28,7	32,3	29,0	37,0	32,9	29,5	27,9	28,8	29,8	26,7	30,7	28,5	31,5	26,6	25,6	23,5	28,9	24,8	24,1	
3	12,4	8,8	15,0	17,4	17,0	15,8	16,5	15,0	12,0	9,2	13,9	20,0	17,2	23,2	13,5	17,5	14,8	19,7	17,5	20,6	19,8	15,7	15,7	13,3	17,1	16,5	17,2	14,9	18,9	12,4	
4	4,0	5,1	10,8	8,4	8,6	6,6	9,2	6,1	5,8	4,0	7,3	13,9	9,9	15,2	5,1	9,2	9,2	13,7	11,5	13,3	13,1	8,6	9,8	6,2	11,7	11,6	13,7	8,7	14,2	8,7	
5	0,6	3,0	7,6	2,3	2,7	1,5	3,6	1,3	2,1	1,3	2,7	6,9	3,9	5,5	1,0	3,0	4,6	6,6	5,6	5,4	5,3	3,1	4,5	1,8	5,9	6,4	9,4	3,7	7,6	6,2	
χ^2 contributions																															
1	0,0195	0,1247	0,1469	0,0061	0,0024	0,1987	0,1515	0,0330	0,0065	0,0050	0,0195	0,2264	0,0085	0,1460	0,0211	0,0247	0,0427	0,4958	0,4852	0,0024	0,1729	0,0000	0,0164	0,0608	0,0534	0,0010	0,0859	0,0042	0,0391	0,0077	
2	0,5553	0,1162	0,1971	0,0181	0,0089	2,0385	0,3307	0,0525	0,0080	0,2948	0,0974	0,4689	0,0542	0,0380	0,1056	0,1145	0,4190	1,3289	2,1308	0,0221	0,5176	0,0034	0,0784	0,6282	0,4223	0,0149	0,1013	0,0307	0,1302	0,6142	
3	2,3293	3,7950	0,2580	0,3426	0,0001	2,9516	0,1358	0,0691	0,3380	0,5423	0,0844	0,0549	0,1942	1,1559	0,4546	0,3726	0,0446	1,1298	3,2487	0,2847	1,9085	0,3516	0,0355	0,4064	0,4905	0,3763	0,0823	0,2882	1,9334	4,3818	
4	0,2602	2,9758	2,5490	0,8405	0,0428	0,3845	0,8492	0,1469	0,7976	0,2525	0,0682	0,6799	0,0839	3,0481	0,2425	0,1590	1,0939	0,0403	0,1904	0,4004	1,3096	1,4865	0,0610	0,8027	5,0274	0,5881	0,7713	0,3356	2,6898	1,2767	
5	0,1959	1,3354	0,9105	0,7466	0,0314	1,4763	1,8738	1,3354	0,5532	0,4320	0,1626	0,5011	0,0008	2,2660	0,0020	0,0008	0,4005	0,2805	0,0624	0,0586	0,0917	0,2576	0,0545	0,7318	0,7677	0,0646	0,1975	0,0299	0,2640	0,0077	
86,1365	3,3602	8,3471	4,0615	1,9539	0,0857	7,0496	3,3410	1,6370	1,7033	1,5267	0,4320	1,9313	0,3416	6,6541	0,8258	0,6716	2,0007	3,2753	6,1175	0,7681	4,0003	2,0991	0,2457	2,6299	6,7613	1,0449	1,2382	0,6885	5,0565	6,2881	
"Solver" parameter	τ_1	τ_2	τ_3	τ_4																											
Thresholds	-0,79	0,28	0,90	1,57																											
Means	-0,3060	-0,6614	0,0271	-0,0299	-0,0448	-0,1351	-0,0401	-0,1596	-0,3370	-0,5556	-0,1282	0,2780	0,0304	0,3413	-0,2265	0,0400	-0,0564	0,2879	0,1545	0,2545	0,3050	-0,0023	0,0624	-0,1631	0,2104	0,2196	0,3631	-0,0046	0,3617	-0,0852	
Variances	0,4596	1,2455	0,9852	0,5134	0,5624	0,4938	0,6481	0,4918	0,7343	0,7687	0,6563	0,5982	0,6237	0,4494	0,4934	0,5344	0,7916	0,5839	0,6585	0,5296	0,5007	0,5989	0,6781	0,5858	0,6463	0,6853	0,7295	0,6666	0,5926	1,0701	
Sample size, n =	1000		To prevent division by zero:																											0	
Hypothesis tests																															
t-value	-4,04	-5,30	0,24	-0,37	-0,53	-1,72	-0,45	-2,01	-3,50	-5,63	-1,35	3,17	0,34	4,50	-2,83	0,47	-0,56	3,29	1,65	3,07	3,63	-0,03	0,64	-1,80	2,21	2,22	3,61	-0,05	3,99	-0,70	
p-value	0,0001	0,0000	0,8077	0,7119	0,5943	0,0894	0,6571	0,0480	0,0008	0,0000	0,1807	0,0022	0,7348	0,0000	0,0060	0,6371	0,5796	0,0016	0,1035	0,0030	0,0005	0,9798	0,5223	0,0769	0,0308	0,0298	0,0006	0,9619	0,0002	0,4872	

Chi-test *p*-value: 0,9828

Table 8: Gaussian distribution fit algorithm continued…

Rescaling of values															
"Expected value" within category:															
1	-1,2963	-1,8390	-1,4825	-1,2538	-1,2868	-1,2691	-1,3341	-1,2745	-1,4710	-1,5700	-1,3630	-1,2320	-1,3024	-1,1371	-1,2946
2	-0,2712	-0,2846	-0,2371	-0,2287	-0,2331	-0,2439	-0,2355	-0,2476	-0,2692	-0,2906	-0,2461	-0,1934	-0,2260	-0,1641	-0,2580
3	0,5419	0,5629	0,5751	0,5606	0,5622	0,5540	0,5657	0,5525	0,5576	0,5514	0,5625	0,5781	0,5679	0,5786	0,5491
4	1,1455	1,1896	1,2000	1,1689	1,1733	1,1606	1,1809	1,1589	1,1747	1,1688	1,1776	1,1927	1,1824	1,1845	1,1553
5	1,8306	2,0924	2,1152	1,8920	1,9143	1,8679	1,9561	1,8637	1,9502	1,9353	1,9462	1,9869	1,9558	1,9165	1,8562
Squared differences from the mean:															
1	0,8739	1,1189	2,2936	1,4847	1,5223	1,2309	1,6557	1,1794	1,1513	0,8349	1,4680	2,4347	1,7910	2,3722	1,0548
2	0,0081	0,2467	0,0724	0,0374	0,0324	0,0071	0,0354	0,0035	0,0166	0,1337	0,0090	0,2722	0,0686	0,3218	0,0001
3	0,8161	1,8068	0,2949	0,3551	0,3784	0,5092	0,3759	0,5491	0,9132	1,4584	0,5096	0,0624	0,2830	0,0308	0,6670
4	2,2709	3,8843	1,3641	1,4502	1,5038	1,7428	1,5087	1,8154	2,4734	3,3308	1,7662	0,7471	1,3144	0,6105	2,0245
5	4,8051	8,2580	4,3397	3,7146	3,8699	4,1106	4,0137	4,2115	5,5140	6,7160	4,4002	2,7506	3,6860	2,2903	4,5103
Variance with Discretisation Error:															
	0,5406	1,3840	1,2315	0,6339	0,6961	0,6005	0,8059	0,5958	0,8748	0,8702	0,8077	0,7596	0,7804	0,5665	0,5916
Rescaled values															
1	-1,38	-1,97	-1,57	-1,33	-1,36	-1,35	-1,41	-1,35	-1,56	-1,67	-1,44	-1,31	-1,38	-1,22	-1,38
2	-0,26	-0,22	-0,25	-0,24	-0,24	-0,25	-0,25	-0,25	-0,26	-0,25	-0,25	-0,22	-0,24	-0,19	-0,26
3	0,62	0,72	0,61	0,60	0,60	0,60	0,60	0,61	0,64	0,68	0,61	0,59	0,60	0,59	0,61
4	1,28	1,43	1,27	1,24	1,25	1,25	1,25	1,26	1,30	1,37	1,26	1,23	1,25	1,23	1,27
5	2,03	2,44	2,23	2,01	2,04	2,01	2,07	2,01	2,14	2,22	2,08	2,07	2,06	2,00	2,02

Rescaling of values															
"Expected value" within category:															
1	-1,2492	-1,4140	-1,2223	-1,2911	-1,1993	-1,1732	-1,2968	-1,3237	-1,3329	-1,2719	-1,2901	-1,2809	-1,3348	-1,2123	-1,5531
2	-0,2198	-0,2407	-0,1907	-0,2131	-0,1891	-0,1781	-0,2290	-0,2247	-0,2494	-0,2058	-0,2075	-0,1953	-0,2319	-0,1823	-0,2469
3	0,5651	0,5691	0,5783	0,5740	0,5757	0,5776	0,5656	0,5707	0,5579	0,5760	0,5770	0,5830	0,5678	0,5818	0,5733
4	1,1751	1,1892	1,1923	1,1905	1,1865	1,1870	1,1788	1,1876	1,1697	1,1924	1,1949	1,2031	1,1839	1,1966	1,1992
5	1,9130	2,0181	1,9813	1,9941	1,9461	1,9394	1,9386	1,9872	1,9085	1,9985	2,0195	2,0707	1,9704	2,0004	2,1273
Squared differences from the mean:															
1	1,6807	1,8153	2,4413	2,1712	2,2498	2,3515	1,6747	1,9527	1,3000	2,3118	2,4006	2,9236	1,7670	2,6882	2,1098
2	0,0713	0,0303	0,2818	0,1565	0,2398	0,2898	0,0512	0,0891	0,0032	0,2064	0,2179	0,3897	0,0513	0,3716	0,0214
3	0,2682	0,4042	0,0567	0,1533	0,0756	0,0473	0,3230	0,2470	0,5634	0,1072	0,1009	0,0237	0,3286	0,0239	0,4541
4	1,2720	1,5771	0,7262	1,0162	0,7848	0,6835	1,3960	1,2407	1,8561	0,8908	0,8753	0,5994	1,4145	0,5919	1,6895
5	3,4812	4,3463	2,6934	3,2822	2,7076	2,4936	3,7686	3,6613	4,4152	3,0624	3,0980	2,6953	3,9043	2,4750	4,9633
Variance with Discretisation Error:															
	0,6659	0,9844	0,7414	0,8326	0,6696	0,6333	0,7462	0,8521	0,7151	0,8194	0,8698	0,9293	0,8324	0,7540	1,3210
Rescaled values															
1	-1,32	-1,49	-1,30	-1,37	-1,27	-1,25	-1,37	-1,40	-1,41	-1,35	-1,37	-1,36	-1,41	-1,29	-1,64
2	-0,24	-0,25	-0,22	-0,23	-0,21	-0,21	-0,24	-0,24	-0,25	-0,23	-0,23	-0,22	-0,24	-0,21	-0,26
3	0,60	0,61	0,59	0,59	0,59	0,59	0,60	0,60	0,61	0,59	0,59	0,59	0,60	0,59	0,62
4	1,24	1,26	1,23	1,24	1,23	1,23	1,25	1,25	1,26	1,24	1,24	1,24	1,25	1,23	1,28
5	2,02	2,14	2,06	2,09	2,03	2,02	2,05	2,09	2,05	2,08	2,10	2,15	2,08	2,07	2,27

Table 9 - Summary of Gaussian distribution fit algorithm

No	Survey Questions on the perceived factors	Mean	t-value	p-value
1	Would you say that the manufacturing personnel has the desired skill set to perform their jobs to their maximum potential?	-0.3615	-4.0375	0.0001
2	Do you believe that your organisation regularly send staff for training and skills development timeously when certification or re-certification is required?	-0.7813	-5.3009	0.0000
3	Do production employees always have tools readily available to perform their daily duties?	0.0320	0.2442	0.8077
4	Is the Quality of the tools being used for manufacturing in a good condition, meaning no damages from wear and tear and it renders the desired results when being used?	-0.0353	-0.3707	0.7119
5	Would you say that your organisation invest regularly in Equipment and machinery?	-0.0530	-0.5347	0.5943
6	Do you consider the equipment and machinery being used in your organisation reliable regarding e.g. quality, breakdowns etc.?	-0.1596	-1.7198	0.0894
7	Would you say that internal failure costs due to wastage such as scraps, reworks, material wastage and losses etc. are a problem within your organisation?	-0.0474	-0.4456	0.6571
8	Does your organisation encounter discrepancies on material e.g. wrong stock count of components in the stores bin to what is listed on the ERP system?	-0.1885	-2.0095	0.0480
9	Does your organisation perform regular stock takes?	-0.3980	-3.4952	0.0008
10	Does your organisation encounter delays to production due to material shortages or losses?	-0.6562	-5.6321	0.0000
11	Would you say that lead times of material is a problem encountered in your organisation?	-0.1514	-1.3520	0.1807
12	Does your organisation miss scheduled maintenance to meet customer delivery?	0.3284	3.1744	0.0022
13	Does your organisation follow a strict Total preventative maintenance (TPM) schedule (Maintaining tools and equipment) meaning that maintenance is not skipped to run production?	0.0359	0.3399	0.7348
14	Does the same type of problems (failures) re-occur within your organisation, meaning that the root cause is not solved creating re-occurrence?	0.4031	4.4967	0.0000
15	Does your organisation follow a root cause analysis methodology?	-0.2676	-2.8297	0.0060
16	Would you say that the root cause analysis method used in your organisation is effective in helping to solve the root causes of problems?	0.0472	0.4738	0.6371
17	Does your organisation have a culture of continuous improvement (continuous improvement is the incremental improvements of products, services and processes)?	-0.0666	-0.5563	0.5796
18	Does your organisation have a culture that accepts change easily?	0.3401	3.2851	0.0016
19	Would you say that your organisation has a continuous improvement strategy that is effective?	0.1824	1.6485	0.1035
20	Does your organisation follow lean practices and principles effectively?	0.3006	3.0689	0.0030
21	Does your organisation make use of mapping tools such as Value Stream mapping and Process Mapping to bring about delivery improvements?	0.3603	3.6319	0.0005
22	Does your organisation make use of Total Quality Management (TQM) tools (Tools to help improve on quality, delivery, output and to reduce costs)?	-0.0027	-0.0254	0.9798
23	Would you say that management in your organisation has a participative and a support managerial style?	0.0737	0.6431	0.5223
24	Do you believe that management in your organisation has sound knowledge of the production processes and policies?	-0.1927	-1.7961	0.0769
25	Is the communication between management and employees within your organisation effective?	0.2485	2.2054	0.0308
26	Would you say that management in your organisation provide solutions to daily problems encountered?	0.2593	2.2190	0.0298
27	Would you say that absenteeism is a problem in your organisation?	0.4289	3.6074	0.0006
28	Would you say that your organisation makes available adequate funds for improvements (e.g. for new machines, to solve problems, to improve processes etc.)?	-0.0055	-0.0479	0.9619
29	Would you say that there is sufficient transparency of information in your organisation?	0.4272	3.9870	0.0002
30	Would you say that all documents relevant for production to perform their duties is readily available and always used by operators?	-0.1006	-0.6985	0.4872

A summary of the results was created in Table 9. Each question was linked to its Mean, T-value and P-value for ease of interpretation and analysis. From this, the significance levels can be clearly seen for each question. In this study an alpha of 0.05 is used as the cut-off for significance. We will conclude that a significant difference does exist if the p-value is less than 0.05 and reject the null hypothesis that there's no difference (Martz, 2015)

Table 10 - Perceived factors contributing negatively to productivity

No	Survey questions on the perceived factors	Mean	t-value	p-value
10	Does your organisation encounter delays to production due to material shortages or losses?	-0.6562	-5.6321	0.0000
2	Do you believe that your organisation regularly send staff for training and skills development timeously when certification or re-certification is required?	-0.7813	-5.3009	0.0000
1	Would you say that the manufacturing personnel has the desired skill set to perform their jobs to their maximum potential?	-0.3615	-4.0375	0.0001
9	Does your organisation perform regular stock takes?	-0.3980	-3.4952	0.0008
15	Does your organisation follow a root cause analysis methodology?	-0.2676	-2.8297	0.0060
8	Does your organisation encounter discrepancies on material e.g. wrong stock count of components in the stores bin to what is listed on the ERP system?	-0.1885	-2.0095	0.0480

From the above table there is a highly significant P-value with a negative mean that indicates there is a negative relationship to productivity. Material, training and skills development as well as preventative measures seems to be the common factors.

Table 11 - Perceived factors that contribute positively to productivity

No	Survey questions on the perceived factors	Mean	t-value	p-value
25	Is the communication between management and employees within your organisation effective?	0.2485	2.2054	0.0308
26	Would you say that management in your organisation provide solutions to daily problems encountered?	0.2593	2.2190	0.0298
20	Does your organisation follow lean practices and principles effectively?	0.3006	3.0689	0.0030
12	Does your organisation miss scheduled maintenance to meet customer delivery?	0.3284	3.1744	0.0022
18	Does your organisation have a culture that accepts change easily?	0.3401	3.2851	0.0016
27	Would you say that absenteeism is a problem in your organisation?	0.4289	3.6074	0.0006
21	Does your organisation make use of mapping tools such as Value Stream mapping and Process Mapping to bring about delivery improvements?	0.3603	3.6319	0.0005
29	Would you say that there is sufficient transparency of information in your organisation?	0.4272	3.9870	0.0002
14	Does the same type of problems (failures) re-occur within your organisation, meaning that the root cause is not solved creating re-occurrence?	0.4031	4.4967	0.0000

From above table there is a highly significant P-value with a positive mean that indicates there is a positive relationship to productivity. Communication, management, processes and culture seem to be the common factors.

Table 12 - Perceived factors that sample population are neutral towards

No	Survey questions on the perceived factors	Mean	t-value	p-value
24	Do you believe that management in your organisation has sound knowledge of the production processes and policies?	-0.1927	-1.7961	0.0769
6	Do you consider the equipment and machinery being used in your organisation reliable regarding e.g. quality, breakdowns etc.?	-0.1596	-1.7198	0.0894
11	Would you say that lead times of material is a problem encountered in your organisation?	-0.1514	-1.3520	0.1807
30	Would you say that all documents relevant for production to perform their duties is readily available and always used by operators?	-0.1006	-0.6985	0.4872
17	Does your organisation have a culture of continuous improvement (continuous improvement is the incremental improvements of products, services and processes)?	-0.0666	-0.5563	0.5796
5	Would you say that your organisation invest regularly in Equipment and machinery?	-0.0530	-0.5347	0.5943
7	Would you say that internal failure costs due to wastage such as scraps, reworks, material wastage and losses etc. are a problem within your organisation?	-0.0474	-0.4456	0.6571
4	Is the Quality of the tools being used for manufacturing in a good condition, meaning no damages from wear and tear and it renders the desired results when being used?	-0.0353	-0.3707	0.7119
28	Would you say that your organisation makes available adequate funds for improvements (e.g. for new machines, to solve problems, to improve processes etc.)?	-0.0055	-0.0479	0.9619
22	Does your organisation make use of Total Quality Management (TQM) tools (Tools to help improve on quality, delivery, output and to reduce costs)?	-0.0027	-0.0254	0.9798
3	Do production employees always have tools readily available to perform their daily duties?	0.0320	0.2442	0.8077
13	Does your organisation follow a strict Total preventative maintenance (TPM) schedule (Maintaining tools and equipment) meaning that maintenance is not skipped to run production?	0.0359	0.3399	0.7348
16	Would you say that the root cause analysis method used in your organisation is effective in helping to solve the root causes of problems?	0.0472	0.4738	0.6371
23	Would you say that management in your organisation has a participative and a support managerial style?	0.0737	0.6431	0.5223
19	Would you say that your organisation has a continuous improvement strategy that is effective?	0.1824	1.6485	0.1035

The above table is a summary of all the perceived factors that the sample population was neutral on.

Table 13- Summary of the perceived contributing factors

Negative	Neutral	Positive
Q1	Q3	Q12
Q2	Q4	Q14
Q8	Q5	Q18
Q9	Q6	Q20
Q10	Q7	Q21
Q15	Q11	Q25
	Q13	Q26
	Q16	Q27
	Q17	Q29
	Q19	
	Q22	
	Q23	
	Q24	
	Q28	
	Q30	

Table 14 - Results of the perceived contributing factors

Negative	Neutral	Positive
Skills	Tools availability	Missing scheduled maintenance
Training & skills development	Quality of tools	Re-occurance of problems
Material discrepancies	Investment in equipment & machinery	Culture that accepts change
Stock takes	Reliability of equipment & machinery	Effective lean practices
Material Shortages	Failure costs	Use of Mapping tools
Root cause analysis methodology	Lead times of material	Effective communication
	Maintenance schedules	Solutions provided by management
	Effectivity of root cause analysis	Absenteesim
	Continuos improvement culture	Transparency of information
	Effective continuos improvement strategy	
	Use of Quality tools	
	Management support	
	Management knowledge	
	Funds for improvements	
	Document availability	

The common perceived factors that negatively affect productivity are:

- Skills (skills, training & skills development)
- Process (material discrepancies, stock take, material shortages)
- Preventative Measures (root cause analysis methodology)

The neutral perceived factors that affect productivity are:

- Managerial factors (tools availability, investment in equipment and machinery, effective continuous improvement strategy, management support, management knowledge and funds for improvements)
- Preventative measures (quality of tools, reliability of equipment and machinery, failure costs and maintenance schedules)
- Process (lead time of materials and document availability)
- Preventative measures (effectivity of root cause analysis)
- Culture (continuous improvement culture, use of quality tools)

The common perceived factors that positively affect productivity are:

- Maintenance (missing scheduled maintenance)
- Culture (culture that accepts change, effective communication, transparency, absenteeism and solutions provided by management)
- Lean practices (effective lean practices, use of mapping tools, recurrence of problems)

4.4 Summary of results

The outcome of the survey was to find out “what is” the perceived factors that are negatively or positively affecting productivity in the South African EMS industry. The results of the survey covered the demographic of the sample used. Descriptive analysis was performed on the data recorded. Descriptive analysis are numbers that are used to summarise and describe data (Hebl, 2018).The information that has been collected from the survey is referred to as “data” (Hebl, 2018). It provides estimates from a sample that can be related to the entire population with a degree of certainty (Sukamolson, 2007). Descriptive analysis forms the basis of virtually every quantitative analysis of data (Trochim, 2006).

The demographics of the sample obtained showed that there is an almost fair distribution of male and females within the industry. The age groups of the respondents were also fairly distributed with the age group 30-39 having a bit higher percentage of about 36%. Approximately 92% of the respondents are permanently employed. Approximately 70% of the respondents have a formal qualification and approximately 78% of respondents have been through formal on-the-job training within their organisations. Most of the population (approximately 70%) claim to have productivity levels between 70% and 89%.

From the descriptive analysis performed, there were three underlying factors that negatively influence productivity i.e. Skills, Process and Preventative Measures. There were three underlying factors that positively influence productivity i.e. Maintenance, Culture and Lean practices.

5 DISCUSSION OF THE RESULTS

5.1 Introduction

In this section, the results obtained from the survey and the statistics applied to analyse the data are discussed and explained. This is done in accordance to the literature review performed and the industry being studied.

5.2 Demographic profile of respondents

The detailed demographic statistics of respondents that completed the survey can be seen in the Pie graph below in Figure 03. It can be seen from Figure 03 that approximately 60% of the respondents are male, approximately 36% are female and there were approximately 4% that chose not to respond.

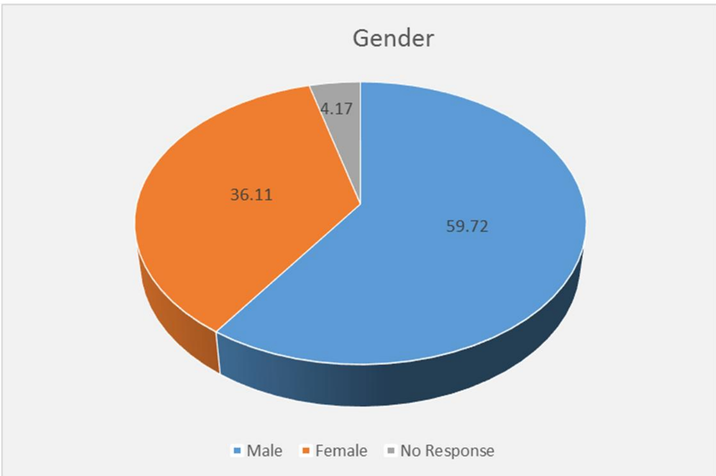

Figure 03: Pie Chart of Gender of Participants

Figure 04 represents the roles that the respondents play in the industry. It can be seen that the majority of the respondents, approximately 63%, are from direct operations. Management combined formed 25% of the respondents and approximately 11% of the respondents were from support roles.

Figure 04: Organisational Role

From Figure 05 below, there is a good distribution of age groups. There are approximately 21% of respondents in the industry who are 50 years and older. With approximately 56% between the ages of 30 to 49 and approximately 24% below 30 years of age. This is an indication that the industry has talent and is retaining talent in the industry through experienced personnel above the 30 year age group and are bringing in and developing new talent with the below 30 year age group.

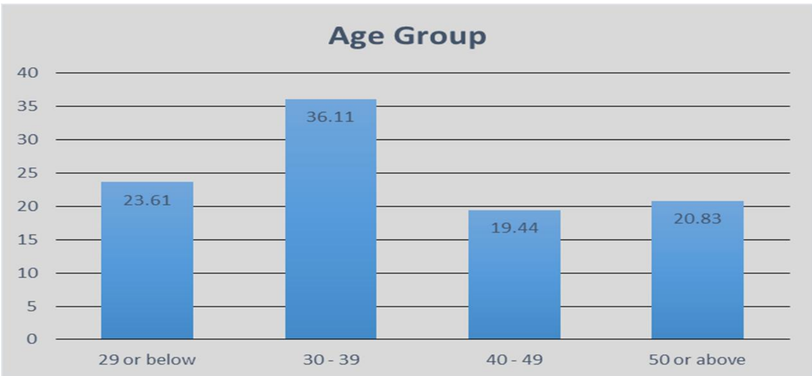

Figure 05: Age Group

From Figure 06 below, approximately 92% of the respondents are employed on a permanent basis, with approximately 8% employed on a contractual basis. This could be due to the industry first providing their potential new employees with a 1- or 2-year work contract for on-the-job training to develop and retain employees with the highest potential. Contractual positions are also offered to students who are required to do practical internships to achieve their educational diploma. Taking into consideration that most of the work being performed by these EMS companies is contracted work, the high rate of permanent employees show that the industry is stable and that there is a consistent amount of work to be performed and could be an indication that the industry is growing.

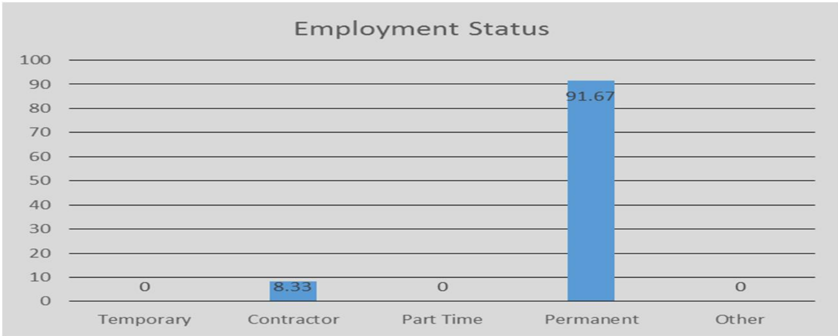

Figure 06: Employment Status

It can be seen from Figure 07 below that approximately 70% of the respondents have a formal qualification from either a university, Technikon or college. Approximately 30% of the respondents do not have a formal qualification. This is a good sign for the industry knowing that people are educating and skilling themselves for the industry. This will make it easier to train people and to get them to perform to high standards within the industry. Part of the South African B-BBEE initiative is for organisations within South Africa to send the historically disadvantaged population for formal education. This is a sign that in the future there should be more formally qualified people in the industry.

Figure 07: Respondents Qualifications

Figure 08 shows that almost 78% of respondents have been given on-the-job training by their organisations with about 22% that have not been through on-the-job training. The reason for those that have not been for on-the-job training could be that they are skilled in their roles already or could be scheduled to be put on training. This again is a good sign for the industry showing that organisations are putting in the effort to equip their employees with the necessary skills to succeed. This also can assist with improved productivity and higher quality outputs from their staff.

Figure 08: On-the-job training

From the below Figure 09, there is a spread in performance in respect to productivity among the different organisations based on respondents' responses. It can be seen from Figure 09 that approximately 60% of respondents claim that their organisations are achieving 70% to 89% productivity. With about 22% of respondents claiming that their organisations are performing below 70% productivity and only about 18% claiming to be achieving above 90% productivity. With approximately 80% of the respondent's response being below 90% shows that there is still room to make significant improvements towards achieving a higher level of productivity in the EMS industry.

Figure 09: Organisational Productivity

5.3 Descriptive Analysis

The perceived factors identified through descriptive analysis to be affecting productivity negatively and positively in the South African electronic manufacturing industry are discussed in this section. From the analysis, it was found that questions 1, 2, 8, 9, 10 and 15 had a negative contribution to productivity. These factors were preventing a high level of productivity from being achieved. Questions 12, 14, 18, 20, 21, 25, 26, 27, and 29 had a positive contribution to productivity. Respondents had a neutral view on the remainder of the questions.

For this study, focus was put on the factors that have a negative contribution to productivity to mitigate them and improve the levels of productivity in the EMS industry. The negative contributing variables were Skills, Training and Skills development, Material discrepancies, Stock takes, Material shortages and Root cause analysis. From these variables, three factors can be identified, namely:

Factor 1: Skills (Skills, training & skills development)

Factor 2: Process (Material discrepancies, stock take & Material Shortages)

Factor 3: Preventative Measures (Root cause analysis methodology)

The influence of the above factors on productivity in the South African electronic manufacturing industry are discussed individually in further detail.

5.3.1 Factor 1: Skills

From the factors that negatively affect productivity, skills and training and skills development were identified as the variables contributing negatively to the factor skills.

According to Abdel-Wahab, Dainty, Ison, Bowen, and Hazlehurst (2008), skills hold the key to productivity improvement within all sectors. There is a direct correlation between skills, productivity and employment (Abdel-Wahab et al., 2008). Mason, O'Leary, and Vecchi (2012) refers to Griffith, Redding, and Van Reenen (2004)'s article which states that workforce skills help to stimulate productivity growth. Skilling employees can give organisations an advantage over their competitors.

Skilled employees can perform their duties easier and faster as they will have a deeper understanding and knowledge of the requirements. Skilled employees also can perform to higher levels of quality as they are aware of what is required. This helps to reduced unforced errors and internal failure costs, allowing for higher levels of productivity. Having skilled employees also impacts on the training of new employees positively. These skilled employees can pass on their knowledge, know-how and expertise to the new employees.

Training plays a very important part in productivity. Training is defined as courses designed to help the individual to develop skills that may be of use in their jobs (Blundell, Dearden, Meghir, & Sianesi, 1999). If an employee is trained to perform a task, there are high levels of accuracy achieved with minimum waste. If an employee is not trained, this can lead to poor levels of quality and low levels of output due to the employee not knowing what exactly needs to be done and how it should be done.

According to Blundell et al. (1999), research shows that the higher levels of labour productivity were closely related to the greater skills and knowledge of the workforce and the lower level of manpower skills affected labour productivity negatively. Holzer, Block, Cheatham, and Knott (1993) and Blundell et al. (1999) both find that training has a positive effect on productivity. According to Barrett and O'Connell (2001), in manufacturing, the higher the off-the-job proportion of training is, the higher the levels of productivity.

Management within the EMS industry in South Africa must invest in skilling and training their employees to achieve higher levels of productivity to have a competitive advantage over their competitors.

5.3.2 Factor 2: Process

The factor process is made up of variables material discrepancies, stock take and material shortages. Having a well-defined and a robust Process is critical for the success of achieving high levels of productivity. The processes defined will determine the pace of output and the quality of goods and services.

Material management includes procurement of material, shop fabrication, logistics, supply chain management and production (Donyavi & Flanagan, 2009). According to Donyavi and Flanagan (2009), better material handling can reduce material wastage and lead to improved productivity. If material is wasted due to scrapping or loss, this can lead to unplanned downtime which will negatively impact productivity. Stoppages due to material availability can lead to poor quality due to incomplete building of parts, forced change overs and downtimes. This disruption can be prevented if material accuracy is guaranteed and this can be achieved through stock takes and well-defined processes to monitor the flow of material and usage.

When ordering materials, lead times must be taken into consideration. Orders must be placed early enough to allow for materials to be available before they are required for use. If not ordered on time, this can also lead to unplanned stoppages. Management within the EMS industry in South Africa must ensure that there is effective planning within the organisation to prevent line stoppage due to material availability by implementing and enforcing effective and robust processes.

5.3.3 Factor 3: Preventative Measures

The third factor that had a negative impact on productivity was Preventative measures which was made up of the variable Root cause analysis (RCA) methodology. Root cause analysis is also a critical component for achieving higher levels of productivity.

According to Mahto and Kumar (2008), a key issue for the manufacturing processes is the RCA identification of quality and productivity related problems. Root cause analysis is a tool used to prevent and eliminate recurring problems and incidents that can create delay, poor quality and defects. RCA is the process of identifying problems by using a structured approach for identifying and resolving problems using techniques designed for this (Mahto & Kumar, 2008). RCA is a common tool being used within the industry and there are multiple types of RCA techniques in use, such as Six Sigma, Ishikawa 5 Why, 8-D reports, etc.

An RCA can prevent unnecessary stoppages due to recurring problems, allowing for a more continuous flow of uninterrupted production leading to higher throughputs, and a higher level of productivity. According to Mahto and Kumar (2008), RCA can be implemented to improve productivity and quality in each and every individual setup of manufacturing.

Management within the EMS industry in South Africa must ensure that RCA is driven effectively to prevent recurrence of problems to allow for higher levels of productivity.

5.4 Proposition vs. Factor categories

From the literature review conducted, 12 variables were identified that could broadly affect productivity. They were grouped into six factors as can be seen below:

Proposition 1: The factors contributing to productivity in the electronic manufacturing industry can be grouped as below:

1. Process
2. Preventative Measures
3. Workforce / Labour
4. Skills
5. Managerial factors
6. Culture

Through the descriptive analysis, it was deduced that from the six proposed factor groups, only three factor groups were responsible for affecting productivity negatively in the South African electronic manufacturing industry. Below are the three factor groups.

Factor 1: Skills (Skills, training & skills development)

Factor 2: Process (Material discrepancies, stock take & Material Shortages)

Factor 3: Preventative Measures (Root cause analysis methodology)

Table 15 - Proposition vs Factor Groups

Proposition Grouping	***Negative Factor Grouping***
Process: Continuous Improvement (CI) Line Balancing Overall Equipment Effectiveness Material Availability	**Skills:** Skills, Training & Skills development
Preventative Measures: Total Productive Maintenance (TPM) Root Cause Analysis (RCA) Total Quality Management (TQM)	**Process:** Material Discrepancies Stock Take Material Shortages
Workforce / Labour: Manpower	**Preventative Measures:** Root Cause Analysis (RCA)
Skills: Skills	
Managerial factors: Human Resource Management Supply Chain Management (SCM)	
Culture: Agility and Flexibility	

Results of the descriptive analysis shows that instead of the six proposed factor groups that there are three factors as can be seen in the above Table 1 that contribute negatively to productivity in the South African electronic manufacturing industry.

5.5 Conclusion

The data gathered from the survey was analysed and discussed in respect to the literature review and industry. There was a discussion around the demographics of the industry that was obtained from the survey. This gave an indication of the distribution between male and female, age groups and skills within the industry. It helps to understand if there are any gaps that may need addressing. From the data gathered, there seems to be an almost fair balance in the industry with the industry still being dominated with males, about 20% more than females.

From the data analysis, it was determined that there were six variables that negatively affected productivity in the South African EMS industry, fifteen variables where respondents were neutral, and nine variables that affected productivity positively. From the negative variables, three common factors were identified, namely Skills, Process and Preventative Measures.

The first identified factor that negatively affects productivity is related to the skills within the organisation. This is made up of the variables Skills and Training and Skills development. Skills is an important contributor to productivity. The more the employees are trained and knowledgeable, the better will be their understanding of the job at hand, making it easier for them to perform their tasks at a much higher speed and level of accuracy.

The second identified factor that affects productivity negatively is related to process. This is made up of the variables material discrepancies, stock take and material shortages. Material and material handling is a very important contributor to productivity. Material needs to be handled accurately and with care. If materials are not available and quantities are inaccurate, this can lead to unplanned line stoppages, late deliveries, poor quality and very low levels of productivity.

The third identified factor that affects productivity negatively is related to Preventative Measures. This is made up of the variable Root cause analysis methodology. Preventative Measures is a very important contributor to productivity. This is to eliminate repeating problems and to prevent recurrence. If problems are not resolved, they will keep popping up and creating unplanned line stoppages and undesired disruptions which can lead to unforced errors and low levels of productivity.

From the literature review, 12 variables were identified as contributors to productivity. These twelve variables were grouped into six proposed factor groups. Through the descriptive analysis, it was found that three of the six proposed factors contributed negatively to productivity in the EMS industry within South Africa.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

In this section, the conclusion that has been derived from the research topic is discussed. Recommendations are made which could be used by the EMS industry in South Africa or whichever company finds it helpful towards increasing productivity.

6.2 Conclusions of the study

The aim of this research was to identify factors that contributed to productivity, either negative or positive within the electronic manufacturing industry in South Africa. From the literature review, 12 broad variables were identified as contributing factors to productivity. The research concluded that six of the 12 variables contributed to productivity negatively. These six variables were grouped broadly into three factor categories namely Skills, Process and Preventative Measures.

The outcome of this study highlights the main contributors to poor productivity and the industry will now be aware of these factors. This gives management within these organisations the opportunity to put effort and resources onto these factors to improve the levels of productivity within their organisations. If these factor groups are overlooked, this can have a negative impact on productivity or no impact at all.

6.3 Recommendations

Through the research and the added knowledge and insights gained on productivity, the following recommendations are made to help improve the levels of productivity positively within the South African electronic manufacturing industry:

- New employees must be put through an organisational orientation to understand the organisation's policies, processes, procedures and way of doing things (culture) before they can start to perform their duties.

- New employees and current employees that have not been for on-the-job training should be sent for on-the-job training to improve their skill level.
- There must be a training matrix implemented for each employee that indicates their level of competence e.g. under training, can work with supervision, able to work alone, able to train.
- There should be regular green area or white board meetings to discuss daily tasks, targets and previous day results, etc. This will also form a communication channel to align all employees with the same goals and objectives.
- There should be a lean champion within the organisation to implement lean strategies such as 5S, U-lines and continuous improvements through Kaizen methods, etc.
- There must be a FIFO system with minimum and maximum indicators for material handling to prevent run-outs of stock.
- There must be regular stock takes to manage the material discrepancies.
- Family settings should be created on production lines to minimise change overs. This means that products that use similar material can be grouped together. This will make production lines more flexible and agile.
- Value Stream Mapping must be used to determine inefficiencies within the processes so that actions can be taken to eliminate them. The findings can also be used to do line balancing.
- Firewalls must be made visible to indicate failures that need to be monitored for recurrence and prevention.
- Teams must be put together to champion problems being encountered within the organisation. They must drive the root cause analysis and put actions in place to prevent recurrence. Some of the tools that can be used are Ishikawa fish bone diagram, 5 why analysis, 8D reports, Six Sigma, etc.
- Quality must drive Failure Mode and Effect Analysis (FMEA) to determine possible failures or problems before new products are introduced onto the production lines.
- There must be more random quality checks on the processes to determine any possible problems that could occur and prevent these before occurrence.

- Staff must perform regular Total Preventative Maintenance (TPM) to prevent and reduce machine downtime. This will help to increase Overall Equipment Effectiveness (OEE).

6.4 Suggestions for further research

- This study had a focus on internal factors affecting productivity within the electronic manufacturing services industry within South Africa and hence there is an opportunity to extend this study to include the external factors that can affect productivity.
- Further research can be done to determine the impact of poor quality on productivity.
- Further research can be done on how product design can affect productivity.
- The research was limited to companies within South Africa, hence an opportunity to extend the study globally.
- There is an opportunity to focus more deeply on a specific individual factor such as the impact of supply chain on productivity and derive improvement standards.

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CONSISTENCY MATRIX

Table 16 - Consistency matrix

Research problem stated here					
Sub-problem	**Literature Review**	**Hypotheses or Propositions or Research questions**	**Source of data**	**Type of data**	**Analysis**
Main Problem To evaluate the perceived factors that most influence productivity in the South African electronic manufacturing industry. **Sub Problem 1** Determine what manufacturing process techniques contribute to productivity? **Sub Problem 2** Determine how employees contribute to productivity?	(Pycraft et al., 2010) (Kumar & Suresh, 2009) (Tangen, 2002) (Krugman, 1994) (Rogers & Rogers, 1998) (Stanfield et al., 2008)	**<u>Proposition 1:</u>** Factors contributing to productivity in the electronic manufacturing industry: 1. Process 2. Preventative Measures 3. Workforce / Labour 4. Skills 5. Managerial factors 6. Culture	Likert type survey	Ordinal	Descriptive statistics

APPENDIX

This section consists of the following:

A. The cover letter that will be sent to the employees of the 6 electronic manufacturing companies requesting their participation in the survey.

B. The survey questionnaire.

Appendix A: Cover Letter

Good day,

My name is Vinay Ramhari. I am currently a part time student studying towards a Master of Business Administration at the WITS Business School (WBS) at the University of the Witwatersrand. I am currently investigating factors affecting productivity in the electronic manufacturing service industry. Through my research I want to identify the common factors contributing to productivity and provide recommendations to the industry on how to achieve maximum productivity.

I am inviting you to be a part of the study through a short online survey. The survey will take no longer than 10 - 15 minutes of your time. It is an anonymous survey and you and your organisation will not be personally identified in the final report. Please click link below to start survey:

https://wits.eu.qualtrics.com/jfe/form/SV_5hH57GoQJq81uHX

The results of the survey will not be linked to any individual or organisation in the final report. The aim of the survey is to get a clear indication of factors contributing to productivity. The research undertaken is solely for academic purposes and once completed will be available electronically and can be accessed publicly. If you have any questions, concerns, or comments or if you would like a copy of the final report, please feel free to contact me at 1545613@students.wits.ac.za or 076 481 1919. Alternatively, you could contact my supervisor Nushil Sookram on nushil.sookram@gmail.com.

Your participation will be greatly appreciated.

Best Regards

Vinay Ramhari
Master of Business Administration student

Appendix B: Survey

SURVEY QUESTIONNAIRE FOR:

"Factors contributing to productivity in the South African Electronic Manufacturing Industry"

B.1) Introduction

You have been invited to complete the following survey. The intention is to use this survey to better understand the factors that contribute to productivity in the electronic manufacturing industry, collect and analyse the response data, and interpret the results. All your responses will remain confidential.

The survey begins with demographic questions, followed by your ratings on the specific factors contributing to productivity followed by your personal comments. All your responses will remain confidential. Personal information is requested for demographic analysis only, and only aggregated results will be presented.

The survey should take no more than 10 - 15 minutes to complete. You are under no obligation to complete the survey and you are free to discontinue participation at any time.

Please contact me if you have any questions or queries regarding the survey.

Vinay Ramhari

1545613@students.wits.ac.za
076-481-1919

Please indicate if you give your informed consent to proceed with this survey:

- ○ No
- ○ Yes

B.2) Demographics

Please indicate your gender identity:

- Male
- Female

Please indicate which of the following options most closely describes your role at your organisation

- High level Management (e.g. CEO, President, Vice President etc.)
- Senior management (e.g. Executive manager etc.)
- Middle management (e.g. Line manager, Team leader etc.)
- Support Role (e.g. Planning, Industrialization, Configuration etc.)
- Direct operations (Operator, Technician, Storeman, assistant etc.)

Please indicate the age category into which you fall:

- 29 or below
- 30 - 39
- 40 - 49
- 50 or above

Please indicate your employment status:

- Temporary
- Contractor
- Part - Time
- Permanent
- Other

Do you have a formal qualification from an academic institution e.g. university, college etc.?

- Yes
- No

Have all the production manufacturing personnel been on formal training to do their jobs within your organisation and are certified?

- Yes
- No

What is the average level of productivity reached in your organisation?

- Less than 50%
- 50% to 69%
- 70% to 79%
- 80% to 89%
- 90% to 100%

B.3) Proposed Survey (Likert Scale)

Factor No.	Factor	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1	Would you say that the manufacturing personnel has the desired skill set to perform their jobs to their maximum potential?					
2	Do you believe that your organisation regularly send staff for training and skills development timeously when certification or re-certification is required?					
3	Do production employees always have tools readily available to perform their daily duties?					
4	Is the Quality of the tools being used for manufacturing in a good condition, meaning no damages from wear and tear and it renders the desired results when being used?					
5	Would you say that your organisation invest regularly in Equipment and machinery?					
6	Do you consider the equipment and machinery being used in your organisation reliable regarding e.g. quality, breakdowns etc.?					
7	Would you say that internal failure costs due to wastage such as scraps, reworks, material wastage and losses etc. are a problem within your organisation?					
8	Does your organisation encounter discrepancies on material e.g. wrong stock count of components in the stores bin to what is listed on the ERP system?					
9	Does your organisation perform regular stock takes?					

10	Does your organisation encounter delays to production due to material shortages or losses?					
11	Would you say that lead times of material is a problem encountered in your organisation?					
12	Does your organisation miss scheduled maintenance to meet customer delivery?					
13	Does your organisation follow a strict Total preventative maintenance (TPM) schedule (Maintaining tools and equipment) meaning that maintenance is not skipped to run production?					
14	Does the same type of problems (failures) re-occur within your organisation, meaning that the root cause is not solved creating re-occurrence?					
15	Does your organisation follow a root cause analysis methodology?					
16	Would you say that the root cause analysis method used in your organisation is effective in helping to solve the root causes of problems?					
17	Does your organisation have a culture of continuous improvement (continuous improvement is the incremental improvements of products, services and processes)?					
18	Does your organisation have a culture that accepts change easily?					
19	Would you say that your organisation has a continuous improvement strategy that is effective?					
20	Does your organisation follow lean practices and principles effectively?					
21	Does your organisation make use of mapping tools					

	such as Value Stream mapping and Process Mapping to bring about delivery improvements?					
22	Does your organisation make use of Total Quality Management (TQM) tools (Tools to help improve on quality, delivery, output and to reduce costs)?					
23	Would you say that management in your organisation has a participative and a support managerial style?					
24	Do you believe that management in your organisation has sound knowledge of the production processes and policies?					
25	Is the communication between management and employees within your organisation effective?					
26	Would you say that management in your organisation provide solutions to daily problems encountered?					
27	Would you say that absenteeism is a problem in your organisation?					
28	Would you say that your organisation makes available adequate funds for improvements (e.g. for new machines, to solve problems, to improve processes etc.)?					
29	Would you say that there is sufficient transparency of information in your organisation?					
30	Would you say that all documents relevant for production to perform their duties is readily available and always used by operators?					

Thank you for completing this survey.

Appendix C: RESEARCH PLANNING

Table 17 - Time-table

Time-plan for completion of research report by 28 February 2018

	11/10/2017	06/11/2017	26/11/2017	15/12/2017	15/01/2018	31/01/2018	28/02/2018
Finalise proposal							
Gain approval							
Gather data							
Do data analysis							
Write report							
Finalise report							