LEAN PRACTICES AND SUPPLY CHAIN COMPETITIVENESS IN THE STEEL INDUSTRY IN GAUTENG, SOUTH AFRICA

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DECLARATION

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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This thesis is being submitted in fulfilment of the requirements for the degree of Master’s in Management.

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This dissertation is the result of my own independent work/investigation, except where otherwise stated. Other sources are acknowledged by giving explicit references. A list of references is appended.

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I hereby give consent for my dissertation if accepted, to be available for photocopying and for interlibrary loan and for the title and summary to be made available to outside organisations.

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It’s essential to give thanks to God who gave me the strength and courage to continue even when it was difficult to do so.

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ABSTRACT

This study examines the influence of lean supply chain management (LSCM) on supply chain competitiveness in the steel industry in Gauteng, South Africa. The industry suffered a huge blow when imported steel took over the market and collapsed big players within the industry in South Africa. A range of problems hit the market hard, leaving companies applying for section 189 of the labour law to reduce overheads and restructure their organisations.

It is evident that organisations need to change their way of thinking, heighten their supply chain strategies and adopt international standards like lean supply chain management practices to become competitive in a broader spectrum. Using a data set of 265 supply chain professionals drawn from the steel manufacturing industry in Gauteng, results showed the importance of proper implementation of LSCM would directly influence SCC, leading to improved organisational performance.

The collected quantitative data were analysed using the Statistical Packages for Social Sciences (SPSS version 27.0) statistical software. Techniques such as correlations and regressions were used to test the hypotheses. The results of the study showed that four lean practices, namely Just in Time, Total Quality Management, Strategic Partnership and Waste Elimination all predict the establishment of a lean culture. However, Human Resource Management was statistically insignificant. The results further showed that Lean culture predicts the competitiveness of the steel supply chain. Therefore, an emphasis on lean supply chain management in the steel industry is an essential contributor to its success.
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ACRONYM LIST

LSCM – Lean Supply Chain Management

SCC – Supply Chain Competitiveness

LC – Lean Culture

TQM – Total Quality Management

HR – Humara Resources

JIT – Just In Time

GDP - Gross Domestic Product

WE – Waste Elimination

IA - Information Analysis

SP - Strategic Partnership

AMSA – Arcelor Mittal South Africa

SANS - South African National Standard

IPAP – Industrial Policy Action Plan

BBBEE - Broad-Based Black Economic Empowerment

AQL - Acceptable Quality Level

EFA - Exporatory Factor Analysis
CHAPTER 1

ORIENTATION OF THE STUDY

1.1 INTRODUCTION AND BACKGROUND OF THE STUDY

In this complex and competitive environment, steel manufacturing organisations are evolving from traditional rigid structures to responsive and customer-oriented business models and inter-organisational forms (Verma & Seth 2014:1198). These organisations must consider the concept of competitiveness to survive in the global marketplace by fulfilling the requirements of the customers for high quality and low-cost products (Kariuki 2013:191). The steel manufacturing industry is one of the most important sectors contributing to the highest South African Gross Domestic Product (GDP) growth in South Africa, with the top five steel-consuming industries together contributing R600-billion to GDP (15% of the total) and employing more than eight million people. As of 2018, third quarter (Statistics South Africa 2018). It is thus a vital part of economic growth for the country (Alabi 2016:1). The steel manufacturing industry is playing a significant role in the national economy and the economies of other Southern African states, including Egypt, Mozambique, Tanzania, Zambia, Kenya, Uganda, Namibia, the DRC, Ghana, and Ethiopia. It serves as a means of job creation for many South Africans (Du Toit 2014:3).

South African steel organisations are well-positioned to support this industry and assist with regional growth emanating from related manufacturing activities (Verma, Seth & Singhal 2011:212). The fierce competition in today’s market is led by advances in industrial technology, increased globalisation, and tremendous improvement in information availability (Verma 2015:491). Competitive priorities have forced organisations to change dramatically due to rising customer expectations, constant increasing competition and mass customisation (Alabi 2016:1). Supply chain competitiveness (SCC) has emerged as an approach where the manufacturing organisations' cost, quality, and delivery requirements are the objectives shared by every stakeholder in the chain (Verma & Seth 2014:1198; Verma 2015:491; Mukhtar 2015:128; Chen 2018:77). In recent years, several changes in the marketplace, such as increasing diversity and competition, have stimulated theory and practices in supply chain competitiveness (Verma 2015:491). The majority of small businesses are
devising initiatives and strategies to improve supply chain competitiveness. It is then accepted as one of the most essential concepts in the supply chain literature (Verma & Seth 2014:1198; Verma 2015:491; Chen 2018:77). Several practitioners and researchers (for example, Lee, Rha, Choi & Noh 2013; Mukhtar 2015; Chen 2018) have tried to identify and implement strategies to optimise the competitive nature of firms’ value chain. As such, lean manufacturing is a critical enabling approach to enhance the competitive aspirations of businesses (Lee et al. 2013:1753). Moreover, Soni, Chandraker, Sinha, Patel and Soni (2013:79) postulated that the adoption of lean procedures results in a more efficient improvement of value chain processes through waste elimination and increased lead-time of operations between firms’ networks.

Studies have been conducted and identified various factors contributing to supply chain competitiveness. For example, Mukhtar (2015:1542) used the perspective of mass customisation and service performance to explain supply chain competitiveness. Chen (2018) describes the competitiveness of the supply chain with improved communication and information sharing. Verma and Seth (2014) focused on a strategy-based view of supply chain competitiveness. Aspects identified include cooperation, agility, delivery performance, customer orientation and their responses as the contributors to supply chain competitiveness. Also, Verma (2015) provided an overview of supply chain competitiveness in manufacturing industries, focusing on the strategies and framework. In the study mentioned above, supply chain strategies such as mass customisation, information and communication, process capabilities, operational effectiveness, operations strategy, coordination, cooperation, collaboration, flexibility, agility, expertise, strategic partnerships/alliances, customer relationship, agility, customer satisfaction, product management, SC flow management, SC synergy, and demand management are regarded as the contributors towards supply chain competitiveness.

On the other hand, a framework for supply chain competitiveness is divided into three categories: SCC inputs, SCC environment, and SCC outcomes (Verma 2015:495). It is evident that studies have been conducted, and several contributors have been identified that affect supply chain competitiveness. However, studies have focused on similar and most researched factors that may not be applicable in the continuous process of the steel industry. This study identifies just in time, TQM, strategic partnership, waste elimination, HR and information analysis as lean practices affecting the lean culture and supply chain competitiveness. Moreover, the impact of lean
practices on supply chain competitiveness is under-researched. Hence, dedicating a study towards this direction is the main objective of this study.

1.2 PROBLEM STATEMENT

South Africa’s steel industry has been constantly declining since 2010 (Du Toit 2014:3). Challenges prevalent in the sector range from structural problems, persistent excess capacity to market demand, resulting in a negative impact on trade and employment (Department of Trade and Industry 2018). The effects of the steel crisis are evident across the value chain, from mining primary steel mills to domestic manufacturers struggling to compete, sustaining jobs and falling domestic primary steel production competitiveness (Van der Walt 2012:3). The major concern within this industry is the inconsistency of primary supply, which could be attributed to a lack of supply chain competitiveness. The inconsistency in supply has resulted in supplier/customer distrust. The inconsistencies in the supply chain could be caused by mismanagement of several practices and factors such as just in time, TQM, strategic partnership, waste elimination, HR, and information analysis. These factors, among others, need to be considered to enhance supply chain competitiveness.

In the pursuit to solve the supply chain crisis in South African steel manufacturing, organisations have been trying to adopt new business initiatives to stay alive in a new competitive marketplace (Khuluse 2015:11; Viljoen 2015:5). Lean practice is one of these initiatives that focuses on many elements which eliminate non-value-added activities (Hosseini, Soltani & Mehdizadeh 2018:2). These lean practices (just in time, TQM, strategic partnership, waste elimination, HR, and information analysis) have been widely used in discrete industries such as automobile manufacturing, electronics, and appliances. The application of lean practices to the continuous process industry, such as steel has been far fewer (Alony, Caputi & Colman 2010:3). In part, it has been argued that this is because such industry is inherently more efficient and present relatively less need for such improvement activities (Van der Walt 2012:3; Kumar, Singh & Sharma 2014:06). Steel manufacturing organisations need to work on strategic partnership to gain customers’ trust which could improve demand, ensuring that products are just in time, total quality management and human resources amongst other need to be improved as incorporated within the Deming’s system of profound knowledge. This research is driven by the current crisis experienced by steel manufacturers and seeks to systematically investigate the influence of lean supply chain
management LSCM practices on lean culture and supply chain competitiveness by developing a model with comprehensive lean practices which lead to lean culture and ultimately supply chain competitiveness.

1.3 RESEARCH OBJECTIVES

Three forms of research objectives, namely primary, theoretical, and empirical, have been formulated to guide the study.

1.3.1 Primary objective

The primary objective of this study was to investigate the relationships between lean supply chain management (LSCM) practices, lean culture, and supply chain competitiveness in the steel industry in Gauteng Province.

1.3.2 Theoretical objectives

The following theoretical objectives were formulated:

❖ to explore literature on the South African steel industry;
❖ to analyse literature on the Deming theory;
❖ to review literature on LSCM practices and culture; and
❖ to examine literature on supply chain competitiveness.

1.3.3 Empirical objectives

The following empirical objectives were formulated:

● to assess the level of implementation of LSCM practices in the steel industry in Gauteng province;
● to examine the extent of the lean culture in the steel industry in Gauteng province;
● to determine the level of SCC in the steel industry in Gauteng province;
● to determine the influence of LSCM practices on the lean culture in the steel industry in Gauteng province; and
● to determine the influence of lean culture on supply chain competitiveness in the steel industry in Gauteng province.

1.4 CONCEPTUAL FRAMEWORK AND HYPOTHESES
This study adopted the conceptual framework presented in Figure 1.1 to conceptualise the relationship between lean practices, namely, just in time, TQM, strategic partnership, waste elimination, HR, information analysis, lean culture, and supply chain competitiveness. Lean

![Figure 1.1: Conceptual framework](image)

**Source:** Own compilation (2020)

Based on the conceptual model presented in Figure 1.1 above, the following hypotheses were developed and tested in the study:

H1: There is a significant positive relationship between just in time and lean culture in the South African steel industry.

H2: There is a significant positive relationship between TQM and lean culture in the South African steel industry.
H3: There is a significant positive relationship between strategic partnership and lean culture in the South African steel industry.
H4: There is a significant positive relationship between waste elimination and lean culture in the South African steel industry.
H5: There is a significant positive relationship between HR and lean culture in the South African steel industry.
H6: There is a significant positive relationship between information analysis and lean culture in the South African steel industry.
H7: There is a significant positive relationship between lean culture and supply chain competitiveness in the South African steel industry.

1.5 THEORY UNDERLYING THE STUDY AND LITERATURE REVIEW

This section discusses the research theory that underpinned this study and provides a review of the literature.

1.5.1 Theory underlying the study

Total Quality Management has been adopted as an underlying theory of this study.

- Deming Theory of TQM

Deming’s (1986) theory rests upon fourteen points of management anchored on the system of profound knowledge, and the Shewart Cycle (Plan-Do-Check-Act) (Khan 2010:47). Total Quality Management (TQM) is a quality improvement body of customer-based and service-oriented methodologies. To achieve supply chain competitiveness, the lean practices need to be considered and the fourteen points proposed by Deming are essential (Curkovic&Pagell 1999:52). According to the theory, not only should the quality of products and processes be improved, but the quality of all activities in the supply chain should be continuously enhanced to generate competitive advantage (Khan 2010:47). Quality of all activities includes active HR, strategic partnership, informational analysis, waste elimination and lean culture of the organisation (Manzouri&Rahman 2013:34). The contemporary quality management philosophy has been strongly influenced by Deming, Juran, Crosby, Feigenbaum, and Ishikawa (1986). Deming’s (1986) fourteen points, Juran’s (1988) trilogy and ten steps, Crosby’s fourteen steps to quality improvement, as identified by Brocka and Brocka (1992), and Feigenbaum’s (1983) approach of
total quality control are essential elements of a quality strategy (Manzouri & Rahman 2013:34). The holistic approach to quality management is vital for competitiveness. Hence, the Deming theory of TQM is used in this study to understand the impact of lean practices on lean culture and supply chain competitiveness within the South African steel industry.

1.5.2 Lean practices

The first objective of lean management is to eliminate every kind of waste on the company to make the business more competitive through good results on innovation, flexibility, cost, quality, and service (Rocha 2017:3). The seven wastes addressed by lean production include defects, overproduction, delay, transporting, over-processing, inventory, and motion. Based on this, Henderson and Larco (2000:22) defined six fundamentals of lean manufacturing to guide the implementation. These fundamentals are environmentally safe; orderly and clean; just in time; six sigma quality; empowerment; visual management; and seeking perfection. They are the basis of lean thinking. Since then, many factors have been identified as lean manufacturing practices. However, this study focuses on just in time, TQM, strategic partnership, waste elimination, HR and information analysis as the lean practices that influence lean culture and ultimately lead to supply chain competitiveness. These are the practices that contribute to supply chain competitiveness in various manufacturing sectors, especially within the steel industries. They are discussed in the sub-sections below.

- Total Quality Management (TQM)

TQM is defined as the sequential development of a product in terms of its quality (Anvari, Ismail & Hojjati 2011:1585). It is an approach in which all the employees work together to improve product, process, and their working environment. The main aim of TQM is the satisfaction of the customers (Soni et al. 2013:80). According to Imai (2012:7), TQM is required in order to conduct successful continuous improvement programmes in the workplace, or “Gemba Kaizen” in Japanese lean terms. TQM has been embodied in the concept of lean culture and these two are commonly associated (Panuwatwanich & Nguyen 2017:6). The above-mentioned authors, including Abd-Elwahed and El-Baz (2018:97) found TQM to be positively correlated with lean culture.
• **Just in time (JIT)**

The concept of JIT is self-explanatory, meaning that only what is required is produced when it is needed at the right time and quantity (Khuluse 2015:17). JIT is fundamentally the reduction of excess inventory (Khuluse 2015:17). It uses the pull system which, according to Simona and Cristina (2015:642), is the centre of any synchronised factory; it works by working backwards, using signals or cards to trigger or start production. Given tight competition in the steel manufacturing industry, it is imperative that customers’ demands are incorporated efficiently and in a way that cost-effectiveness is recognised. From the time a customer places an order, the manufacturing company resumes production by signalling back to the process. All processes are interleading; therefore, they send signals to the preceding process (Sharma, Dixit & Qadri 2015:1218).

• **Strategic partnership**

Strategic partnerships with suppliers are organised efforts to create and maintain a network of qualified suppliers. This effort includes all activities that are needed to improve the current performance of suppliers (Mohanty & Gahan 2012:320). Strategic partnerships with suppliers have been designed to be similar to the strategic and operational capabilities of separate organisations with suppliers to help them achieve significant benefits (Elms & Low 2013:12; El-Deeb 2013:176). The main objective of strategic partnerships with suppliers is increasing the functional capability desired by them (Mohanty & Gahan 2012:320). A good relationship with business partners, including key customers, is an important role in the success of supply chain management practised by organisation (Janet et al. 2015:65). Information sharing with business partners enables organisations to make better decisions and take action because of greater visibility (Elms & Low 2013:12). Well managed strategic alliances and consolidation are viewed as essential to provide long term sustainability, growth, and supply chain competitiveness (Mracek & Mucha 2011:109).

• **Waste elimination**

Wastes are activities that add cost or time but do not add value, consuming more resources (time, money, space, etc.) necessary to produce the goods or services that the customer wants (Panuwatwanich & Nguyen 2017:9). Rocha (2017:3) maintains that the first objective of lean is
eliminating every kind of waste on the company to change the business to be more competitive through good results of innovation flexibility, cost, quality, and service. The seven wastes addressed by lean production include defects, overproduction, delay, transporting, over-processing, inventory, and motion. The main work strategy opted for process improvement is by applying lean principles in material handling in steel plants. The work is basically based on eliminating wastes that are generating in a steel plant in the form of rework (Kumar, Singh & Sharma 2014:06).

- **Human resources**

Past research suggests that an organisation's employees can be a source for sustained competitive advantage and can determine the ultimate success of their organisations (Njeri&Thuo 2014:8). Given the importance of people in organisations, most strategic human resource departments consider the management of the competencies and capabilities of these human assets the primary goal (Karuoya 2014:2). It is generally accepted that firms can create a competitive advantage from human resources and their management practices. Effective human resource management generates a higher capacity to attract and hold qualified and motivated employees for good performance, and the benefits from having adequate and qualified employees are numerous (Carvalho, Alves & Lopes 2011:6). Some examples are higher profitability, less rotation, higher product quality, lower costs in manufacturing and a faster acceptance and implementation of the organisational strategy. Organisational resources lead to a sustained competitive advantage when they are valuable, rare, and inimitable and have no substitute (Fahmi &Abdelwahab 2012:1).

- **Information analysis**

Information analysis is the process of breaking complex substances into smaller components to better understand the supply chain (Verma & Seth 2011:6211). Information analysis is vital in both private and public sectors (Alabi (2016:42). Analysts identify, obtain, analyse, and synthesise information to provide insights and advice to policy makers on critical decisions to be made about the business, including SCC (Kumar, Singh & Sharma 2014:7). The impact of different supply chain components can be recognised in achieving SCC (Verma & Seth 2011:6211). The different components of the supply chain must be competitive enough to achieve overall competitiveness. Alabi (2016:42) suggested information and communication as the most profound and influencing
changes that affect companies as well as the SCC. Conducting information analysis for an organisation should be a cultural activity associated with the company (Zarbo 2012:121). Hence, this study proposes the relationship between information analysis and lean culture within the steel manufacturing industry within this background.

1.5.3 Lean culture

Organisations using traditional manufacturing methodologies have been found to struggle to compete successfully with those adopting lean practices (Van der Merwe, Pieterse & Lourens 2014:132). However, lean success is largely dependent on the attainment of a lean culture. Companies that utilise mass production systems controlled by top-down management approaches, find that the change to a lean system is dependent on a significant shift in organisational culture (Miller 2011:18; Imre, Jenei & Losonci 2013:21). According to Alabi (2016:18), lean culture is the inclusion and engagement of every employee in continuous improvement. Mann (2014:6) described a lean culture as one of the four components of a successful lean implementation and explained that lean implementation consists of four components, namely, lean planning, lean concepts, lean tools, and lean culture.

Organisations or manufacturing industries that have successfully instilled a lean culture within the organisation and workforce will consistently realise supply chain competitiveness, more innovative, team-directed solutions, lower employee turnover and better success at sustaining improvements amongst others (Van der Merwe 2014:132). Besides, Prudentino (2012:16) offered similar sentiments that lean cultured organisation offers many benefits, including greater competitive advantage within its supply chain. Hence this study proposes that lean culture influences supply chain competitiveness in the steel manufacturing industry.

1.5.4 Supply chain competitiveness

Supply chain competitiveness (SCC) is the capability of the supply chain to deliver value to the customer for competitive advantage. SCC refers to the ability of the supply chain to gain competitive advantage compared to other competing supply chain/s (Antai 2011:85; Shang, Zhou & Van Houtum 2010:23). Segarra-Moliner, Moliner-Tena and Sánchez-Garcia (2013) assert that currently, competition and rivalry exist between one supply chain with another supply chain rather than between two firms based on value delivered to the customer. SCC is considered a substantial tool for gaining a competitive advantage. Due to speedy technological innovations, globalisation,
widely used information technology, supply chain competitiveness is now considered necessary for firms to be the strategic focus (Rajagopal 2010). The strategic focus of supply chain demands to make alliances, reengineer, renovate, or refine the operations and develop strategies. Supply chain competitiveness is the solution to survive in hyper-competitive market environment (Antai 2011:85).

1.6 RESEARCH METHODOLOGY

All scientific research must be conducted using some relevant methodology (Neuman 2010:69). A methodology provides a piece of research with its philosophy, the values and assumptions that drive the rationale for the investigation and the standards that will be utilised for the interpretation of information and the drawing of conclusions (Creswell 2014:31). This section covers topics such as the research design, sampling design, procedures for data gathering, analysis and ethical issues.

1.6.1 Research design

A research design is defined as a plan or framework for formulating and addressing research objectives and hypotheses (Polit & Beck 2012:802). It enables a researcher to develop a specific structure to solve a particularly growing research problem, question, or opportunity (McDaniel & Gates 2013:42). This study followed a correlational research design, specifically a single-cross sectional study because data were collected only once from the sample elements (Burns, Veeck & Bush 2018:99). A correlational study determines whether two or more variables are correlated (Creswell 2014:32). The single cross-sectional study is quantitative in nature, meaning that it seeks to understand the sample structure and thereafter recommends a final course of action (Malhotra 2010:108). The cross-sectional strategy was chosen on the basis that it provides inexpensive methods of collecting data over a large sample and it pairs well with quantitative design (Creswell 2014:32). Quantitative research, using the survey method, was used in this study. In the quantitative research strategy, two methods of research are conducted, namely, a literature review as well as a primary investigation based on empirical data.

1.6.2 Literature review

Literature appraisal on relevant variables in this study was conducted with the sole determination of addressing its theoretical intentions. The literature review focused on concepts such as lean practices, lean culture, and supply chain competitiveness. To achieve this goal, a review of South
African and international literature using secondary data sources such as Internet, textbooks, business journals, academic peer reviewed journals and online academic databases were consulted.

1.6.3 Empirical process

In this study, the empirical study involved the collection of primary data and focused on the sampling design, procedures for data collection, data analysis, as well as the reliability and validity of the applicable measuring instrument. A quantitative approach was employed, as indicated earlier. Upon following the quantitative research approach, the following sampling design steps, as recommended by Brown, Suter, and Churchill (2018:205) were employed. These steps include the target population, sampling frame, sampling size, sampling method, data collection method and measurement instruments, which are discussed in the following sub-sections.

1.6.3.1 Target population

A target population is a group of individuals or objects that meet specific requirements for inclusion in the overall group from which information is required (Brown et al. 2018:205). In other words, a group of individuals from which questions can be asked or observations made, with the intent to establish required data structures and information. The target population can include individuals, groups, organisations, sales, territories, and companies (Babin & Zikmund 2016:337). The target population relevant to this study comprised supply chain and operations’ managers and practitioners from steel manufacturing companies based in Gauteng province. Both males and females from all racial groups in South Africa constituted the sample.

1.6.3.2 Sampling frame

A sampling frame refers to a list of individuals or objects from which a sample is extracted (Clow & James 2014:227). In other words, it is a list from where a researcher may draw the potential respondents to be included in a study. The sampling frame of this research study was made up of lists of supply chain and operations’ practitioners in the various steel industry companies chosen for this study’s purpose. The lists were obtained from the HR departments of the companies. The selected industry was chosen owing to the accessibility of the sample, cost and time associated with data collection.
1.6.3.3 Sampling method

There are two main types of sampling methods that are available to researchers, namely, probability and non-probability sampling (Gupta 2011:191). In probability sampling, the members of a population have a known and equal chance of being selected. With non-probability sampling, the researcher’s subjective opinion determines which sampling elements is to be included in a study and which is not (Berndt & Petzer 2011:173). A non-probability convenience sample was used in this study. Supply chain operations managers and practitioners were contacted in person to complete the questionnaire. Convenience samples are sometimes regarded as ‘accidental samples’ because elements may be selected in the sample simply because they just happen to be situated or administratively near to where the researcher is conducting the data collection (McDaniel & Gates 2013:284). The rationale behind using convenience sampling is that it was difficult to contact the respondents after the emergence of the COVID-19 pandemic since the country was placed on a series of lockdowns (from 26 March 2020 to July 2021). In addition, convenience sampling is affordable, easy and the subjects are readily available and identified based on their in-depth knowledge (Malhotra 2010:459).

1.6.3.4 Sample size

A sample size refers to the actual number of population elements chosen for inclusion in a study (McDaniel & Gates 2013:284). There are various factors to be considered when determining the sample size, such as the nature of the research, completion rates and resource constraints (Hair, Black, Babin & Anderson 2014:85). The chosen sample size for this study was pegged at n=400. The sample size determination was based on two approaches. Firstly, the historical evidence approach was used, which focuses on previous similar studies. For example, Khuluse (2015) used a sample of n=250 on the study, focusing on lean practices in small and medium manufacturing enterprises in KwaZulu-Natal. Another study by Viljoen (2015) on the selected lean principles in a South African gold processing plant utilised n=115; while in Alexandria Al Dekheila, Egypt, Fahmi and Abdelwahab (2012) sampled 350 manufacturers. Secondly, considering that various multivariate statistical analysis techniques were used to analyse the data and test the hypotheses in this study, it is noted that these statistical techniques require a substantial amount of sample units (Hair et al. 2014:85). For example, Pallant (2007:185) recommends a minimum of 150
respondents, while Tabachnick and Fidell (2007:613) propose a sample size of at least 200 cases for multivariate analysis.

1.6.3.5 Data collection and measuring instrument

Data must be collected once the target population, sampling frame, sampling method, and sample size have been selected (Creswell 2014:31). Data were collected through a survey using a self-administered questionnaire. Surveys are renowned for reducing response bias, as well as the ability of the respondents to interact with the researcher (Babin & Zikmund 2016:179). Several benefits characterise self-administered questionnaires. The benefits include respondents being able to answer the questionnaires at their own convenience, having no need to set up interview appointments, having no interviewer present to inject bias in the way questions are asked, and the low cost-per-completion makes it an economical method for surveying large samples (Bryman & Bell 2007:242).

The questionnaire was divided into four sections. Section A elicited the biographical details of the respondents such as gender, ethnicity, age, location, and the business profile. Section B covered information on lean practices divided into sub-sections which addressed the six selected practices (just in time, TQM, strategic partnership, waste elimination, HR, information analysis). Section C covered information from respondents about the lean culture in their organisations while Section D required information on supply chain competitiveness. Section A was presented using multiple choice and dichotomous questions. Section B – D applied a seven-point Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. The adapted questions were adjusted accordingly to fit the current context of this study, using feedback collected from a pilot test. The questions were closed-ended (structured) for simplicity of answering.

1.7 DATA ANALYSIS

After the fieldwork, collected data was edited and cleaned for inconsistencies and any missing data. Thereafter, the data was captured into a Microsoft Excel spreadsheet, after which it was imported into the Statistical Package for Social Sciences (SPSS Version 27.0) for analysis. Initially, the sample composition was analysed using frequency distribution graphs and tables.
Thereafter, an exploratory factor analysis (EFA) was conducted in view of summarising the data set. From the factor scores, the descriptive statistics was computed, comprising measures of central tendency (mean, median and mode), measures of variability (variance and standard deviation) as well as the measures of peakedness (skewness and kurtosis). Thereafter, the strength and direction of relationships between the identified variables were analysed using Pearson’s correlation analysis. The posited hypotheses were tested using regression analysis (Malhotra 2010:286).

1.8 RELIABILITY AND VALIDITY ASSESSMENT

Reliability is defined as “the degree to which measures are free from random error and thus provide consistent data” (McDaniel & Gates 2013:215). In other words, reliability refers to the extent to which a measure is unbiased and ensures consistency across time (Sekaran & Bougie 2013:228). This study’s reliability was thus assessed by computing Cronbach’s Alpha coefficients, whereby values between 0.70 and 1.00 were considered adequate evidence of the internal consistency among the scale items.

Validity refers to the extent to which the measurement is accurate. It is an assessment of the exactness of the measurement, relative to what exists (Burns & Bush 2014:214). It refers to how well a developed instrument measures the concept it is supposed to measure and/or the extent to which the variable or relationship being measured is actually measured (Feinberg, Kinnear & Taylor 2013:128). In this research, face, content, and construct validity were evaluated. First, face validity was assessed through an expert de-brief, whereby a statistician and two experts from the supply chain discipline reviewed the accuracy of the measuring instrument. Secondly, content validity was determined through a pilot study with a conveniently selected sample of 20 participants. The pilot study was accompanied by a minimal review of the questionnaire based on a limited assessment of the reliability of the scale items.

The study also checked for face, content, construct and predictive validities. A more detailed discussion is provided in Chapter Five of the study (data analysis and discussion of empirical results).

1.9 ETHICAL CONSIDERATIONS

Ethics are moral principles or values that generally govern a particular group of individuals (McDaniel & Gates 2013:22). In research, ethics refers to the principles and guidelines that clarify
conditions under which the research was conducted (Oates, Kwiatkowski & Coulthard 2010:4). This study complied with specific standards of ethical research before, during and after data collection. Prior to data collection, each respondent was informed about the purpose and legitimacy of the study, including the institution of affiliation. Participation in the study was also voluntary. During the fieldwork process, the researcher treated all the respondents equally and with respect, while attempting not to be biased or influencing a respondent’s opinions in any way. This was done to uphold the research principle of ‘good faith’. Furthermore, the identity of each respondent was protected during and after the fieldwork process. In particular, the respondents were not forced to disclose their names, whereas the research findings would only be used for research purposes and was reported on an aggregate basis. After the data collection process was over, the researcher reported the findings truthfully and with honesty in the form of a dissertation report.

1.10 KEY TERMS

This section provides definitions of key terms employed in this study. These terms are operationalised in the context of the current study.

- **Lean practices**: are activities undertaken by the firm in eliminating every kind of waste on the company to change the business to be more competitive through good results of innovation, flexibility, cost, quality, and service (Rocha 2017:3).

- **Supply chain competitiveness**: is the capability of supply chain to deliver value to the customer for the sake of competitive advantage (Antai 2011:85).

- **Lean culture**: is the inclusion and engagement of every employee in continuous improvement (Alabi 2016:18).

- **Total Quality Management**: is an approach in which all the employees work together for the improvement in product, process, and their working environment. Its main aim is satisfaction of the customers (Soni et al. 2013:80).

- **Just in Time**: is self-explanatory, meaning that only what is required is produced when it is needed at the right time and quantity (Khuluse 2015:17).

- **Human resource**: lean in human resources is defined as driving waste out of HR processes (Khan, Taha, Ghouri, Khan & Yong 2013:178).
• Waste elimination: is one of the initiatives that focus on cost reduction by eliminating non-value-added activities (KuCerová et al. 2015:30).

• Information analysis: is the process of breaking complex substances into smaller components to gain a better understanding of the supply chain (Verma & Seth 2011:6211).

• Strategic partnership: is considered to be formal relationships between two or more parties who act in accordance with a common goal to satisfy certain business needs while retaining their status of independent organisations (McFarlin 2017:13).

1.11 CHAPTER LAYOUT

The results of this research are compiled in the form of an academic dissertation as follows:

Chapter 1: Introduction and background to the study

This chapter comprises the introduction, problem statement, research objectives as well as the literature review. Furthermore, the conceptual model as well as research hypotheses are set out in this chapter. Finally, the research design and methodology followed as well as the reliability, validity and ethical considerations of this study are outlined in summary.

Chapter 2: Literature review on the Steel Manufacturing Industry in South Africa

This chapter provides an overview of the steel manufacturing industry, at the global as well as the South African levels.

Chapter 3: Literature review on lean practices, lean culture, and supply chain competitiveness

The chapter elaborates further on lean practices. In addition, lean culture is scrutinised and a comprehensive review of literature on supply chain competitiveness is provided.

Chapter 4: Research design and methodology

This chapter discusses the methods and design used in the study, including the sampling techniques and the data collection methods. The process of developing the research questionnaire is evaluated.
Additionally, the data analysis and statistical techniques that are relevant for this research are examined.

**Chapter 5: Data analysis, discussion and interpretation of the findings**

This chapter presents the results of the statistical data analysis and provides a subsequent discussion related to the interpretation of the results by cross-referencing with the literature.

**Chapter 6: Conclusion, limitations and recommendations of the study**

This chapter presents the main results in summary and outlines how the research objectives were achieved. In view of this, the conclusion and primary implications of this work are stated. The chapter also includes a discussion on the recommendations of the study, as well as its limitations, which provides avenues for future research.

**1.12 CHAPTER SUMMARY**

This chapter serves as an introduction and background to the study. Its main purpose was to provide an overview of its content and delineates its scope. Accordingly, it touches on important elements such as the study background, research problem and identification of the research gap, the research objectives formulation and methodology. It also provides a preliminary literature review and briefly presented the proposed conceptual model developed in this study. It concludes by providing definition of key terms and chapter classification of the six chapters that constitute this dissertation.

As highlighted earlier in the background of this study, the relevance of this study lies in the lean practices and supply chain competitiveness by the Southern African steel manufacturers. The next chapter provides a detailed discussion of the steel manufacturing sector worldwide with a focus on South Africa.
CHAPTER 2

OVERVIEW OF STEEL MANUFACTURING INDUSTRY IN SOUTH AFRICA

2.1 INTRODUCTION

The preceding chapter focused on the provision of the introduction and background to the study. It provided the theoretical framework and preliminary literature review. In addition, the problem statement and research objectives were formulated as well as the methodology employed in the study. The focus of this chapter necessitates an overview of the steel manufacturing industry in the South African setting. The value of this industry in employment creation and economic prosperity for both developed and developing economies has been known for decades. In an economy desperate for economic growth, with high unemployment figures and various other economic challenges, the steel manufacturing sector presents itself as an opportunity for economic growth in South Africa that can be nurtured.

Steel manufacturing is a very complex sector that is intrinsically linked with the world economy. This industry is also a major source of environmental releases and organic compounds from electric arc furnaces. This chapter is broken into sections which provide an overview of the manufacturing industry both from a global and local perspective. Secondly, the steel industry is discussed, focusing on its socio-economic benefits, contributions to the GDP and job creation, the characteristics of the steel manufacturing, challenges and highlights the obstacles faced by this sector.

2.2 OVERVIEW OF THE GLOBAL MANUFACTURING INDUSTRY

The steel industry remains at the heart of global development. The April Short Range Outlook (2019) forecasted that global steel demand was expected to continue to grow in 2019 and 2020, but growth rates would moderate in tandem with a slowing global economy. However, uncertainty over the trade environment and volatility in the financial markets continue and could pose downside risks to this forecast (Popescu, Nica, Nicolaescu & Lazaroiu 2016:123). World steel recently concluded a global economic modelling exercise with Oxford Economics, that found that in 2017, the steel industry sold US$2.5 trillion worth of products and created US$500 billion value-added (Goyal, Routroy & Singhal 2018:301). For every $1 of value that is added by work within the steel industry itself, a further $2.50 of value-added activity is supported across other sectors of
the global economy because of purchases of raw materials, goods, energy, and services (Debnath & Sebastian 2014:5). This generates over US$1.2 trillion of value-added. On the employment side, the steel industry employs more than 7 million people and for every two jobs in the steel sector, 13 more jobs are supported throughout its supply chain, in total around 40 million jobs globally (Navneeth, Mubeen & Gokhale 2016:15). At present, the steel industry is a booming and growing industry since the adoption of liberalisation policies worldwide. Since adopting them the steel industry has been thriving (Goyal, Routroy & Singhal 2018:301). The increasing demand for it was mainly generated by the adoption of various projects which required steel to succeed (Mukherjee & Roy 2010:156). Projects ranging from stadiums, malls and other developmental structures of the economy contribute vastly to the demand for steel. Breaking down the world steel by individual countries based on the impact these countries have to the overall steel production, Table 2.1 presents the top 50 countries as the largest producers of steel globally.

**Table 2.1: Top 50 major steel producing countries in 2018**

<table>
<thead>
<tr>
<th>Country</th>
<th>Rank</th>
<th>Tonnage (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1</td>
<td>928.3</td>
</tr>
<tr>
<td>Japan</td>
<td>2</td>
<td>106.5</td>
</tr>
<tr>
<td>India</td>
<td>3</td>
<td>104.3</td>
</tr>
<tr>
<td>United States</td>
<td>4</td>
<td>86.6</td>
</tr>
<tr>
<td>South Korea</td>
<td>5</td>
<td>72.5</td>
</tr>
<tr>
<td>Russia</td>
<td>6</td>
<td>71.7</td>
</tr>
<tr>
<td>Germany</td>
<td>7</td>
<td>42.4</td>
</tr>
<tr>
<td>Turkey</td>
<td>8</td>
<td>37.3</td>
</tr>
<tr>
<td>Brazil</td>
<td>9</td>
<td>34.9</td>
</tr>
<tr>
<td>Italy</td>
<td>10</td>
<td>24.5</td>
</tr>
<tr>
<td>Iran</td>
<td>11</td>
<td>24.5</td>
</tr>
<tr>
<td>Taiwan, China</td>
<td>12</td>
<td>23.2</td>
</tr>
<tr>
<td>Ukraine</td>
<td>13</td>
<td>21.1</td>
</tr>
<tr>
<td>Mexico</td>
<td>14</td>
<td>20.2</td>
</tr>
<tr>
<td>France</td>
<td>15</td>
<td>15.4</td>
</tr>
<tr>
<td>Spain</td>
<td>16</td>
<td>14.3</td>
</tr>
<tr>
<td>Vietnam</td>
<td>17</td>
<td>14.1</td>
</tr>
<tr>
<td>Canada (e)</td>
<td>18</td>
<td>12.9</td>
</tr>
<tr>
<td>Poland</td>
<td>19</td>
<td>10.2</td>
</tr>
<tr>
<td>Belgium</td>
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<td>8.0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>21</td>
<td>7.8</td>
</tr>
<tr>
<td>Austria</td>
<td>22</td>
<td>7.3</td>
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<tr>
<td>Netherlands</td>
<td>23</td>
<td>6.9</td>
</tr>
<tr>
<td>South Africa</td>
<td>24</td>
<td>6.8</td>
</tr>
<tr>
<td>Egypt</td>
<td>25</td>
<td>6.3</td>
</tr>
<tr>
<td>Country</td>
<td>Rank</td>
<td>Tonnage (Millions)</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Australia</td>
<td>26</td>
<td>5.7</td>
</tr>
<tr>
<td>Indonesia (e)</td>
<td>27</td>
<td>5.5</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>28</td>
<td>5.2</td>
</tr>
<tr>
<td>Slovak Republic (e)</td>
<td>29</td>
<td>5.2</td>
</tr>
<tr>
<td>Argentina</td>
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<td>5.2</td>
</tr>
<tr>
<td>Czech Republic</td>
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<td>Pakistan</td>
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<td>4.7</td>
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<tr>
<td>Sweden</td>
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<td>4.7</td>
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<tr>
<td>Kazakhstan (e)</td>
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</tr>
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</tr>
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<td>Romania</td>
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</tr>
<tr>
<td>Malaysia (e)</td>
<td>38</td>
<td>3.5</td>
</tr>
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<td>United Arab Emirates</td>
<td>39</td>
<td>3.2</td>
</tr>
<tr>
<td>Qatar</td>
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<td>2.6</td>
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<tr>
<td>Byelorussia (e)</td>
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<td>Luxembourg</td>
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</tr>
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<td>Portugal</td>
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</tr>
<tr>
<td>Oman (e)</td>
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<td>Algeria (e)</td>
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<tr>
<td>Serbia</td>
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<td>2.0</td>
</tr>
<tr>
<td>Switzerland (e)</td>
<td>48</td>
<td>1.5</td>
</tr>
<tr>
<td>Philippines (e)</td>
<td>49</td>
<td>1.5</td>
</tr>
<tr>
<td>Greece</td>
<td>50</td>
<td>1.5</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>14.0</td>
</tr>
<tr>
<td>World</td>
<td></td>
<td>1 808.4</td>
</tr>
</tbody>
</table>

Note e=estimate

Source: Basson (2019:5)

China, Japan and India are the largest steel producers, with over 100 million tonnage. India has come a long way, with the country having risen to the fifth largest crude steel producer globally (Debnath& Sebastian 2014:5). Since 2002, India has also maintained the position of the largest direct reduced iron (DRI) or sponge iron manufacturer globally. India was poised to become the second largest producer of crude steel in the world (after China) in 2015 (Navneeth et al. 2016:15).

The steel industry consists of some large firms that operate globally and have a significant output, and many small firms that operate at a lesser scale. Recently, some of those firms have consolidated into large multinationals (such as ArcelorMittal, formed in 2006 by the merger Arcelor and Mittal.
Steel), Arcelor being the result of the previous merger of Aceralia (ES), Usinor (FR), and Arbed (LX) in 2002. Table 2.2 presents the top 50 largest producers of steel by individual firms.

**Table 2.2: Top steel makers in 2018**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Company</th>
<th>Tonnage (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arcelor Mittal</td>
<td>96.42</td>
</tr>
<tr>
<td>2</td>
<td>China Baowu Group</td>
<td>67.43</td>
</tr>
<tr>
<td>3</td>
<td>Nippon Steel Corporation</td>
<td>49.22</td>
</tr>
<tr>
<td>4</td>
<td>HBIS Group</td>
<td>46.80</td>
</tr>
<tr>
<td>5</td>
<td>POSCO</td>
<td>42.86</td>
</tr>
<tr>
<td>6</td>
<td>Shagang Group</td>
<td>40.66</td>
</tr>
<tr>
<td>7</td>
<td>Ansteel Group</td>
<td>37.36</td>
</tr>
<tr>
<td>8</td>
<td>JFE Steel Corporation</td>
<td>29.15</td>
</tr>
<tr>
<td>9</td>
<td>Jian long Group</td>
<td>27.88</td>
</tr>
<tr>
<td>10</td>
<td>Shougang Group</td>
<td>27.34</td>
</tr>
<tr>
<td>11</td>
<td>Tata Steel Group</td>
<td>27.27</td>
</tr>
<tr>
<td>12</td>
<td>Nucor Corporation</td>
<td>25.49</td>
</tr>
<tr>
<td>13</td>
<td>Shandong Steel Group</td>
<td>23.21</td>
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<td>14</td>
<td>Valin Group</td>
<td>23.01</td>
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<td>15</td>
<td>Hyundai Steel</td>
<td>21.88</td>
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<td>16</td>
<td>Maanshan Steel</td>
<td>19.64</td>
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<td>17</td>
<td>NLMK</td>
<td>17.39</td>
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<td>18</td>
<td>JSW Steel</td>
<td>16.83</td>
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<td>19</td>
<td>IMIDRO</td>
<td>16.79</td>
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<td>20</td>
<td>SAIL</td>
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<td>21</td>
<td>Benxi Steel</td>
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<td>15.88</td>
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<td>Gerdau</td>
<td>15.80</td>
</tr>
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<td>24</td>
<td>Fangda Steel</td>
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<td>25</td>
<td>Techint Group</td>
<td>15.38</td>
</tr>
<tr>
<td>26</td>
<td>U. S. Steel Corporation</td>
<td>15.37</td>
</tr>
<tr>
<td>27</td>
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<td>Rizhao Steel</td>
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<td>Liuzhou Steel</td>
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<td>Jingye Steel</td>
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<td>Anyang Steel</td>
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<tr>
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<td>Tonnage (millions)</td>
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<td>SSAB</td>
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<tr>
<td>50</td>
<td>Donghai Special Steel</td>
<td>7.61</td>
</tr>
</tbody>
</table>

Source: Basson (2019:5)

Steel products are needed by many industries, such as automotive, construction, and other manufacturing sectors (Gonzalez & Kaminski 2015:3). The steel industry uses significant amounts of raw materials (mainly iron ores, coal, and scrap) and energy (Smyth, Narayan & Shi 2012:526). This industry is also a major source of environmental releases such as (among others) emissions of dust, heavy metals, sulphur dioxide, hydrochloric acid, hydrofluoric acid, polycyclic aromatic hydrocarbons and persistent organic pollutants from sinter plants and coke ovens (European Commission 2011; Basson 2019:5).

2.3 SOUTH AFRICAN STEEL MANUFACTURING INDUSTRY OVERVIEW

The steel manufacturing is not, by definition, a growing industry, although there are individual firms that can fit within that category (Kariuki 2013:192). It is a mature sector, where the remaining global players are generally seeking to obtain a larger share of the stagnant share (Basson2019:5). There has been a lengthy trend towards competing products, notably aluminium and plastics, taking over from steel. Thus, there are increases and decreases in metals’ consumption going on concurrently (Alabi 2016:2). Overall, the steel market is not growing on secular bases, although ups and downs are seen within the business cycle (Cookhead 2013:6). As such, it is important that the manufacturers of the metal gobble up market share, notably at the expense of lesswell-endowed competitors. This is a highly competitive industry, with competitors often located both stateside and overseas. The steel manufacturing industry will continue to serve as a stimulus to national development and an economy boaster to the industrial development of a country (Alabi 2016:1). In South Africa, the roots of the steel industry dateback to the fifth century (Du Toit 2014:3), with the smelting of iron lumps in pit furnaces. Since then, it has evolved to the reduction of iron ore in...
blast furnaces. The period of the Iron Age extends from 200 CE to 1840 (ArcelorMittal South Africa 2016:2). Iron tools have been crucial to economic development and industrialisation. The industry will serve as the backbone of the industrialisation of our great country, South Africa, if all the necessary parameters are put in place (Cookhead 2013:6). The benefits of having a functional steel industry will translate to a country. It should also be noted that it will contribute to all the facets of the economy, including the important role steel plays in economic development and growth (Dondofema, Matope & Akdogan 2017:2).

South Africa’s large, well-developed steel industry, with vast natural resources and a supportive infrastructure, represents roughly a third of all South Africa’s manufacturing (Cape Gate Group of Companies 2019:2). It comprises basic iron ore and steel, basic non-ferrous metals, and metal products. The basic industries involve the manufacture of primary iron and steel products from smelting to semi-finished stages (Cookhead 2013:6). Primary steel products and semi-finished products include billets, blooms, slabs, forgings, reinforcing bars, railway track material, wire rod, seamless tubes, and plates (Kariuki 2013:192).

South Africa was the world’s 25th-largest crude steel producer in 2018, with output of 6.8 million tons (Mt) (Department of Trade and Industry 2019:1). South Africa exported 2.7Mt of semi-finished and finished steel products worth US$2.4bn. The country produced 5.4Mt of iron and exported 662.4 kilotons (kt) of iron worth US$245.2m (Statistics South Africa 2019:1). The volume of basic iron and steel products produced increased by 1.6% in the year to March 2019, while the sales value of these products at current prices rose by 9.0% over the same period. High production costs, the inconsistent supply of electricity, and poor domestic demand continue to significantly impact the performance of local manufacturers and wholesalers of basic iron and steel (Trade & Industrial Policies Strategies 2018:3).

South Africa ranks 24th among the crude-steel producing countries globally, growing in the region of 1% of the world’s crude steel (Department of Trade and Industry 2019:1). South Africa is also the largest steel producer in Africa: it is responsible for more than half of the total crude steel production of the continent. South Africa’s steel production bucked the global trend in 2013, increasing by 4.1%, from 6.9-million tonnes a year to 7.8-million tonnes. Of that amount, the South African Iron and Steel Institute stated that 1.74-million tonnes of primary steel products were
exported (TIPS 2018:3). The international and local steel industry has changed dramatically over the past two years. Several steel companies have fallen away, and protectionism has increased (Xiong & Helo 2016:4). The South African primary steel industry has taken major steps to become more efficient and competitive (Dondofemaet al. 2017:2). Many local steelworks have engaged in restructuring and improvements to productivity.

South Africa’s non-ferrous metal industries comprise aluminium and other metals (including copper, brass, lead, zinc, and tin). Aluminium is the largest sector, but feedstock is imported as South Africa has no commercially exploitable deposits (Alabi 2016:3). South Africa is ranked eighth in the world production of aluminium. Key players include Billiton (with smelters in Richards Bay) and Hulett Aluminium (Basson 2019:5). Other non-ferrous metals have a lesser role but are still important for exports and foreign exchange earnings. Although the country’s copper, brass and bronze industries have declined, it is hoped that new mining and reclamation technologies will allow the exploitation of previously unviable deposits (Cape Gate Group of Companies 2019:2).

Steel manufacturing firms must consider the concept of competitiveness to survive in the global market by fulfilling the requirements of the customers for high quality and low-cost products (Kariuki 2013:191). The steel manufacturing industry is one of the most important sectors, contributing to the highest GDP growth in South Africa, with the top five steel-consuming industries together contributing R600-billion to GDP (15% of the total) and employ more than eight million people, as of 2018 third quarter (Statistics South Africa 2018). It is thus a vital part of economic growth for the country (Alabi 2016:1). The steel manufacturing industry is playing a significant role in the national economy and in the economies of other African states, including Egypt, Mozambique, Tanzania, Zambia, Kenya, Uganda, Namibia, the DRC, Ghana, and Ethiopia and serves as a means of job creation for many South Africans (Du Toit 2014:3).

The next section discusses the role of the steel manufacturing sector in the economic development of South Africa.

2.4 THE ROLE OF STEEL MANUFACTURING IN ECONOMIC DEVELOPMENT

It is well known that steel is crucial for the development of any economy and is the backbone of human civilisation (Dondofemaet al. 2017:2). To measure the socio-economic development and
standard of living in any country, the level of per capita consumption of steel is treated as one of the important indices. As the steel sector is deregulated, the government does not keep a count of the exact number of people employed in this sector, but the estimate seems to be around 8 million people (Trade & Industrial Policies Strategies 2018:2). The role of steel manufacturing in the economic development is divided into six categories, as discussed below.

2.4.1 Steel industry contribution to the national economy

The steel manufacturing industry is generally linked to economic growth and international competitiveness. Ocheri, Ajani, Daniel and Agbo (2017:5) mentioned that it is generally known that the present material civilization has been largely due to man’s knowledge and application of metals. Without metals, there would be no railways, aero-planes, automobiles, ships, turbines, electric motors and generally no electrical power. There would be no modern bridges or massive oil rigs and the little but important things of life from simple razor blades to knives and forks and the printed newspaper would be essentially lacking; perhaps a few of these could be fashioned from wood, but they couldn’t go very far (Bobenič, Hintosová, Hliboká&Vasková 2015:572). It is also widely recognised that central to all these metallic inventions, innovations, and motive power, is the particular class of metal known as “STEEL” (Popescuet al. 2015:124).

Every 1 000 tonnes produced locally adds R9.2 million to GDP, provide three jobs directly and three indirectly enable domestic procurement to the value of R5.3 million, of which R500 000 is with small and medium enterprises, and contributes R130 000 in tax to the fiscus (Dondofemaet al. 2017:2). Steel making represents 1.5% of GDP (1.1% directly, 0.4% indirectly) and accounts for 190 000 jobs in the primary and immediate downstream industries, with 100 000 more jobs through suppliers, such as those transporting raw materials and steel (Department of Trade and Industry 2019:2). Further, the industry plays a critical role in mineral beneficiation: steel quadruples the economic value of South Africa’s iron ore, adding R26-billion in value (Alabi 2016:4). Steel is a key enabler of every part of the economy including the automotive, mining, construction, energy, and infrastructure sectors, all of which have been identified as major growth drivers by the National Development Plan (Department of Trade and Industry 2019:2). The top five steel-consuming industries together contribute R600 billion to GDP (15% of the total) and employ more than eight million people (Statistics South Africa 2019:2). South Africa has sub-
Saharan Africa’s only primary steel making capability. This is an encouraging opportunity to supply steel to neighbouring economies, many of which are growing at more than 5% per annum (Dondofema et al. 2017:2). These numbers, while impressive, do not include the capital investment by local steel makers into ensuring the sustainability of the steel industry. ArcelorMittal South Africa alone has committed to investing R4.6 billion over the next five years. Being part of the world’s leading steel company with a presence in over 60 countries brings significant benefits for South African business and, in turn, the local steel making industry and the national economy (TIPS 2018:3).

2.4.2 Steel and employment opportunities
Steel making remains a key strategic industry, making a meaningful contribution to the fiscus and job creation (Department of Trade and Industry 2019:2). Each tonne of steel produced creates jobs and provides value through the beneficiation of natural resources. Steel is fundamental to manufacturing in SA a significant value adds, representing more than 190 000 jobs in the direct iron-ore, steel making and fabrication industries (Basson 2019:5). The steel manufacturers have the prospect of employing much of the nation’s labour force (Ocheriet al. 2017:5). For example, ArcelorMittal itself employed more than 10 000 employees directly while it would create employment for millions of South Africans indirectly through the upstream and downstream industries (ArcelorMittal 2019:2). This would further help to alleviate the ridiculous unemployment problem of the nation. As an important element of industrialisation, the steel industries are vital for developing linkages with all other sectors of the economy (Basson 2019:5).

2.4.3 Steel as a strategic industry
The steel industry is the bedrock of the industrial growth of any nation (Ocheriet al., 2017:5). It is so vital to the development of any nation that every country attempts to acquire and take control of the sector even in cases where the raw materials are not available locally (Bobeničet al., 2015:572). For instance, Japan and South Korea, which are among the largest producers of steel in the world today, do not have the raw materials for steel production locally. The giant technological strides that they have experienced over the years is attributable to the development of their steel industries (Xiong&Helo 2016:3). Today, over 80% of the world’s industrial goods and infrastructures are steel-based. Furthermore, products of integrated steel firms sustain spare
parts and components of the industries that produce these goods (Basson 2019:6). Such industries would provide South Africa’s industrial take-off (ArcelorMittal 2019:2).

2.4.4 Steel as an index of power

The nations of the world have come to appreciate the unique role of steel as the base for rapid technological progress and steel has become an index of national power since World War II (Shaari, Hussain & Rashid 2014:42). Steel had enabled Britain to launch the first industrial Revolution and Western Europe to colonise most of the world. Germany overran Europe while Japan suddenly leapt to the forefront of modern technology (Debnath & Sebastian 2014:5).

Similarly, the United States became a supreme post-war global power as it systematically boosted its steel capacity to excel the entire output of continental Europe (Goyal et al. 2018:301). About 1780, over two centuries ago, the greatest amount of iron produced in the world was less than 20,000 tonnes a year (Sivakumar 2012:106). By 1840, the figure was about 1.25 million tonnes, and by 1900 it was 9 million tonnes (Vadde & Srinivas 2012:178).

Today, iron and steel production has become phenomenal giant. Nations like the United States, the former USSR and Japan produced 326 million tonnes of steel in 1970 and over 405 million tonnes in 1974, the peak year in world steel output (Shaari et al. 2014:42). In 1980 the total world output was estimated at 900 million tonnes of raw steel (Goyal et al. 2018:301). Therefore, it is not surprising that South Africa’s emergence on the steel scene was widely acclaimed locally and generated understandable euphoria throughout the country (Department of Trade and Industry 2019:2). Steel being the necessary and almost sufficient condition for a nation’s power base, it is wise that a great country like SA strengthens its steel manufacturing for sustainability (Du Toit 2014:4).

2.4.5 Steel as economic nerve trigger

The great importance of steel-making to the national economy is not restricted to its immediate or direct application (Debnath & Sebastian 2014:5). For its smelting alone, as suggested by Goyal et al. (2018:301), it triggers a series of economic activities for its input raw materials and energy such as:

• Iron ore: mining, transportation, beneficiation, preparation.

• Coke: coal mining, sizing, and preparation, coking in coke ovens.

• Limestone: quarrying and calcining.
• Oxygen: manufacture of oxygen and lances for steel refining.
• Refractory bricks: clay preparation and firing.
• Additives: manufacture of nozzles.
• Air and fuel: pre-heating and atomizing of oil and gas.
• Energy: power construction, generation and distribution, services, etc.

Added to these large-scale economics and industrial activities associated with the raw materials used for steel making, are ancillary downstream foundry, machining, fabricating, and processing industries, as well as extensive services such as transportation and supplies which are given a big boost (Sivakumar 2012:106). Statistical evidence indicates that raw steel production is attended to by over twenty types of ancillary industries and associated economic activities: These do not include continuing research into the further development, utilisation, and adoption of raw materials resources and technology (Xiong&Helo 2016:3).

2.4.6 Foreign exchange earner

The amount of foreign exchange being expended on the importation of steel today runs into billions of dollars (Basson 2019:6). This colossal amount of money is an unacceptable waste of our meagre resources and could have been diverted to other vital sectors of the economy (Goyal et al. 2018:301). The products of steel manufactures would be exported to the African continent at large.

The next section discusses the characteristics or sub-sectors of the steel manufacturing within the South African context.

2.5 CHARACTERISTICS/SUB-SECTORS OF STEEL MANUFACTURING

Steel manufacturing in South Africa is characterised by sub-sectors which contribute vastly to the overall manufacturing. These sub-sectors are discussed in the next section.

● Iron and steel mills

This sector comprises establishments primarily engaged in one or more of the following: (1) direct reduction of iron ore; (2) manufacturing pig iron in molten or solid form; (3) converting pig iron into steel; (4) making steel; (5) making steel and manufacturing shapes (e.g., bar, plate, rod, sheet, strip, wire); and (6) making steel and forming tube and pipe (Department of Trade and Industry 2019:2).
• **Electrometallurgical ferroalloy product manufacturing**

This sector comprises establishments primarily engaged in manufacturing electrometallurgical ferroalloys. Ferroalloys add critical elements, such as silicon and manganese for carbon steel and chromium, vanadium, tungsten, titanium, and molybdenum for low- and high-alloy metals (Kariuki 2013:191). Ferroalloys include iron-rich alloys and more pure forms of elements added during the steel manufacturing process that alter or improve the characteristics of the metal being made (Department of Trade and Industry 2019:2).

• **Iron and steel pipe and tube manufacturing from purchased steel**

This industry comprises establishments primarily engaged in manufacturing welded, riveted, or seamless pipe and tube from purchased iron or steel (Alabi 2016:1).

• **Rolled steel shape manufacturing**

This sector comprises establishments primarily engaged in rolling or drawing shapes (except wire), such as plate, sheet, strip, rod, and bar, from purchased steel (Basson 2019:5).

• **Steel wire drawing**

This sector comprises establishments primarily engaged in drawing wire from purchased steel (Cape Gate Group of Companies 2019:2).

• **Alumina refining**

This sector comprises establishments primarily engaged in refining alumina (i.e., aluminium oxide), generally from bauxite (Alabi 2016:1).

• **Aluminium production**

This industry comprises establishments primarily engaged in (1) making aluminium from alumina and/or (2) making aluminium from alumina and rolling, drawing, extruding, or casting the aluminium they make into primary forms (e.g., bar, billet, ingot, plate, rod, sheet, strip). Establishments in this industry may make primary aluminium or aluminium-based alloys from alumina (Kariuki 2013:191).

• **Secondary smelting and alloying of aluminium**
This industry comprises establishments primarily engaged in (1) recovering aluminium and aluminium alloys from scrap and/or dross (i.e., secondary smelting) and making billet or ingot (except by rolling) and/or (2) manufacturing alloys, powder, paste, or flake from purchased aluminium (Alabi 2016:1).

- **Smelting and refining of copper**

This industry comprises establishments primarily engaged in (1) smelting copper ore and/or (2) the primary refining of copper by electrolytic methods or other processes. Establishments in this industry make primary copper and copper-based alloys, such as brass and bronze, from ore or concentrate (Cape Gate Group of Companies 2019:2).

- **Copper wire (except mechanical) drawing**

This industry comprises establishments primarily engaged in drawing or drawing and insulating communication and energy wire and cable from purchased copper or in integrated secondary smelting and wire drawing plants (Department of Trade and Industry 2019:2).

- **Iron foundries**

This industry comprises establishments primarily engaged in pouring molten pig iron or iron alloys into moulds to manufacture castings (e.g., cast iron manhole covers, cast iron pipe, cast iron skillets). Establishments in this industry purchase iron made in other establishments (ArcelorMittal 2019:2).

- **Steel investment foundries**

This industry comprises establishments primarily engaged in manufacturing steel investment castings. Investment moulds are formed by covering a wax shape with refractory slurry. After the refractory slurry hardens, the wax is melted, leaving a seamless mould. Investment moulds provide highly detailed, consistent castings. Establishments in this industry purchase steel made in other establishments (Department of Trade and Industry 2019:2).

### 2.6 MANUFACTURERS OF STEEL IN SOUTH AFRICA

The primary steel industry is a significant contributor to the economy and earns considerable amounts of valuable foreign exchange. Arcelor Mittal SA (AMSA), formerly Iscor and now part of global steel company ArcelorMittal, is South Africa’s largest steel producer. To date, other key players in the South African iron and steel industry include AMSA, Scaw Metals Group, Columbus...
Stainless (Pty) Limited, South Africa Steelworks, and Unica Iron and Steel (Pty) Limited (Dondofema et al. 2017:3). With stiff competition from external iron and steel producers, local iron and steel production has been rapidly decreasing since 2005. The contribution of industrial engineers to the South African iron and steel industry is also very limited, judging from the survey of publications produced by SAIIE and SAJIE databases.

2.6.1 ArcelorMittal South Africa (AMSA)

ArcelorMittal South Africa (AMSA) is the largest iron and steel producer on the African continent, with an annual production capacity of 6.1 million tonnes of liquid steel (Department of Trade and Industry 2019:3). The company, founded in 1928 and headquartered in Vanderbijlpark in South Africa’s Gauteng province owns five plants: three integrated steelworks in Vanderbijlpark, Newcastle, and Saldanha, and two plants producing steel through the mini-mill route in Vereeniging and Vanderbijlpark (ArcelorMittal 2019:1). The company has a depth of technical and managerial expertise carefully nurtured since 1928, a reputation for reliability and a sharply defined business focus, which has forged the organisation into a modern, highly competitive supplier of steel products to the domestic and global markets (Research and Markets 2019:1).

This has been achieved through ongoing alignment with international best practices and a comprehensive understanding of the steel business environment, ensuring the company’s continued global competitiveness and participation in international markets (TIPS 2018:3). ArcelorMittal South Africa's global standing is further underpinned by becoming part of the world’s largest steel producer, the ArcelorMittal Group (Research and Markets 2019:1). The company is the world’s number one steel company, with over 316 000 employees worldwide. ArcelorMittal is the leader in all major global markets, including automotive, construction, household appliances and packaging, with leading R&D and technology, as well as sizeable captive supplies of raw materials and outstanding distribution networks (Dondofema et al. 2017:5). With an industrial presence in 27 countries across Europe, the Americas, Asia and Africa, ArcelorMittal has a balanced geographic diversity within all the key steel markets, both developing and developed (ArcelorMittal 2019:1). Through this association, ArcelorMittal South Africa has access to world-class research and development, best practice processes, aggressive procurement contracts and international market leverage to ensure the company remains at the cutting edge of the international steel industry (Alabi 2016:1). The company’s ability to generate profits and cash
throughout the fluctuations of the steel cycle is testimony to the success of years of intensive business re-engineering and the cultivation of a continuous improvement culture that has embedded ArcelorMittal South Africa’s position among the world’s lowest cash cost producers of steel (TIPS 2018:3).

2.6.2 Scaw Metals Group

The Scaw Metals Group is an international group, manufacturing a diverse range of steel products, with key operations in South Africa, Australia, and a smaller presence in Namibia, Zimbabwe, and Zambia (Research and Markets 2019:1). Scaw’s key facilities are in Johannesburg, providing proximity to key African mining locations and industrial centres. The company employs over 2000 employees and manufactures rolled and wire rod products. Scaw’s rolled steel operation is one of the largest suppliers of long steel products in South Africa. Scaw Metals Germiston produces half a million tonnes of liquid steel each year using 100% of its recycled steel scrap and directly reduced iron from its rotary kilns (Department of Trade and Industry 2017:6). The scrap metal processing facility located at the union Junction plant in Germiston has the largest scrap shredder in Africa. Scaw is committed to a philosophy of zero harm to both employees and our environment. It has implemented the necessary standards and practices to achieve this commitment. Presently Scaw is registered as leader with respect to its safety performance. The company supplies industries such as global construction, power generation, mining, marine and engineering (Dondofema et al. 2017:3).

2.6.3 Cape Gate Private Limited

Cape Gate (Pty) Limited was established by the purchase of a small wire netting plant on 15 hectares in Vanderbijlpark, Gauteng province, in 1962 (Huffman 2007:8). Cape Gate is a company which has always valued its self-reliance. Through full vertical integration, Cape Gate has grown from a small wire netting manufacturing company in 1962 to a major producer of wire and steel products with its own source of raw materials. The company has set new standards and found innovative hi-tech solutions for a broad spectrum of strategic industries, which demand dependability. “All our products meet recognised international standards, and we are proud to be recognized as a reliable supplier of high-quality products” (Research and Markets 2019:2). The company serves industries including mining, agriculture, commerce, civil engineering and
construction, domestic and foreign markets with over 227 employees (Cape Gate Group of Companies 2019:2).

2.6.4 Columbus Stainless Private Limited

Columbus Stainless is South Africa’s and Africa’s only producer of stainless steel flat products founded in 1966. The company manufactures the most popular grades of stainless steel, such as austenitic grades 304 stainless and 316, ferritic grades 430, 444 and 441, as well as 3CR12 corrosion resisting steel that are developed for improved weldability and low-cost applications. The firm also supply duplex stainless-steel grades 2205 and 2304 in sheet and coil. Because of the boundless potential for stainless steel as a metal for the future, Columbus remains dedicated to becoming one of the leading suppliers of stainless steel in both the domestic and the global arena (Wu, Ly, Liang & Hu 2017:39).

Acerinox, S.A. (Spain), a major international stainless producing Group holds a 76% shareholding in Columbus Stainless (Pty) Ltd. The balance of the shares (24%) is held by the IDC (Industrial Development Corporation). Columbus Stainless is situated in Middelburg in the Mpumalanga Province of South Africa. Its plant is a technologically advanced, fully integrated, single-site operation. This gives the flexibility to adjust quickly to changes in the market. The company has created a modern, efficient stainless steel production facility that meets the changing demands of users in the domestic market and around the world. With a wide range of products in Austenitic, Ferritic, Utility and Duplex grades produced in its plant in Middelburg, the company can offer a variety of grades of stainless steel suitable for most applications. Its exported products are channelled through a well-developed network of agents and group sales outlets operating in Europe, the Americas, the Middle East, and the Far East. In addition, the company trade directly to several end-user and some re-roller customers.

2.6.5 South Africa Steelworks

SA Metal is a proudly South African company and has a long tradition of trading in most Southern African countries, including Mozambique, Namibia, Botswana, Swaziland, Lesotho, Zambia, and Zimbabwe. SA Steelworks is a division of SA Metal Group (South Africa’s oldest and largest metal recycling company founded in 1919 and celebrating 100 years as of 2019), manufactures steel billets, reinforcing bar, round and square bar and other custom-produced steel bars. All
products are manufactured from 100% recycled scrap steel, thus contributing to preserving the environment. Steel scrap is melted using energy-saving and low-emission electric induction furnaces and is then refined, alloyed, and stirred in an arc ladle furnace before being continuously cast into billets. Billets are then rolled into final products, all manufactured in accordance with international and South African National Standard (SANS) specifications.

In the last century, the Group has purchased, collected, processed and recycled all forms of ferrous metals (iron and steel) and non-ferrous metals (aluminum, copper, zinc, stainless steel, lead, nickel, brass, tin, bronze and others) (Department of Trade and Industry 2018:2). From its conveniently-located scrap yards in and around Cape Town, Johannesburg and Pretoria, South Africa Steelworks purchase scrap metals from a range of Southern African sources, including industrial enterprises, public entities, scrap metal dealers and private individuals. In addition, the Group acquires scrap metal from off-site demolition projects, where it can provide expert demolition services to mines and factories. It is fully equipped to deal with all environmental hazards, including radioactive material and asbestos. The company is fully committed to preserving the fragile environment in which we live and dealing with all materials in an environmentally responsible manner. The company prides itself on impeccable health and safety record throughout the Group (Van der Walt 2012:3).

The following section presents the challenges/obstacles facing the steel manufacturing and its development.

2.7 CHALLENGES AND OBSTACLES FACED BY STEEL MANUFACTURING IN SOUTH AFRICA

The steel industry holds ample promising prospects for growth and profit. However, it cannot entirely be labelled as a sector that is devoid of threats and challenges. Currently, trade and overcapacity are some of the dominant issues for steel manufacturers (Research and Markets 2019:4). But the list, unfortunately, does not end there; there are still several issues that steel manufacturers need to address to ensure that they function smoothly in the long run (ArcelorMittal Report 2019:7). Furthermore, the increasingly competitive environment is putting pressure on global steel companies to search for better ways to gain a competitive advantage in the market. The local steel sector has been in decline since 2008/9, with pricing, margins and profitability
being negatively affected by surplus, the large number of competitors, weak demand, and imports of cheap steel (Van der Walt 2012).

Demand from the important steel-consuming construction sector has decreased as fewer projects are being undertaken by the private and public sectors (Department of Trade and Industry 2018:9). Consumption by the mining sector has also declined. The stainless-steel industry is affected by cheaper imports from China, high labour costs, and increasing electricity prices (Yin, Tan, Liu, Wang, Liang, Qu, Feng, Qiu, Tan & Liu 2016:182). A proposed US$10bn metallurgical complex in the Musina Makhado special economic zone is expected to have significant repercussions for the local industry. Apart from weak demand, a major cause of the decline is cheap steel imports, which adversely affect the profitability and capacity utilisation rates of the domestic steel producers aggravated over the years due to the situation of global excess capacity and falling domestic primary steel production competitiveness. There are key challenges that steel manufacturers need to tackle for hindrance free long-term sustainability in the market (Department of Trade and Industry 2018:2).

2.7.1 Solid waste management
Steel manufacturing involves the production of large amounts of solid wastes while processing materials through various processes. But what steel manufacturers often overlook is the fact that these solid wastes contain several valuable products which can be reused if recovered economically. Players in the steel industry need to figure out ways by which they can make the best out of solid waste and reduce wastage of useful resources (ArcelorMittal 2019:1).

2.7.2 The problem of excess capacity
Despite growth rates for steel production being tapered globally since 2008, China continues to produce more steel every year (Xiong&Helo 2016:8). Consequently, almost half of the world’s steel is now manufactured in China. In South Africa, the high rates of overproduction, combined with volatile raw material prices, add to the struggle of steelmakers to make good profit margins (Department of Trade and Industry 2019:3). Therefore, before any long-term structural growth in the steel industry, the amount of excess and less-efficient capacity needs to be shut down. However, factors such as labour laws, environmental costs, and permanent loss of the optionality value of the plants are curbing steel manufacturers from shutting down steel capacity permanently.
Additionally, government intervention in the steel industry provides an additional political incentive to keep employing workers regardless of profitability (Dondofema et al. 2017:6).

2.7.3 Growth in demand
The effects of the steel crisis are evident across the value chain, from mining, primary steel mills to domestic manufacturers struggling to compete, sustain jobs and invest (Brimacombe 2008:91). With the increasing focus on infrastructure and development, global steel use is expected to rise in the years to come (Statistics South Africa 2018:1). However, there are some uncertainties in the rate of growth in emerging economies such as South Africa due to unresolved structural issues, political instability, and volatile financial markets. Much of the rise in demand will be met by primary raw materials (coal and iron ore) (Arcelor Mittal 2019:3). In years to come, increasing urbanisation in emerging markets and the renewal of infrastructure in developed markets should mean that steel consumption will continue to grow steadily (Research and Markets 2019:2). The big question for steel manufacturers is whether they would be able to meet the growing demand, especially from emerging economies, in the long run (Cape Gate Group of Companies 2019:2).

2.7.4 Price volatility of raw materials
The constantly fluctuating price of raw materials and weak steel prices have put significant pressure on steel margins (Department of Trade and Industry 2019:2). However, steel manufacturers have been working hard to become competitive in other ways. They have been taking several steps to gain more control of their raw material pricing, while cost-cutting has led to production cuts in some regions (ArcelorMittal 2019:1). Several steel manufacturers are also investing a considerable amount of money into R&D for differentiating their products from other players in the market (Yin et al. 2016:182).

2.7.5 Engineering and technical skill scarcity
One major challenge facing the future steel industry is recruiting the engineers and technical talent required to keep the industry vibrant and growing technologically (Brimacombe 2008:91). This is a challenge on numerous fronts. First, many of the engineers, technical staff and management in the steel industry are baby boomers and will be retiring in large numbers over the next ten years. This will require an influx of new talent to replace those retiring. In addition, newer steel plants require a larger percentage of the workforce to possess technical degrees and need less unskilled labour. It is interesting that there has been some replacement of workers with bachelor’s degrees during the last ten years, but there has been a general lack to hire workers with graduate degrees.
Although this is the demographics of the general workforce in the United States, the trends are not much different in the steel industry (Dondofema et al. 2017:6). The next section discusses the policies and legal framework guiding the steel manufacturing sector in South Africa.

2.8 POLICY AND LEGAL FRAMEWORK ON STEEL DEVELOPMENT IN SOUTH AFRICA

Policies and legal frameworks are very important to guide the development activities of any nation (Dondofema et al. 2017:5). South Africa has released several fiscal and economic development policies. The successful transformation of South Africa’s iron and steel industry is attributed to the vision of its pioneers and supporting legislation. The passing of the Iron and Steel Industry Act in 1928 marked the beginning of a prosperous era for the South African iron and steel industry (TIPS 2018:3). The entry of Anglo American in 1960 through the Highveld Development Corporation, stimulated competition between the major actors in the industry, leading to the increased production of pig iron and steel (Cape Gate Group of Companies 2019:2).

2.8.1 The industrial Policy Action Plan

The Industrial Policy Action Plan (IPAP 8) was introduced. The Department of Trade and Industries (DTI) raised tariffs on ten items and had followed the due process required by the World Trade Organisation (WTO). DTI could not sign off overnight on curve increases. Upon agreement of the process in High Tech, the Minister of Trade and Industry signed off on the tariff increases on condition that the primary steel producer would not increase prices because of the tariff. The primary steel producer indicated that it had to increase the prices in some cases due to the dramatic increase of the input cost (Research and Markets 2018:5).

In terms of steel-intensive products, inadequate investment in new planting technology was identified when the primary steel producer was at the top of the commodity super-cycle in the boom years (Basson 2019:5). This inadequate investment resulted from repeated breakdowns of steel manufacturing production, which meant that the company had become uncompetitive, falling behind the global technology curve despite repeated efforts to build a collaborative relationship with the company. At that time, because of import parity pricing in the designation where DTI had to stipulate every item that was deemed local, DTI deemed all steel (including imported steel) as local. Now that there was a very significant problem, DTI was removing the deeming from the
designation, which would take time because it had to work with the National Treasury and issue new instruction notes for all the designations (Kariuki 2013:191). DTI was conscious of not passing higher prices of steel produced in South Africa to the downstream (Alabi 2016:1). It was difficult to get back steel production capabilities after they had been lost. Once market conditions improved, South Africa would have no influence on the market prices and would become importers and price takers of steel producers in other countries. Nevertheless, there was a need to support the downstream. Rebates existed for importing steel, re-rolling steel products, and exporting steel with added value. South Africa was currently behind the curve in protecting its steel industry (Basson 2019:5).

2.8.2 The Competition Act
The Competition Commission is a legislative body that was promulgated to investigate, control and evaluate business practices. This includes abuse of power and joint ventures in order to achieve equity and efficiency in the South African economy (Van Niekerk 2019:13). The Steel industry is one of the sectors prioritised by the Commission to impact competition within the steel market and the South African economy. The steel sector is identified because of high concentration levels and high barriers to access to the market and fewer competition or potential entrants to the market. The contemporary increases in the price of steel have also meant that the sector has a huge impact on the competitiveness of downstream industries and, importantly, in driving up costs.

2.8.3 The Broad-based black economic empowerment (BBBEE)
The Broad-based black economic empowerment is a programme that enhances the South African economy's transformation through enforcement that black people participate in the economy. BBBEE also seeks to address past injustice that was created by apartheid prior to 1994 (Southall, 2014:15).
The steel sector plays a vital role in transforming black people within the South African economy. It is also pertinent that such a legislative framework is imposed on steel manufacturing business so that the advancement of black people is yielded within one of the most contributing sectors of the gross domestic product in the South African economy.

2.9 CHAPTER SUMMARY
This chapter discussed the global and local perspectives of the steel manufacturing industry and the sector’s contribution to economic growth and employment creation. Steel industry firms in South Africa have not developed to their full growth potential. Their growth depends on the growth of the macro-economy and on support interventions (Basson 2019:6). It remains empirically unknown whether macro-economic policies have, in the last two decades since 1994, made enough effort to act as a catalyst to the overall performance and growth of the industry organisations. As annotated in this chapter, South Africa’s steel manufacturing industry is expected to fulfil a number of roles, ranging from poverty alleviation and employment creation to international competitiveness. In an economy with a high unemployment rate, steel manufacturing is faced with many challenges (Dondofema et al. 2017:4).

One of the greatest difficulties confronting policy makers is how best to develop an approach that would achieve a sufficient degree of coordination between supply-side effort and demand potential and functional and interventional capacity (Alabi 2016:5). Although there is the risk of investing in resources in improving supply potential where demand constraints are high, a major question is whether supply-side incentives have frequently been ineffective because of such demand. It is acknowledged that the development of steel manufacturing also requires supply chain competitiveness and marketing competencies in the context of the challenges that are clearly relevant for steel manufacturers (Department of Trade and Industry 2019:2).

This chapter gave a detailed description of the steel manufacturing industry both internationally and locally was provided. The review of the top 50 major steel-producing countries, as well as the top 50 steel makers (companies) were also identified and listed. The chapter further provided the role of steel manufacturing in the economic development of South Africa and elaborated on the characteristics/sub-sectors of the steel manufacturing industry. It concluded by discussing the steel manufactures in South Africa.

The next chapter provides a literature review of supply chain competitiveness.
CHAPTER 3

DEMING THEORY OF TOTAL QUALITY MANAGEMENT, LEAN PRACTICES, LEAN CULTURE AND SUPPLY CHAIN COMPETITIVENESS

3.1 INTRODUCTION

This chapter provides a comprehensive review of the theories and models underlying this study to understand the lean practices as drivers of lean culture and supply chain competitiveness. It is divided into four broad areas: The first section discusses the use of the Deming theory by various studies to understand lean practices. The second section discusses the lean practices such as just-in-time, TQM, strategic partnership, waste elimination, human resource, and information analysis. The third section examines lean culture mediating the relationship between lean practices and supply chain competitiveness. The fourth section is dedicated to the discussion of supply chain competitiveness.

3.2 DEMING THEORY OF TQM

Deming theory is used in this study as a cornerstone to examine SCP effecting lean culture and SCC. Deming is considered by many to be the father of the total quality management (TQM) movement (Manzouri & Rahman 2013:34). Deming theory is based on the simple concept that continual improvement can help increase quality while decreasing costs (Khan 2010:47). Established in the 1940s, Deming (1982:12) suggested that the manufacturing process is not a series of unrelated processes, but is an entire system, and when viewed as an entire system, opportunities to improve efficiencies are more easily identified (Anderson, Rungtusanatham & Schroeder 1994:473). Deming is known for his ratio that quality is equal to the result of work efforts over the total costs. If a company is to focus on costs, the problem is that costs rise while quality deteriorates. Deming’s theory rests upon fourteen points of management identified as the system of profound knowledge (Koskela, Tezel & Patel 2019:1381). The framework of Deming’s system of profound knowledge consists of the following points as shown in the table below:

Table 3.1: 14 principles of the Deming theory of TQM

<table>
<thead>
<tr>
<th>Point</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Create constancy of purpose toward improvement of product and service, with the aim of becoming competitive, staying in business, and providing jobs</td>
</tr>
<tr>
<td>2</td>
<td>Adopt the new philosophy. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change.</td>
</tr>
<tr>
<td>Point</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>Point 3</td>
<td>Cease dependence on mass inspection. Build quality into the product from the start.</td>
</tr>
<tr>
<td>Point 4</td>
<td>End the practice of awarding business based on price tag alone. Instead, minimise total cost. Move towards a single supplier for any item, based on a long-term relationship of loyalty and trust.</td>
</tr>
<tr>
<td>Point 5</td>
<td>Improve constantly and forever the system of production and service to improve quality and reduce waste.</td>
</tr>
<tr>
<td>Point 6</td>
<td>Institute training and retraining.</td>
</tr>
<tr>
<td>Point 7</td>
<td>Institute leadership. The aim of supervision should be to lead and help people to do a better job.</td>
</tr>
<tr>
<td>Point 8</td>
<td>Drive out fear so that everyone may work effectively for the company.</td>
</tr>
<tr>
<td>Point 9</td>
<td>Break down barriers between departments. People in research, design, sales, and production must work as a team, to foresee and solve problems of production.</td>
</tr>
</tbody>
</table>
| Point 10 | a) Eliminate slogans, exhortations, and targets for the workforce as they do not necessarily achieve their aims.  
B) Eliminate management by objective. Eliminate management by numbers, numeric goals. Substitute leadership. |
| Point 11 | Eliminate numerical quotas to take account of quality and methods, rather than just numbers. |
| Point 12 | a) Remove barriers that rob the hourly worker of his/her right to pride of workmanship. The responsibility of supervisors must be changed from sheer numbers to quality.  
b) Remove barriers that rob people in management and in engineering of their right to pride of workmanship. This means, inter alia, abolishment of the annual or merit rating and of management by objective. |
| Point 13 | Institute a vigorous program of education and re-training for both the management and the workforce. |
| Point 14 | Take action to accomplish the transformation. Management and workforce must work together. |

**Source:** Deming (1986:23)

In its current form, the Deming system contains a prescriptive set of points that serve as guidelines for appropriate organisational behaviour and practice regarding quality management. Deming created this framework to develop knowledge in the workplace and can be used to guide long term business plans and aims (Khan 2010:47). The points constitute not so much an action plan as a philosophical code for management. They have been extensively interpreted by as many commentators on quality, as on other management disciplines. Some of the 14 points recommend behavioural practices aimed at changing the organisation's infrastructure and cultural system. For example, suppose organisational members practice points 8 and 9. In that case, they will foster an
open, trusting, and cooperative culture in which all employees from top managers to blue-collar workers perform to achieve the common goal of firm survival. Other points like 3, 4, and 5 implicitly advocate methodological practices, including the use of specific tools and statistical methods in the design, management, and improvement of processes, products, and services (Manzouri & Rahman 2013:34). Although behavioural and methodological practices can provide distinctly separate opportunities for organisational improvement, it is important to realise that both (types of practices) are integral to improving quality. The synergistic implementation of all the points will improve quality in a never-ending fashion (Koskela et al. 2019:1381).

The nature of the Deming framework is further complicated by the interrelationships among the 14 statements. For instance, in both points 6 and 13, for example, Deming argues for continual development of the abilities of the individual, these being on-the-job skills and personal intellectual enrichment. These abilities and skills would be useful in the steel manufacturing industry where the processes are more demanding. Less obvious is the relationship between points 4 and 8, which are fundamentally linked by the need to understand variation (Anderson 1994:473). These interrelationships among the 14 points are better revealed from a careful analysis of the text accompanying each point (Deming 1986). Given such interdependencies, Gartner, and Naughton (1988) restated the warning by Gitlow and colleagues (1989) against interpreting or embracing each point independent of the remaining points. Deming (1981,1982) asserted, "failure of top management to act on any of the fourteen points… will impair efforts on the other thirteen."

3.3 The application of Deming’s theory in 14 points to steel manufacturing

To achieve continuous improvements in steel manufacturing, Deming’s theory of TQM is adopted. Although organisations have probably always been interested in the bottom line (profits and growth) obtained at by the business, it is only recently that the quality of manufacturing has become an issue of common concern (Koskela et al. 2019:1381). The theoretical essence of the Deming approach to TQM concerns the creation of an organisational system that fosters cooperation and learning for facilitating the implementation of process management practices, which, in turn, leads to continuous improvement of processes, products, and services as well as to employee fulfilment, both of which are critical to customer satisfaction, and ultimately, to firm survival (Deming 1986:23).
Point 1: Create constancy of purpose towards improvement of product and services

To understand this point and the following ones, it should be clear that the main intention of Deming’s philosophy was to encourage Western management to go for the long-term perspective instead of making minor amendments to achieve short-term profit. Steel manufacturing is one of the main contributors to the country’s economy. Therefore a long-term plan needs to be a priority. By creating ‘constancy of purpose’; he hoped to help man live a better and fuller life (Neave 1990:292). It can be achieved by developing an understanding of the need for constancy of purpose and an understanding of how continuous improvement may satisfy that need. Deming suggests that this can be attained in steel manufacturing by establishing clear long-term aims, principles, values and norms to guide the supply chain practices of employees.

Point 2: Adopt the new philosophy

Adopting a new philosophy coincides with Deming’s framework because it builds up a system for continuous improvement in steel manufacturing. This may prove helpful to many employees. How may systematic improvements support and heighten supply chain performance and competitiveness? Since the Deming theory provides profound knowledge about the system, steel manufacturers may find it valuable to be more aware of how it impacts on manufacturing processes.

Point 3: Cease dependence on inspection to achieve quality; eliminate the need for inspection by building quality into the processes

To cease dependence on using inspectors to achieve quality is a current warning for many organisations. The use of special inspectors is costly and inefficient, and it does not add any value to the process or service. The main point is to deal constructively with building quality into the manufacturing processes without inspecting the end product. Since quality should be evaluated in terms of customer satisfaction with the product/service offered, firms should be concerned about how well their supply chain services meet customer problems, needs and expectations. As part of the planning and execution of their manufacturing, both management and supply chain practitioners may find the Deming cycle an appropriate tool to ensure that quality is built into the processes. Scherkenbach (1982:25) found a useful definition of a process that distinguishes between inputs, the processing system, and outputs or outcomes. This illustrates one single
process. However, it should be remembered that several processes are often linked in the supply chain. They may form chain events, where the outcomes of one process simultaneously serve as inputs for the next link in the process chain. This operationalising process shows that the inputs and outcomes contain the same factors (Neave 1990:292).

**Point 4: Improve constantly and forever the system of production and service to improve quality and productivity**

Generally, continuous improvement is often encouraged in manufacturing. Improvement must be built into the whole system of supply chain. If we start with the buildings, it means that thinking about making improvements should be an integral part of the planning, design and building processes (Scherkenbach 1982:25).

**Point 5: Remove barriers that rob people of pride of workmanship**

Deming contends that people who are robbed of experiencing such pride in their own work are left with a job that yields them only pay, which in the long run does not offer much joy. What does it mean if we adopt this point of view in manufacturing? It means that all those working in supply chain should be entitled to ample opportunities to experience pride in workmanship. The good feeling of working and successfully completing a job or task serves as fuel, stimulation, and inspiration for further contribution. Pride of workmanship is thus a personal feeling of satisfaction that stems from the successful completion of a manufacturing task on the solution of a problem.

**Point 6: Drive out fear**

Driving out fear is of crucial importance in the supply chain because there may be much fear among employees of being evaluated by colleagues and by external experts who perform regular or irregular appraisals of them. They may also fear the unknown and failure in the performance of their jobs. It is a good idea to attempt to drive out fear since this negative emotion may interfere with the execution of supply chain performance and competitiveness.

**Point 7: Break down barriers between departments to enhance the use of teams across internal borders**
Manufacturing companies are divided into departments, sections, and the like, to create contact and cooperation. An organisational group may develop a kind of self-sufficiency that hampers cooperation between employees of different sections or departments, which should be there to provide tasks and problems adequate to meet customer wants and needs. Barriers created by cliques should also be broken down.

**Point 8: Eliminate slogans, exhortations, and targets**

According to Deming’s estimate, more than 90% of all faults, flaws, etc., depending on the system. In his terms, only top leadership can change the system. One suggestion is that they should analyse the situation to reveal what may, in effect, cause failures, distortions, etc., to occur (Deming 1986:66). Slogans such as ‘Do it right first time’ and ‘be proud of your work’ direct customers’ attention to quality but may have a detrimental effect. Such slogans may aggravate the situation by offering a stimulating goal but not providing the means of reaching it.

**Point 9: Eliminate work standards and management by objectives, by numbers, numerical goals; substitute leadership**

A work standard may be expressed as a concrete measure of a day’s work, several produced items during a fixed period of time or a quota. Deming (1986:70) reports that the work standard for a bank teller was stated in terms of the exact number of customers he should handle per hour. Likewise, an airline secretary was requested to make 25 telephone calls per hour. In Deming’s view, a standard is a ‘fortress against improvement’. The only thing that counts is to reach the standard, as no claim is made about the quality of the work performed. To work with such standards, which are inherent parts of management by objectives, can confuse employees in manufacturing conceptions of their jobs.

**Point 10: Institute leadership**

Deming considers leadership as being primarily about leading people. In steel manufacturing, as in other spheres of life, the leader’s main task is to help people do a better job and be a leader whom others can count on. Leadership is not linked to specific positions but can be practised by all members of an organisation. By their leadership practice, employees can serve as models: and the better their leadership acts contain and mediate the message of total quality management (TQM), the better they contribute to their students’ understanding and potential practice of it.
Point 11 and 12: Institute a vigorous programme of training and self-improvement

Owing to today’s rapidly changing world, manufacturing employees should be prepared to face chaotic situations. Regular, frequent retraining must be a central part of such preparation. The main objective of organised training on the job should be to enhance job-related skills. Because of this, attempts should be made to transform steel manufacturing firms into learning organisations. The firm needs not just good employees; it needs people who are improving through workshops (Deming 1986:86). It is applicable also to steel manufacturing since they experience great joys and challenges in their jobs. These facts stress the need of employees for services from a vigorous programme of training and self-improvement. Such a programme should be considered as an investment and not registered as a cost. Employees are the human capital who create the internal process of the supply chain system and need to be empowered with knowledge, intelligence, humour and socially and emotionally active life.

Point 13: End the practice of awarding business based on price alone

The main object here is that price should be neither the only nor the decisive factor under consideration in deciding what steel manufacturing equipment to buy. It is necessary to request quality and to recognise its importance for supply chain practice. A way of achieving this may be to establish long-term cooperative contacts with suppliers and producers to build up their quality consciousness and knowledge of how to achieve and improve the quality of steel products (Deming 1986:67).

Point 14: Put everybody in the organisation to work to accomplish the transformation. The transformation is everybody’s job

Top management has a special responsibility for starting and maintaining the transformation process. To transform success, the leader and their leader group must be committed to the task. They must be prepared to tackle the various setbacks, hardships and resistance that would probably occur during the implementation process. Every member of the organisation must participate in the transformation. To ensure that the transformation process permeates the whole organisation, everybody must feel that their contribution is important.

In conclusion, Deming (1986:67) stressed the responsibilities of top management to take the lead in changing processes and systems. Leadership ensures the success of quality management because
it is the top management’s responsibility to create and communicate a vision to move the firm toward continuous improvement. Top management is responsible for most quality problems; it should give employees clear standards for acceptable work and provide the methods to achieve it. These methods include an appropriate working environment and climate for work-free fault-finding, blame or fear. Deming (1986:68) also emphasised the importance of identifying and measuring customer requirements, creating supplier partnerships, using functional teams to identify and solve quality problems, enhancing employee skills, employee participation, and pursuing continuous improvement.

The means to improve SCC lie in the ability to control and manage systems and processes properly, and in the role of management responsibilities in achieving this. Deming (1986) advocated methodological practices, including the use of specific tools and statistical methods in the design, management, and improvement of processes, which aim to reduce the inevitable variation that occurs from “common causes” and “special causes” in production. “Common causes” of variations are systemic and are shared by many operators, machines, or products. They include poor product design, non-conforming incoming materials, and poor working conditions. These are the responsibilities of management. “Special causes” relate to the lack of knowledge or skill or poor performance. These are the responsibilities of employees.

The next section discussed the lean supply chain practices.

3.4 LEAN PRACTICES

Lean manufacturing is described by employing continuous improvement processes that focus on eliminating non-value-added steps within the organisation (Rocha 2017:3). The concept of lean manufacturing is defined as a combination of the best concepts of mass and craft production (Pall 2013:19). A lean system arose from Toyota Production System (TPS) and gained popularity as one of the best strategic practices in manufacturing sectors. Its tools and techniques have been widely used in both manufacturing and service sector regardless of size and activities (Graham-Jones & Al-Muhareb 2014:65). The resultant model focused on reducing waste throughout the product and people value streams using the Toyota way to model values that enable it to become a learning company that is continuously improving and achieving results (Salah & Sayed 2015:3). The proven success of Toyota has driven the attention of many managers in all business industries to emulate and implement the system in their organisations (Masudin & Kamara 2018:11). Although
lean has been used all over the globe, many authors and researchers have viewed lean in different angles, which proves that this system cannot be copied and emulated. Hence, serious attention needs to be paid to the variables that might affect a lean journey. JIT, TQM, strategic partnership, waste elimination, human resource, and informational analysis are identified as lean practices for this study purpose.

The following section discusses the lean practices identified for this study purpose.

3.4.1 Just in Time concept

The following section discusses the Just in time construct.

3.4.1.1 The philosophy of just in time and its origin

The just in time (JIT) philosophy advocates the elimination of waste by simplifying production processes (Masudin & Kamara 2018:12). Reductions in setup times, controlling material flows, and emphasising preventive maintenance are seen as ways by which excess inventories can be reduced or eliminated and resources utilised more efficiently (Simona & Cristina 2015:642). The JIT philosophy requires emphasis to be put on global quality control with a continuous improvement mentality, that is, defects in products, in raw materials, in components or in services provided by suppliers or to customers would bring about a waste of resources at a high cost (Singh, Singh, Mand & Singh 2013:86). Besides quality, the JIT principles prioritise customer satisfaction which can drastically condition how products are manufactured, processed, and distributed. The JIT methodology owes its name to the philosophy of doing only what is necessary when it is necessary and in necessary amounts. Neither before, which would provoke an accumulation of inventory or unfinished products, nor after, which would mean a delay in serving customers and the corresponding increase in their dissatisfaction (Sharma, Dixit & Qadri 2015:1218). In its origins, the norm is that factories follow a push system in which each phase in the manufacturing process accumulates its production, which would then be removed by the following phase (Masudin & Kamara 2018:14). The great revolution of the JIT as a system was that it followed a pull system in which each phase of the production asked the previous phase for what is needed when it needed it. In this way, they only produced what was necessary when it was necessary and in necessary amounts, reducing the accumulation of inventory to a minimum (Simona & Cristina 2015:643). The Kanban system, based on cards, was created to communicate
the demands of one phase to the previous phase. This made it necessary to optimise all the production phases as well as a coordinated operation with suppliers and customers (Singh et al. 2013:86).

3.4.1.2 Just in time defined

Just-in-time (JIT) is an inventory management philosophy aimed at reducing waste and redundant inventory by delivering products, components, or materials just when an organisation needs them (Sharma et al. 2015:1218). JIT is a philosophy that relates to the manufacturing industry which plans to dispose of waste, as waste is or results from any action that adds cost to the process of production without essentially increasing the value of the item being produced, for example, transporting inventories from one distribution centre to the next or the basic demonstration of putting them into storage (Madanhire & Mbohwa 2016:184). The JIT methodology has been applied to manufacturing processes for decades, but market globalisation, the increase in competitiveness and the boom in electronic commerce have made it necessary for the JIT methods to be adapted to the logistics along the whole supply chain (Wyk & Naidoo 2016:237). According to Simona and Cristina (2015:642), JIT is often identified with inventory management and the reduction in the need for safety stock but it is more than just that. JIT is based on the principle of eliminating all waste (Mukwakungu, Mabasa, Mankazana, Mzileni & Burakeye 2019:1274). All those tasks that do not value the manufactured product or service provided must be eliminated. This makes it necessary to maintain a problem-solving attitude by identifying the real causes (Sharma et al. 2015:1218). Instead of increasing the safety stock necessary to make up for the differences between customers’ demands and the entry of supplies, the real causes are identified to eliminate these differences (Syed, Barlow & Syed 2018:105). The JIT methodology is one of the methods that contribute to mitigating the bullwhip effect (Madanhire & Mbohwa 2016:186). The main objective of JIT is sustaining the advantage the organisation has over its competition. It accomplishes this by focusing on its customers and delivering a performance that is exceptionally superior while keeping the cost of production of goods and services at a minimum level and continuously improving quality (Syed et al. 2018:105). This is one of the reasons JIT is one of the tools mostly used for inventory management systems, and why it has been successful over the years. The financial implications of JIT, however, are very critical. JIT adds to the enhancement of business forms by applying basic leadership, operations research, and different
points models, all identified with procedures and activities. This thus sparks the light on the pertinence of JIT practice in organisations, which depends on its commitment to enhancing the money-related aftereffects of the executives, assessed all the time through execution monetary pointers (Juárez, Pérez & Useche 2017:17).

The basic premise of JIT is to have just the right amount of inventory, whether raw materials or finished goods, available to meet the demands of the production process and the demands of end customers (Mukwakungu et al. 2019:1274). JIT is the Toyota Production System (TPS) solution to reduce inventory and waiting times. It was coined by Toyota managers to indicate a method aimed at ensuring the right products in the right quantities just in time, where they are needed (Giordano & Schiraldi 2015:16). According to Danese, Romano and Boscari (2017:26), successful JIT implementation depends on the coordination of production schedules with supplier deliveries, and on high levels of service from suppliers, both in terms of product quality and delivery reliability. This requires the development of close relations with suppliers and integrating production plans with those of suppliers (Khuluse 2015:17). JIT as a philosophy, developed in past years, has evolved from the traditional way of doing things within the manufacturing industries to a philosophy that is applicable in every sector, service and steel manufacturing alike. Table 3.2 below shows and contrasts the JIT philosophy and the traditional material handling procedures.

<table>
<thead>
<tr>
<th>TRADITIONAL</th>
<th>JIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Push System</td>
<td>1. Pull system</td>
</tr>
<tr>
<td>2. Significant Inventories</td>
<td>2. Insignificant or zero inventories</td>
</tr>
<tr>
<td>TRADITIONAL</td>
<td>JIT</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>5. Acceptable quality level (AQL)</td>
<td>5. Total Quality Management (TQM)</td>
</tr>
</tbody>
</table>

**Source:** Mukwakungu *et al.* (2019:1273)

The table above illustrates how the traditional material handling and inventory management system have evolved into JIT.

- **Benefits of JIT**

The widespread adoption of JIT inventory principles undoubtedly makes production operations more efficient, cost-effective and customer-responsive (Khuluse 2015:17). Firms effectively implementing JIT principles have substantial competitive advantages over competitors that have not (Madanhire & Mbohwa 2016:185; Danese *et al.* 2017:112). The trick is figuring out how to apply JIT principles to gain competitive advantages in a specific industry and business situation. The closer a firm gets to operating in a true JIT situation, the more responsive a firm is to its customers and the less capital you have tied up in raw materials and finished goods inventory (Wyk & Naidoo 2016:237). The less a business spends to store and carry inventory, the less obsolescence to write off, and the better to optimise transportation and logistics operations (Giordano & Schiraldi 2015:16). Ultimately, this all translates into saving real money for the firm. The downside of JIT is that it is a continuum; the closer a business gets to it, the more beneficial it is to the firm (Wyk & Naidoo 2016:238). But by going too far and reducing inventories, the less beneficial it is for the business. Too much or too little inventory leaves the business at a competitive (or cost) disadvantage to the competitors. JIT applied to production systems increases the pressure on logistics, which needs to work with maximum efficiency. JIT methodology makes it essential for the relationship between different suppliers (raw material, components, services) and its B2B customers to be fluid, with open and efficient communication (Mukwakungu *et al.* 2019:1273). With the globalisation of markets, greater competitiveness and the boom in electronic commerce, consumers demand greater variety in products and reduced delivery times. A traditional approach would tend to increase safety stocks, to face up to fluctuations in demand but market evolution and consumer behaviour demand instead of an approach focused on more efficient supply chains.
It spreads its application beyond production systems since JIT logistics is spoken of in customer service, order preparation, inventory management and transport (Giordano & Schiraldi 2015:16).

In supply chain management (SCM) it is necessary to have warehouses at those points in the chain where the goods have to stop, either to store them until they are sold or wait for their distribution or temporary storage awaiting transport (Ansah 2016:82). Warehouses also have to follow JIT principles, making it necessary to eliminate anything that could be considered to be unnecessary; speeding up picking tasks in the preparation of orders by using automated systems which reduce inventory errors, speeding up tasks related to reverse logistics, optimising the routes for fork lift trucks or warehouse workers and using the most suitable metal racking systems for each level of rotation and goods flow (Madanhire & Mbohwa 2016:186). In general, JIT produces benefits for firms in four major areas: improved inventory turns, better customer service, decreased warehouse space, and improved response time. Other specific benefits are:

- Improve productivity with greater control between various production stages.
- Diminished raw materials, work in progress, and finished goods inventory.
- Reduction in manufacturing cycle times.
- Dramatically improve inventory turnover rates.
- Reduce distribution costs.
- Lower transportation costs.
- Improve quality of supplier products.
- Reduce number of transportation carriers and suppliers.

Organisations that have applied JIT have managed to gain a competitive edge, improve the quality of the products, and reduce waste (Wyk & Naidoo 2016:238; Juárez et al. 2017:5; Mukwakunguet al. 2019:1274). According to Khuluse (2015:18), there are three main objectives when applying Just in Time. These are viewed as: enhancing the organisation’s ability to compete with rival firms and remain competitive over the long run and gain competitive advantage; increasing the degree of efficiency within the production process; and reducing the level of wasted materials, declining time and effort involved in the production process and inventory management. These points are used as part of the guidelines when assessing South African steel manufacturing organisations. These points are extensive and consequently they allow the flexibility for applying JIT in various
organisations regardless of size and complexities. These objectives of a JIT approach can be a valuable instrument to assist steel manufacturers in identifying their peculiar precise purposes when it comes to using JIT within their organisation.

The next section discusses the problems in the implementation of JIT.

### 3.3.1.3 Problems associated with the implementation of a JIT System

Many organisations have successfully introduced JIT into their operations; however, not all organisations find it suitable. JIT system has three inherent problems which need to be managed:

- **Supplier production schedules**

  A JIT depends on a supplier’s ability to provide parts in accordance with the firm’s production schedule. Smaller, more frequent orders can result in higher ordering cost. Furthermore, many small quantities are produced; suppliers may incur higher production cost and setup costs (Wyk & Naidoo 2016:237).

- **Level production schedules**

  A JIT is difficult to implement with uneven demand and does require level production schedules. If the business operates in high demand variation environment, then the JIT cannot be feasible (Madanhire & Mbohwa 2016:187).

- **Suppliers’ locations**

  A JIT is not suitable for long distance suppliers. As distance between the firm and its supplier increases, delivery times may become more erratic and less predictable and short frequent suppliers are not practical (Khuluse 2015:17). Another problem area that can become obstacles to a JIT system, especially in implementation, are lack of system support, inability to define service levels, a lack of good planning and shift of inventory at supplier location as observed by Giordano and Schiraldi (2015:18).
• **Guidelines of JIT based operations**

The following are some guidelines to help steel manufacturing firms transform and coordinate business functions into more JIT-based operations as Khuluse (2015:17) recommended.

➢ **Production planning**

Under production planning, the following are applicable:

❖ **Lean/flow-based production**

A key enabler of JIT manufacturing is a production process that minimises the amount of time it takes for product to flow through the production process from start to finish. A lean production process is one where the actual flow-through time is nearly equal to the actual value-added processing or manufacturing time. This means material spends a minimal amount of time in work-in-process (Giordano & Schiraldi 2015:18).

❖ **JIT Production Planning**

Production planning in a lean JIT environment means doing things differently. Since there is less margin for error, the planner needs to be very familiar with the process capability in terms of changeover times, changeover patterns (the relative difficulty of switching from one specific product to another) and the true lead-times of each product. Having a good handle on product demand patterns is essential for inventory queues and stockrooms.

❖ **Improving Process Flexibility**

Inherently inflexible production processes often run large batches of one product before switching to another product. In a lean JIT environment, a cross-section of all products is made every day (Giordano & Schiraldi 2015:18). Doing this effectively requires a production process that is flexible enough to change readily from one product to another.

❖ **Demand-based Material Pull Systems**

In JIT systems often referred to as demand-pull systems – a demand signal is the trigger for material to move or be reordered. Pull systems should be deployed throughout the plant to manage
both material flow and work-in-process inventory levels. Pull systems are also used to manage raw materials flow into the process from outside plants and suppliers. Implementing a pull system designed for your specific application requires extensive experience in Kanban systems and other demand-based methods and technologies (Danese et al. 2017:18).

➢ **Sourcing**

❖ **Strategic sourcing to support JIT objectives**

Selecting supplier partners in a JIT environment requires a different mindset. Suppliers that can supply lowest-cost, acceptable-quality products and materials may not be sufficient. JIT requires your supplier partners to support you in other ways as well. Arrangements such as consignment inventory and setting up pull systems between the business and its supplier where materials are replenished as they are used are examples of more JIT-friendly supplier partnerships (Khuluse 2015:17). Selecting suppliers based on common geography so materials can be pooled to leverage logistics spending effectively is another example of strategic sourcing. Before deciding on suppliers, the company needs to define the parameters and qualifications of a JIT-capable supply base. It should be known how to evaluate the current suppliers and the enhancements needed for them to serve the business operation in converting to a JIT environment (Danese et al. 2017:19).

❖ **Total cost of material analysis**

Understanding what the business spends for its raw materials is not simply the purchase price plus the transportation cost. To achieve the true landed cost of materials, all the cost implications of ordering, transporting, handling and storing materials as well as implications such as obsolescence, spoilage, loss, etc need to be considered (Giordano & Schiraldi 2015:18). Understanding the true cost of purchased materials will often change the equation used to make the sourcing decisions. Knowing how to analyses and assess these figures can help develop a more robust total cost picture of the raw materials and products purchased by the business.

➢ **Logistics**

❖ **Bundled versus unbundled transportation services**

Traditionally, buying materials in bulk quantities and buying logistics services as bundled solutions for delivering this material was the way to go. But the movement toward JIT, where
smaller quantities of material need to move more frequently, changes the equation. In transportation and logistics, scale is and always has been the key to cost effectiveness. So how does a firm get the cost benefits of scale when following JIT principles of buying in smaller lots? Increasingly, the answer is to unbundle the transportation solution using the myriad of third-party logistics providers, freight or warders and consolidators (Ansah 2016:33).

❖ **Transportation network optimisation**

Before buying the logistics solution and services to support a JIT environment, a thorough, fact-based assessment of the transportation network should be completed. This is especially true for companies with a base of owned or leased assets for transportation, warehousing, etc. Performing such an assessment is a complex, data-intensive affair and requires substantial expertise and mathematical modelling skills to complete. The good news is there are a few software tools that enable this complex analysis to be completed quickly and relative inexpensively without buying any software. Such assessments and models allow the firm to determine the optimal locations for warehouses and DCs, what the optimal stocking strategies are for each and what combination of transportation routings and modes are optimal to achieve the cost and service-level objects.

- **Limitations of JIT**

Irrespective of the great benefits associated with JIT, the philosophy also has its various limitations. These are outlined below according to Ansah (2016:33) and Mukwakungu *et al.* (2019:1275):

- Cultural difference is one factor that may lead to unsuccessful implementation for JIT. This is because some organisations find it hard to change and adopt new organisational culture changes.
- Most organisations still follow traditional methods of handling material. These organisations pile up stock to meet supply in periods of high demand. Such agencies normally have problems with the use of JIT.
- Given that JIT was established in Japan, some of the countries need to make amendments when applying JIT in their own countries, and this poses a challenge when it comes to implementing JIT successfully.
Steel manufacturing organisations need to take the above-mentioned limitations in cognisance to implement a JIT system to improve their supply chain performance.

### 3.4.2 Strategic partnership

Strategic partnership and strategic alliance have been used interchangeably in the literature to explain the partnership between two or more firms. Alliances and partnerships are characteristic of all areas of human activity, and entrepreneurship is not an exemption (Išoraitė 2009:15). Alliance is considered as formal relationships between two or more parties who act according to a common goal to satisfy certain business needs while retaining their status as independent organisations (McFarlin 2017:13). The aim of the alliance is to gain higher benefits from mutual collaboration among several enterprises wherein each party shares its knowledge, resources, and risks to jointly achieve aims that would not have been attainable individually (McKay 2014:2; Caspar-Terizakis & Yu 2016:4). A strategic alliance is sometimes equated with a joint venture, but an alliance may involve competitors and generally has a shorter life span (Vanags, Ābeltiņa & Zvirgzdiņa 2018:337). A strategic partnership is a closely related concept and is applied in this study.

The definition relates to alliances, but the explanation fully corresponds to strategic partnerships. Various researchers have defined strategic partnership within the context of their fields. Hence, there is no universal definition of the construct. Table 3.3 sums up some of the definitions of strategic partnership widely accepted in the literature. The formation of strategic partnerships has been seen as a response to globalisation and increasing uncertainty and complexity in the business environment.

#### Table 3.3: Definitions of strategic partnership

<table>
<thead>
<tr>
<th>Author</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>McFarlin (2017:13)</td>
<td>A strategic partnership is an agreed-upon collaboration between businesses with common missions.</td>
</tr>
<tr>
<td>Author</td>
<td>Definition</td>
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<td>--------------------------------</td>
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<tr>
<td>Caspar-Terizakis and Yu (2016:4)</td>
<td>Strategic partnership is usually defined as “An arrangement between two companies or organisations to help each other or work together, to make it easier for each of them to achieve the things they want to achieve”</td>
</tr>
<tr>
<td>Gentimir (2015:289)</td>
<td>A strategic partnership is a formal alliance between two or more higher education institutions developed through an intentional process whereby the partners share resources and leverage complementary strengths to achieve defined (common) objectives.</td>
</tr>
<tr>
<td>Henderson and Dhanaraj (2014:3)</td>
<td>Strategic partnership is an agreement between two or more organisations to cooperate in a specific business activity, so that each benefit from the strengths of the other, and gains competitive advantage</td>
</tr>
<tr>
<td>McKay (2014:2)</td>
<td>Strategic partnership involve the sharing of knowledge and expertise between partners as well as the reduction of risk and costs in areas such as relationships with suppliers and the development of new products and technologies.</td>
</tr>
</tbody>
</table>

**Source: Own Compilation (2020)**

Based on the afore-mentioned definitions, a strategic partnership can be seen as the cooperation of companies’ management specified by cross-shareholdings, the coincidence of strategic interest for the development and diversification of production, the expansion of markets, expansion into new markets, and the like. Thus, the partnership could be regarded as a form and the certain maturity stage of relationships with the stakeholders which is based on the shared goals and pooling the resources (Henderson & Dhanaraj 2014:3). Partnerships and alliances have always been part of human history in all areas of life, from private to public and from politics to business. Many companies and institutions have worked with partners across countries, businesses or within their value chains for a variety of reasons, whether from a desire to expand or a need to cut costs (McFarlin 2017:13). Yet in recent years the growth of partnerships has accelerated, driven by the benefits of risk-sharing and resource pooling, technology convergence, industry deconstruction from linear value chains to industry value networks) and knowledge diffusion needs to acquire new capabilities within their existing business (Caspar-Terizakis & Yu 2016:4). Strategic partnerships can take the form of minority equity investments, joint ventures, or non-traditional
contracts (such as joint R&D, long-term sourcing, shared distribution/services) (Salimova 2013:26).

Strategic partnerships inevitably involve challenges that must be resolved efficiently to ensure the longevity and success of the alliance, such as isolating proprietary knowledge, processing multiple knowledge flows, creating adaptive governance and operating global virtual teams (Bendiek & Kramer 2010:456). If these challenges are not tackled, the partnership will more than likely fail, which, as the empirical research shows, happens in more than half of the cases. Strategic cooperation is tied to the strategic goals and objectives of an academic unit, college, or university. It indicates a multidimensional engagement between the involved institutions and implies the joint undertaking of a diverse range of activities with the aim of the parties’ mutual benefit (Freeman 2010:31).

Nowadays, many organisations have found that if they worked together, total interest income is earned when they work without coordinating with related agencies (Janet, Wilbrodah, Mbithi & Douglas 2015:65). Mohanty and Gahan (2012:320) stated that in order to make the supply chain competitive, a necessary first step is to acquire a clear understanding of supply chain concepts and be willing to share information with supply chain partners openly. In a strategic partnership the partners remain independent; share the benefits from, the risks in and have control over joint actions; and further make ongoing contributions in strategic areas.

- **Characteristics of a strategic partnership**

A strategic partnership focuses on long-term relationships and is based on the accumulation of resources for future development. To be regarded as strategic, the partnership as a form of relationships with the stakeholders should meet the following criteria as suggested by several researchers (Bendiek & Kramer 2010:456; Salimova, Guskova, Vatolkina & Krakovskaya 2012:23; Salimova, Vatolkina & Makolov 2014:109):

- **Priority:** the cooperation is developed in the key areas of activity that lead to the achievement of the strategic goals.
- **Complexity:** the cooperation is implemented in several areas of activity. Partnership is focused on expansion of cooperation.
• **Longevity**: cooperation is based on long-term strategic partnership agreements with the application of private contracts.

• **Institutional level**: the strategic partnership could be established with the company, not the person. It should be based on a legal basis, mechanisms, and forms of cooperation.

• **The exchange of assets**: a common pool of tangible or intangible assets, managed and used together to perform joint projects to achieve common goals.

• **Efficiency**: getting results from a partnership that would have been impossible without it; the excess of income obtained from partnership over expenditure to develop and support it.

• **Manageability**: the presence of general control and participation in the partner organisation's management. Focus on long-term partnership development.

• **Stability**: collaboration on a systematic and predictable basis.

• **Risk diversification**: the partnership can significantly mitigate risks and improve the capabilities of the organisation.

• **The importance of strategic partnership**

Strategic partnerships are critical to organisations for several key reasons, as outlined below:

- Organic growth alone is insufficient for meeting most organisations’ required rate of growth.
- Speed to market is essential, and partnerships greatly improve it.
- Complexity is increasing, and no single organisation has the required total expertise to best serve the customer.
- Partnerships can defray rising research and development costs.
- Alliances facilitate access to global markets.

Strategic partnerships are becoming an important form of business activity in many industries, particularly in view of the realisation that companies are competing in a global field (Gentimir 2015:289). Strategic partnerships are not a panacea for every company and every situation (Salimova, Guskova & Palkina 2013:107). However, through this association, organisations can improve their competitive positioning, gain entry to new markets, supplement critical skills, and share the risk and cost of major development projects (Salimova 2013:26).
• **Benefits of strategic partnership**

There are four potential benefits that steel manufacturers may realise from strategic partnerships as suggested by McFarlin (2017:13) and Caspar-Terizakis and Yu (2016:4):

• **Ease of market entry:** Advances in telecommunications, computer technology and transportation have made entry into foreign markets by international firms easier. Entering foreign markets further confers benefits such as economies of scale and scope in marketing and distribution. The cost of entering an international market may be beyond a single firm’s capabilities. By entering into a strategic alliance with an international firm, it will benefit from rapid entry while keeping the cost down. Choosing a strategic partnership as the entry mode may overcome the remaining obstacles, including entrenched competition and hostile government regulations.

• **Shared risks:** Risk sharing is another common rationale for undertaking a cooperative arrangement—when a market has just opened up, or when there is much uncertainty and instability in a particular market, sharing risks becomes particularly important. The competitive nature of the business makes it difficult for a business to enter a new market or launch a new product, and forming a strategic alliance is one way to reduce or control a firm’s risks.

• **Shared knowledge and expertise:** Most firms are competent in some areas and lack expertise in other areas; forming a strategic alliance can allow ready access to knowledge and expertise in an area that a company lacks. The information, knowledge, and expertise that a firm gains can be used, not just in the joint venture project, but for other projects and purposes. The expertise and knowledge can range from learning to deal with government regulations, production knowledge, or learning how to acquire resources. A learning organisation is a growing organisation.

• **Synergy and competitive advantage:** Achieving synergy and competitive advantage may be another reason why firms enter into a strategic alliance. Compared to entering a market alone, forming a strategic alliance becomes a way to decrease the risk of market entry, international expansion, research, development, etc. Competition becomes more effective when partners leverage each other’s strengths, bringing synergy into the process that would be hard to achieve if attempting to enter a new market or industry alone. In business, entering a new market is an expensive and time-consuming process. Forming strategic
alliances with an established company with a good reputation can help create a favourable brand image and efficient distribution networks.

- **Types of Strategic partnership**

There are many types of strategic partnerships (Spear 2014; Vanags 2014; Vanags, Ābeltiņa & Zvirgzdiņa 2018), which are, but not limited to, in the list below:

- **Joint Ventures**: a joint venture is an agreement by two or more parties to form a single entity to undertake a certain project. Each business has an equity stake in the individual business and shares revenues, expenses, and profits. Joint ventures between small firms are rare, primarily because of the required commitment and costs (Spear 2014:13).

- **Outsourcing**: the 1980s was the decade where outsourcing really rose to prominence, and this trend continued throughout the 1990s to today, although to a slightly lesser extent (Vanags 2014:16).

- **Affiliate Marketing**: affiliate marketing has exploded over recent years, with the most successful online retailers using it to great effect. The nature of the Internet means that referrals can be accurately tracked right through the order process. Amazon was the pioneer of affiliate marketing and now has tens of thousands of websites promoting its products on a performance-based basis (Zariņa, Begec & Vanags 2014:52).

- **Technology Licensing**: this is a contractual arrangement whereby trademarks, intellectual property and trade secrets are licensed to an external firm. It is used mainly as a low-cost way to enter foreign markets. The main downside of licensing is the loss of control over the technology which as soon as it enters other hands the possibility of exploitation arises (Vanags, Ābeltiņa & Zvirgzdiņa 2018:61).

- **Product Licensing**: This is similar to technology licensing, except that the license provided is only to manufacture and sell a certain product. Usually, each licensee will be given an exclusive geographic area to sell. It is a lower-risk way of expanding the reach of your product compared to building your manufacturing base and distribution reach (Tyson 2015:427).
• **Franchising.** Franchising is an excellent way of quickly rolling out a successful concept nationwide. Franchisees pay a set-up fee and agree to ongoing payments, so the process is financially risk-free for the company. However, downsides do exist, particularly with the loss of control over how franchisees run their franchise.

• **R&D.** Strategic alliances based around R&D tend to fall into the joint venture category, where two or more businesses decide to embark on a research venture through forming a new entity (Spear 2014:13).

• **Distributors.** If you have a product one of the best ways to market it is to recruit distributors, where each one has its own geographical area or type of product. This ensures that each distributor’s success can be easily measured against other distributors (Tyson 2015:427).

• **Distribution Relationships.** This is perhaps the most common form of alliance. Strategic alliances are usually formed because the businesses involved want more customers. The result is that cross-promotion agreements are established (Zariņa, Begec&Vanags 2014:52).

• **Key factors determining the success of a strategic partnership**

The following key factors that determine the success of a strategic alliance, which are presented in Figure 3.1, were identified by Biggs (2006).
Figure 3.1: Critical success factors affecting strategic partnership

Source: Biggs (2006) and Spear (2014:13)

It may well be that the advantages of partnerships have been stressed and sometimes overemphasised without a balanced presentation of costs and risk. In the situation of a small innovative organisation, in partnership with a larger firm whose core strength is in its physical asset base, competitive outcomes can quickly be determined by who has the easiest access to the complementary assets – be it specialised marketing, manufacturing or distribution (Vanagset et al.2018:61).

3.4.3 Total Quality Management

The concept of total quality management is discussed in this section focusing on the definition, steps in the implementation of TQM, approaches to TQM and review of TQM models.

- TQM defined

The first step of defining total quality management is to understand the concept of quality management. Quality management can be defined as all activities of the overall management function that determine the quality policy, objectives and responsibilities and implement them by
means such as quality planning, quality control, quality assurance and quality improvement within the quality system (De Oliveira & Nisbett 2017:783). Total quality management (TQM) is defined as a management philosophy for continuously improving overall business performance based on leadership, supplier quality management, vision and plan statement, evaluation, process control and improvement, product design, quality system improvement, employee participation, recognition and reward, education and training, and customer focus (Abd-Elwahed & El-Baz 2018:97-107). Oliveira, Corrêa, Balestrassi, Martins and Turrioni (2017:2) define TQM as a set of techniques and procedures used to reduce or eliminate variation from a production process or service-delivery system in order to improve efficiency, reliability, and quality. It is a participative, systematic approach to planning and implementing a constant organisational improvement process. It integrates fundamental management techniques, existing improvement efforts, and technical tools under a disciplined approach focused on continuous improvement (Luburić 2014:60).

TQM is a continuous process of improvement for individuals, groups of people, and whole firms. It encompasses a set of four principles (delight the customer, management by fact, people-based management, and continuous improvement) and eight core concepts (customer satisfaction, internal customers are real, all work is process, measurement, teamwork, people make quality, continuous improvement cycle, and prevention) Sreedharan, Raju, Rajkanth and Nagaraj (2016:686). Antony, Vikas and Ghadge (2016:1139) defined TQM as an integrated approach to achieving and sustaining high-quality output, focusing on the maintenance and continuous improvement of processes and defect prevention at all levels and in all functions of the firm in order to meet or exceed customer expectations. TQM is a quality improvement body of customer-based and service-oriented methodologies (Dahlgaard-Park 2011:493). It was first developed in Japan and then spread in popularity. However, while TQM may refer to a set of customer-based practices that intend to improve quality and promote process improvement, several different theories at work guide its practices (Koskela, Tezel & Patel 2019:1381).

TQM is an approach to management that can be characterised by its principles, practices, and techniques. Its three principles are customer focus, continuous improvement, and teamwork (Siva, Gremyr, Bergquist, Garvare, Zobel & Isaksson 2016:148). Each principle is implemented through a set of practices, simple activities such as collecting customer information or analysing processes
The practices are, in turn, supported by a wide array of techniques. Its approach is focused on exceeding customers’ expectations, identifying problems, building commitment, and promoting open decision-making among workers (Cherrafi, Elfezazi, Chiarini, Mokhlis & Benhida 2016:829). De Oliveira and Nisbett (2017:783) studied the TQM paradox using process quality, human resources management, strategic quality planning, and information and analysis as the constructs of TQM implementation. Dahlgaard-Park (2011:493) identified ten critical factors of TQM: people and customer management; supplier partnership; communication of improvement information; customer satisfaction orientation; external interface management; strategic quality management; teamwork structure for improvement; operational quality planning; quality improvement measurement systems; and corporate quality culture.

The following elements were identified as TQM framework by Juran (1995 and 1999): executive commitment; adopting the philosophy; closer to customers; closer to suppliers; benchmarking; training; open organisation; employee empowerment; zero-defects mentality; flexible manufacturing; process improvement; and measurement. Sreedharan et al. (2016:686) identified ten TQM elements: leadership; commitment; total customer satisfaction; continuous improvement; total involvement; training and education; ownership; reward and recognition; error prevention; and cooperation and teamwork. Besides, Cherrafi et al. (2016:830) identified eight key TQM elements as: top management commitment to place quality as a top priority; a broad definition of quality as meeting customers’ expectations; TQM values and vision; the development of a quality culture; involvement and empowerment of all organisational members in cooperative efforts to achieve quality improvements; an orientation toward managing-by-fact; the commitment to continuously improve employees’ capabilities and work processes through training and benchmarking; and attempts to get external suppliers and customers involved in TQM efforts.

In addition, ten elements were provided by Zairi (2013:660). They are: supplier improvement; process control and improvement; internal customer focus; measurement and reporting; leadership; quality system; participation; recognition; education and training; and external customer focus. Although much research has been conducted in the field of TQM implementation, no universally accepted TQM definition or elements presently exist. Actually, researchers have different ideas about the TQM concept and elements. However, most agree that TQM is a philosophy or approach to management focusing on continuous improvement, customer focus,
systematic process management, supplier partnership, and teamwork (Bozdogan 2010:51; Syed 2015:18; Zhang, Luo, Shi, Chia & Sim 2016:4; Koskela et al. 2019:1381). The implementation of such a management philosophy requires a set of practices.

- **Five major steps essential to implement TQM**

There are five major steps to TQM, according to several researchers (Assarlind & Gremyr 2013:397; Douglas, Douglas & Ochieng 2015:774; Ribeiro de Jesus, Antony, Lepikson & Peixoto 2016:702; Pattanayak, Pattanayak, Koilakuntla, Koilakuntla, Punyatoya & Punyatoya 2017:364), and each is essential to successful implementation.

  ➢ **Commitment and understanding from employees**

It is key to ensure that all employees within your organisation know about the TQM policies and make them a fundamental part of their work (Syed 2015:18). Employees should know the corporate goals and recognise the importance of these goals to the organisation's overall success. Employees need to know what is expected from them and why. It may sound like a no-brainer, but this is not often driven home by management (Douglas et al. 2015:775). When employees understand and share the same vision as management, a world of potential is unleashed. If they are in the dark, commitment is lacking, and policies will not be successfully deployed (Pattanayak et al. 2017:364).

  ➢ **Quality improvement culture**

The organisational culture needs to be modernised on a continuous basis to encourage employee feedback (Assarlind & Gremyr 2013:397). Employees are full of valuable knowledge and management needs to embrace it by listening to those executing the processes that keep the business moving daily. If employees have an idea on how to improve operations, they need to know management respects their ideas or they will not share (De Oliveira & Nisbett 2017:783).

  ➢ **Continuous improvement in process**

There is no standing still. TQM is a continuous process and not a programme. Therefore, if the business is not moving forward, it is moving backwards. This requires constant improvement in all the related policies, procedures and controls established by management (Luburić 2014:61). Do
your research. Keep your ear to the market and make an effort to revise all aspects of your operation routinely. There should be a constant effort to improve proficiency, resulting in constant scopes for improvement (even if some improvements are small) (Zairi 2013:660).

➢ Focus on customer requirements

Hietschold, Reinhardt and Gurtner (2014:6254) suggest that customers require and expect perfect goods and services with zero defects in today's competitive market. Therefore, focusing on customer requirements is significant to long term survival and essential in order to build relationships with customers. People do business based on emotion. Competitors will always be a risk. Keep the customers close and happy. Ensure that all customers' precise requirements are documented and understood by everyone that touches the account (Abd-El wahed & El-Baz 2018:100).

❖ Effective control

It is essential to monitor and measure the performance of the business. It is easy to forget how many times in a year an employee does not conform to a controlled procedure, or how many times a piece of equipment was down due to unplanned maintenance (Luburić 2014:61). If strict documentation is maintained, the business will be able to objectively quantify areas for improvement and focus its efforts where they will provide the greatest return of both the time and financial resources (Zairi 2013:660). Therefore, it is to understand the approaches steel manufacturing companies should take to TQM.

• Approaches to TQM

This study systematically reviews the five quality gurus’ (Deming, Juran, Crosby, Feigenbaum and Ishikawa) propositions about TQM. According to their review results, the following five interventions are the core of TQM: explicit identification and measurement of customer wants and needs; creation of supplier partnership; use of functional teams to identify and solve quality problems; use of scientific methods to monitor performance and identify points of high leverage for performance improvement; use of process management heuristics to enhance team effectiveness (Panuwatwanich & Nguyen 2017:10). Five quality gurus have been used to understand the approaches of TQM.
Deming’s Approach to TQM

The theoretical essence of the Deming approach to TQM concerns the creation of an organisational system that fosters cooperation and learning for facilitating the implementation of process management practices, which, in turn, leads to continuous improvement of processes, products, and services as well as employee fulfilment, both of which are critical to customer satisfaction, and ultimately, to firm survival (Fotopoulos 2010:539). Deming (1986:2) stressed the responsibilities of top management to take the lead in changing processes and systems. Leadership plays a crucial role in ensuring the success of quality management because it is the top management’s responsibility to create and communicate a vision to move the firm toward continuous improvement (Siva et al. 2016:148).

Top management is responsible for most quality problems; it should give employees clear standards for what is considered acceptable work and provide the methods to achieve it. These methods include an appropriate working environment and climate for work-free fault-finding, blame or fear (Panuwatwanich & Nguyen 2017:10). Deming (1986:2) also emphasised the importance of identifying and measuring customer requirements, creating supplier partnerships, using functional teams to identify and solve quality problems, enhancing employee skills, employee participation, and pursuing continuous improvement. According to Gimenez-Espin, Jimenez-Jimenez and Martinez-Costa (2013:680), the effectiveness of the Deming management method arises from leadership efforts toward the simultaneous creation of a cooperative and learning organisation to facilitate the implementation of process-management practices, which, when implemented, support customer satisfaction and organisational survival through sustained employee fulfilment and continuous improvement of processes, products, and services. The means improved quality lies in the ability to control and manage systems and processes properly, and in the role of management responsibilities to achieve this. Deming (1986:2) advocated methodological practices, including the use of specific tools and statistical methods in the design, management, and improvement of processes, which aim to reduce the inevitable variation that occurs from “common causes” and “special causes” in production. “Common causes” of variations are systemic and are shared by many operators, machines, or products. They include poor product design, non-conforming incoming materials, and poor working conditions. These are the responsibilities of management. “Special causes” relate to the lack of knowledge or skill or poor
performance. These are the responsibilities of employees. Deming proposed 14 points as the principles of TQM (Deming 1986:11), as outlined and discussed earlier in the chapter (see section 2.2)

➢ Juran’s Approach to TQM

Juran (1993) believes that main quality problems are due to management rather than workers. The attainment of quality requires activities in all functions of a firm (Juran & Gryna 1993). Firm-wide quality assessment, supplier quality management, statistical methods, quality information systems, and competitive benchmarking are essential to quality improvement. Juran’s approach. Project work, which promotes quality improvement, improves communication between management and an employee’s coordination. It emphasises team (QC circles and self-managing teams) and project work, promoting quality improvement, improving communication between management and the employee’s coordination, and improving coordination between employees (Juran 1995). The author also emphasised the importance of top management commitment and empowerment, participation, recognition, and rewards. According to Juran (1999), it is very important to understand customer needs. This requirement applies to all involved in marketing, design, manufacture and services.

Identifying customer needs requires more vigorous analysis and understanding to ensure the product meets customers’ needs and is fit for its intended use, not just meeting product specifications (Sreedharan et al. 2016:686). Thus, market research is essential for identifying a customer’s needs. In order to ensure design quality, Juran (1999) proposed the use of techniques including quality function deployment, experimental design, reliability engineering and concurrent engineering. Juran (1993) considered three basic processes of quality management (also referred to as Juran Trilogy): quality control, quality improvement, and quality planning. In his view, the approach to managing for quality consists of detecting the sporadic problem and acting upon by the process of quality control; the chronic problem requires a different process, namely, quality improvement; and such chronic problems are traceable to an inadequate quality planning process (Panuwatwanich & Nguyen 2017:8). Juran defined a universal sequence of activities for the three quality processes, which is listed in Table 3.4. Juran (1999) defined four broad categories of quality
costs, which can be used to evaluate the firm’s costs related to quality. Such information is valuable to quality improvement. The four quality costs are listed as follows:

- **Internal failure costs** (scrap, rework, failure analysis, etc.) are associated with defects found before the transfer of the product to the customer.
- **External failure costs** (warranty charges, complaint adjustment, returned material, allowances, etc.), associated with defects found after product is shipped to the customer.
- **Appraisal costs** (incoming, in-process, and final inspection and testing, product quality audits, maintaining the accuracy of testing equipment, etc.) incurred in determining the degree of conformance to quality requirements.
- **Prevention costs** (quality planning, new product review, quality audits, supplier quality evaluation, training, etc.), incurred in keeping failure and appraisal costs to a minimum.

**Table 3.4: Universal processes for managing quality**

<table>
<thead>
<tr>
<th>Quality planning</th>
<th>Quality control</th>
<th>Quality improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establish quality goals</td>
<td>Choose control subjects</td>
<td>Prove the need</td>
</tr>
<tr>
<td>Identify customers</td>
<td>Choose units of measure</td>
<td>Identify projects</td>
</tr>
<tr>
<td>Discover customer needs</td>
<td>Set goals</td>
<td>Organise project teams</td>
</tr>
<tr>
<td>Develop product features</td>
<td>Create a sensor</td>
<td>Diagnose the causes</td>
</tr>
<tr>
<td>Develop process features</td>
<td>Measure actual performance</td>
<td>Provide remedies, prove remedies are effective</td>
</tr>
<tr>
<td>Establish process controls, transfer to operations</td>
<td>Interpret the difference</td>
<td>Deal with resistance to change</td>
</tr>
<tr>
<td></td>
<td>Take action on the difference</td>
<td>Control to hold the gains</td>
</tr>
</tbody>
</table>

**Source:** Panuwatwanich and Nguyen (2017:10)

- **Crosby’s Approach to TQM**

There are a number of important principles and practices for a successful quality improvement programme, which include management participation, management responsibility for quality, employee recognition, education, reduction of the cost of quality (prevention costs, appraisal costs, and failure costs), emphasis on prevention rather than after-the-event inspection, doing things right the first time, and zero defects, identified by Crosby (1979). Crosby claimed that mistakes are caused by two reasons: lack of knowledge and lack of attention (Antony, Vikas & Ghadge...
Education and training can eliminate the first cause and a personal commitment to excellence (zero defects) and attention to detail will cure the second (Oliveira, Corrêa, Balestrassi, Martins & Turrioni 2017:5). Moreover, Crosby (1979) also stressed the importance of management style to successful quality improvement. The key to quality improvement is to change the thinking of top managers-to get them not to accept mistakes and defects, as this would in turn reduce work expectations and standards in their jobs. Understanding, commitment, and communication are all essential (Dahlgaard-Park 2011:493).

Crosby presented the quality management maturity grid, which can be used by firms to evaluate their quality management maturity. The five stages are uncertainty, awakening, enlightenment, wisdom, and certainty. These stages can be used to assess progress in a number of measurement categories such as management understanding and attitude, quality organisation status, problem handling, cost of quality as percentage of sales, and summation of firm quality posture (Koskela, Ferrantelli, Niiranen, Pikas & Dave 2018). The quality management maturity grid and cost of quality measures are the main tools for managers to evaluate their quality status.

Crosby (1979) offered a 14-step programme that can guide firms in pursuing quality improvement. These steps are listed as follows:

- Management commitment: to make it clear where management stands on quality.
- Quality improvement team: to run the quality improvement program.
- Quality measurement: to provide a display of current and potential non-conformance problems in a manner that permits objective evaluation and corrective action.
- Cost of quality: to define the ingredients of the cost of quality and explain its use as a management tool.
- Quality awareness: to provide a method of raising the personal concern felt by all personnel in the company toward the conformance of the product or service and the quality reputation of the company.
- Corrective action: to provide a systematic method of resolving forever the problems those is identical through previous action steps.
- Zero defects planning: to investigate the various activities that must be conducted in preparation for formally launching the Zero Defects program.
- Supervisor training: to define the type of training those supervisors need in order to actively carry out their part of the quality improvement program.
❖ Zero defects day: to create an event that will make all employees realize, through a personal experience, that there has been a change.
❖ Goal setting: to turn pledges and commitment into actions by encouraging individuals to establish improvement goals for themselves and their groups.
❖ Error causal removal: to give the individual employee a method of communicating to management the situation that makes it difficult for the employee to meet the pledge to improve.
❖ Recognition: to appreciate those who participate.
❖ Quality councils: to bring together the professional quality people for planned communication on a regular basis.
❖ Do it over again: to emphasise that the quality improvement program never ends.

➢ Feigenbaum’s Approach to TQM

TQM is defined as an effective system for integrating the quality development, quality-maintenance, and quality-improvement efforts of the various groups in a firm so as to enable marketing, engineering, production, and service at the most economical levels which allow for full customer satisfaction, according to Feigenbaum (1991). He claimed that effective quality management consists of four main stages, described as follows:

❖ Setting quality standards.
❖ Appraising conformance to these standards.
❖ Acting when standards are not met.
❖ Planning for improvement in these standards.

The quality chain starts with the identification of all customers’ requirements and ends only when the product or service is delivered to the customer, who remains satisfied (Feigenbaum 1991). Thus, all functional activities, such as marketing, design, purchasing, manufacturing, inspection, shipping, installation, and service, etc. are involved in and influence the attainment of quality. Identifying customers’ requirements is a fundamental initial point for achieving quality (Cherrafi et al. 2016:829). He claimed that effective TQM requires a high degree of effective functional integration among people, machines, and information, stressing a system approach to quality. A
clearly defined total quality system is a powerful foundation for TQM. Total quality system is defined as follows:

The agreed firm-wide operating work structure, documented in effective, integrated technical and managerial procedures, for guiding the coordinated actions of the people, the machines, and the information of the firm in the best and most practical ways to assure customer quality satisfaction and economical costs of quality (Bozdogan 2010:9). Feigenbaum (1991) emphasised that efforts should be made towards the prevention of poor quality rather than detecting it after the event. He argued that quality is an integral part of the day-today work of the line, staff, and operatives of a firm. There are two factors affecting product quality:

- The technological - that is, machines, materials, and processes; and
- the human - that is, operators, foremen, and other firm personnel.

Of these two factors, the human is of greater importance by far. Feigenbaum considered top management commitment, employee participation, supplier quality management, information system, evaluation, communication, use of quality costs, use of statistical techniques to be essential component of TQM (Oliveira et al. 2017:3). They further argued that employees should be rewarded for their quality improvement suggestions. Quality is everybody’s job. He stated that effective employee training and education should focus on the following three main aspects: quality attitudes, quality knowledge, and quality skills.

➢ Ishikawa’s Approach to TQM

It was argued that quality management extends beyond the product and encompasses after-sales service, the quality of management, the quality of individuals and the firm itself by Ishikawa (1985). He claimed that a firm's success is highly dependent on treating quality improvement as a never-ending quest. A commitment to continuous improvement can ensure that people will never stop learning. He advocated employee participation as the key to the successful implementation of TQM. Quality circles, he believed, are an important vehicle to achieve this. Like all other gurus, he emphasised the importance of education, stating that quality begins and ends with it. He has been associated with the development and advocacy of universal education in the seven QC tools (Ishikawa 1985). These tools are listed below:

- Pareto chart.
❖ Cause and effect diagram (Ishikawa diagram).
❖ Stratification chart.
❖ Scatter diagram.
❖ Check sheet.
❖ Histogram.
❖ Control chart.

The assessment of customer requirements serves as a tool to foster cross-functional cooperation; selecting suppliers should be on the basis of quality rather than solely on price; cross-functional teams are effective ways for identifying and solving quality problems (Ishikawa 1985). Ishikawa’s concept of TQM contains the following six fundamental principles:

❖ Quality first-not short-term profits first.
❖ Customer orientation-not producer orientation.
❖ The next step is your customer-breaking down the barrier of sectionalism.
❖ Using facts and data to make presentations-utilization of statistical methods.
❖ Respect for humanity as a management philosophy, full participatory management.
❖ Cross-functional management.

• Results from quality gurus

After the approaches to TQM of the five quality gurus have been reviewed, it has become evident that each has its own distinctive approach. Nevertheless, the principles and practices of TQM proposed by these quality gurus provide the steel manufacturers with a better understanding of the concept of TQM. Their insights offer a solid foundation for organisations to approach TQM. Although their approaches to TQM are not totally the same, they do share some common points, which are summarised as follows:

❖ It is management’s responsibility to provide commitment, leadership, empowerment, encouragement, and the appropriate support to technical and human processes. It is top management’s responsibility to determine the environment and framework of operations within a firm. It is imperative that management foster the participation of the employees in quality improvement and develops a quality culture by changing perception and attitudes toward quality.
❖ The strategy, policy, and firm-wide evaluation activities are emphasised.
- The importance of employee education and training is emphasized in changing employees’ beliefs, behaviour, and attitudes, enhancing employees’ abilities in carrying out their duties.
- Employees should be recognized and rewarded for their quality improvement efforts.
- It is very important to control the processes and improve quality system and product design. The emphasis is on prevention of product defects, not inspection after the event.
- Quality is a systematic firm-wide activity from suppliers to customers. All functional activities, such as marketing, design, engineering, purchasing, manufacturing, inspection, shipping, accounting, installation, and service, should be involved in quality improvement efforts.

- **Review of Quality Award Models**

Globally, there are several quality awards, such as the Deming Prize in Japan (1996), the European Quality Award in Europe (1994), and the Malcolm Baldrige National Quality Award in the United States of America (1999). The broad aims of these awards are described as follows:

- Increase awareness of TQM because of its important contribution to superior competitiveness.
- Encourage systematic self-assessment against established criteria and market awareness simultaneously.
- Stimulate sharing and disseminating information on successfully deployed quality strategies and benefits derived from implementing these strategies.
- Promote understanding of the requirements for the attainment of quality excellence and successful deployment of TQM.
- Encourage firms to introduce a continuous improvement process.

Each award model is based on a perceived model of TQM (Sabella, Kashou & Omran 2014:1487). The award models do not focus solely on either product or service perfection or traditional quality management methods, but consider a wide range of management activities, behaviour and processes that influence the quality of the final offerings (Sinha, Garg & Dhall 2016:338). They provide a useful audit framework against which firms can evaluate their TQM implementation practices, seek improvement opportunities, and the end results (Ooi, Lin, Tan & Chong 2011:410).
3.4.4 Waste elimination

A new vocabulary has developed in the past decade that stems from the Toyota Production System. Lean manufacturing is a concept whereby all production employees work together to eliminate waste (Dixit, Dave & Singh 2015:532). Major businesses globally have been trying to adopt new business initiative in order to stay alive in the new marketplace. Lean manufacturing is one of these initiatives that focus on cost reduction by eliminating non-value-added activities (Kučerová, Mlkva, Sablik & Gejguš 2015:30). Manufacturers throughout industries from steel, chemical, automotive to aircraft to paint, computers to furniture, and so on are moving to a different production system called lean manufacturing. It is not about adding new techniques onto how now build products but actually changing the way of thinking about manufacturing. The first step in implementing lean manufacturing successfully is eliminate or reduce the various types of wastes, and then eliminate or reduce them (Puvanasvaran, HuiHui & Norazlin 2014: 271; Crociataa, Agovino & Sacco 2015:40).

Industrial engineering, industrial technologists, and other groups within management have been attempting this by themselves since the beginning of the industrial revolution(Simboli, Taddeo &Morgante 2014:173). Still, now that has a well-educated, motivated production workforce, modern manufacturing management has discovered the advantage of seeking help of the workforce in eliminating waste (Manzouri, Ab-Rahman, Zain &Jamsari 2014:9179). Waste affects every part of the manufacturing and weakens the supply chain, and is not only damaging but also expensive (Pal &Kachhwaha 2013:387). Whilst much attention has previously been paid to re-use, recycling, and waste management, this study focuses on waste elimination. There is now a need for steel manufacturers to promote the importance of waste elimination in improving supply chain competitiveness. Waste in terms of industry is “defined as anything that does not add any value to the end product from customer’s perspective” (Demeter &Matyusz 2011:54). Wastes are activities that add cost or time but do not add value, consuming more resources (time, money, space, etc.) necessary to produce the goods or services that the customer wants (Pal &Kachhwaha 2013:387). In manufacturing industries, basically two types of waste generated, these are:

- waste which is seen or calculated; and
waste which is not seen or not calculated in terms of waste. Sang, Khairuzzaman, Abdul and Boon (2013:31) related that the first objective of lean is eliminate every kind of waste on the company to change the business to be more competitive through good results about innovation, flexibility, cost, quality, and service. For example, the leading lean paradigm of Toyota is on the edge of becoming the largest automaker in the world in terms of overall sales. The strongest proof of the power of the lean enterprise is looking at Toyota’s overriding achievement from increasing sales and market shares in every global market to a clear lead in hybrid technology (Marshall & Farahbakhsh 2013:988). Elimination of wastes can be considered in the human resources, design, production processes and activities, distribution, and inventory sections (Parthan, Milke, Wilson & Cocks 2012:584). If several kinds of waste can be eliminated, how do companies practice the fundamental principles of lean to build adaptive, flexible, and creative supply chains?

Three wastes are available as Toyota defined: Muri, Mura, and Muda. Muri, meaning overloaded, is the unreasonable amount or type of work that is given by management to workers or machines (Guerrero, Maas & Hogland 2013:220). This can be dangerous working tasks, heavy weight carrying, or working too fast for the workers' pace. Muri is also seen as pushing and overworking employees beyond their limits (Manzouri et al. 2014:9179). Mura, on the other hand, means unevenness and variation, is all due to human error (Paneru 2011:3). Examples may include assembly line problems and scheduling conflicts. Muda means eliminating wastes, and is divided into seven types of wastes, namely, overproduction, waiting, transporting, inappropriate processing, unnecessary inventory, unnecessary/excess motion, and defects (Chauhan, Rangrej, Samvatsar & Patel 2015:12).

The seven wastes addressed by lean production are proposed in the Figure 3.2 and discussed thereafter.
Seven wastes of lean manufacturing

❖ Over-production

Over-production is producing more than what is needed of a specific product or part. It is unnecessarily producing more than demanded or making it too early before it is required (Grossi, Blessi, Sacco & Buscema 2011:129). This happens when a manufacturing company produces products at a too high rate for customer needs and wants. This occurs due to undependable equipment, unreliable processes, and high changeover times (Grossi, Sacco, Blessi & Cerruti 2010:387). Overproduction is seen as a waste because it increases unnecessary costs for the company as well as lowers the quality with its long storage time on the shelf (Crociata, Agovino & Sacco 2014:219). This increases the risk of obsolescence, increases the risk of producing the wrong thing and increases the possibility of having to sell those items at a discount or discard them as scrap (Miafodzyeva & Brandt 2013:221).
However, there are some cases when extra supplies of semi-finished or finished products are intentionally maintained, even by lean manufacturers (Tang, Chen & Luo 2011:848). Overproduction is regarded as the most serious waste as it discourages a smooth flow of goods or services and is likely to inhibit quality and productivity. Such overproduction also tends to lead to excessive lead and storage times. As a result, defects may not be detected early, products may deteriorate and artificial pressures on work rate may not be generated (Crociataaa et al. 2015:40).

In addition, it leads to excessive work-in-process stocks, which result in the physical dislocation of operations with consequent poorer communication (Puvanasvaran et al. 2014:271). Overproduction leads to inventory stockpiles, extra equipment, unbalanced material flow, extra parts storage, extra workforce, batch processing, complex inventory management, excessive investment, additional floor space storage, hidden problems, and large lot sizes (Scott 2011:7). This state of affairs is often encouraged by bonus systems that promote the push of unwanted goods. Toyota employed the pull (Kanban) system as a way of overcoming this problem. Steel manufacturing could use this model in order to improve their supply chain competitiveness.

❖ Waiting/delay

Waiting or delay is time that is wasted due to parts that are not moving (Kučerová et al. 2015:32). Waiting is seen as a waste due to the fact that parts are never supposed to wait to undergo the next transformation phase (Shaaban 2012:18). This happens due to long production runs, unnecessary travel distances and poor material flow. Waiting usually happens when processes in production are not balanced (Paneru 2011:13). Suppose machines and operators need to wait either for a previous process to bring the material (starved) or for an on-going operation to receive material (blocking). In that case, the production lines are not producing value (Forrester, Shimizu, Meier, Reyes & Basso 2010:853). Machines that are idling or waiting to manufacture still consume energy water and create dangerous and greenhouse emissions.

Waiting is idle time for workers or machines due to bottlenecks or inefficient production flow on the factory floor (Guerrero al. 2013:221). Waiting also includes small delays between processing of units. Waiting results in a significant cost insofar as it increases labour costs and depreciation costs per unit of output (Sang, Khairuzzaman, Abdul & Boon 2013:32; Manzouri et al. 2014:9179). When time is being used ineffectively, and then the waste of waiting occurs. This
waste occurs whenever goods are not moving or being worked on. This waste affects both goods and workers, each spending time waiting (Miafodzyeva & Brandt 2013:222). The ideal state should be no waiting time with a consequent faster flow of goods. Waiting time for workers may be used for training or maintenance activities and should not result in overproduction (Crociata et al. 2014:219). Waiting leads to unbalanced operations, lack of operator concern for equipment breakdown, and unplanned equipment downtime (Kučerová et al. 2015:31).

❖ Transporting
Transporting means the movement of products from one location to another (Demeter & Matyusz 2011:55). Transportation is classified as a waste due to the fact that it adds no value to the product (Pal & Kachhwaha 2013:388; Sang et al. 2013:32). Process flows are mapped incorrectly that causes unnecessary movements which result in damaged or lost goods that lead to a waste of money. Although this waste is easy to identify, it is difficult to eliminate. Mapping the transportation of each individual product will give a clearer view of what can be seen as unnecessary or transportation that can be eliminated to reduce time as well as costs. Transportation includes any movement of materials that does not add any value to the product, such as moving materials between workstations (Forrester, Shimizu, Meier, Reyes & Basso 2010:853). The idea is that transportation of materials between productions stages should aim for the ideal that the output of one process is immediately used as the input for the next process. Transportation between processing stages results in prolonging production cycle times, the inefficient use of labour and space and can also be a source of minor production stoppages (Miafodzyeva & Brandt 2013:223).

Taken to an extreme, any movement in the firms could be viewed as waste. So, transportation minimisation rather than total removal is usually sought (Crociataa, Agovino & Sacco 2015:42). In addition, double handling and excessive movements are likely to cause damage and deterioration. The distance of communication between processes proportional to the time it takes to feedback reports of poor quality and take corrective action (Crociata, Agovino & Sacco 2014:219). Transportation waste leads to multiple storage locations, extra material racks, complex inventory management, extra facility space, incorrect inventory counts, and damaged materials (Puvanasvaran et al. 2014:273).

❖ Unnecessary Inventory
Unnecessary inventory is the waste of having too much inventory on your company's floor when production is taking place (Parthan, Milke, Wilson & Cocks 2012:584). It usually also covers up other wastes and can lead to amplified lead times, limited floor space and poor communication. Unnecessary inventory is the direct effect of waiting and overproducing waste (Bleck & Wettberg 2012:2010). Inventory waste means having unnecessarily high levels of raw materials, works-in-process, and finished products. Extra inventory leads to higher inventory financing costs, storage costs, and defect rates (Demeter & Matyusz 2011:55).

Inventory tends to increase lead-time, prevents rapid identification of problems, and increase space requirements, thereby discouraging communication. To conduct effective purchasing, it is especially necessary to eliminate inventory due to incorrect lead times and due dates. Removal of buffer stock is a major problem that should be addressed on the shop floor (Simboli, Taddeo & Morgante 2014:173). Inventory waste leads to extra space on receiving docks, materials among processes, stagnated material flow, LIFO instead of FIFO, extensive rework, long lead time, and additional material handling resources (Manzouri et al. 2014:9180).

❖ Inappropriate/over Processing

Over-processing means using the wrong equipment or processes for a simple part (Shaaban 2012:6). At times a worker will attempt to make a faultless part, surpassing the customer’s requirement. While their intentions are meant to be good, over-processing can direct to defects. A lot of companies use expensive overcomplicated equipment to produce simplicity (Kučerová et al. 2015:30). This can happen by using the wrong suppliers or using the wrong process to do a specific job (Paneru 2011:21). High precision equipment usually leads to overproduction of goods. An example of inappropriate processing can be seen as applying too much heat to a solder joint to make it perfect, beyond customer requirements, and burning up the electronic component in the process.

❖ Unnecessary/excess motion

Unnecessary motion is the waste that is caused by health and safety risks (Crociataa et al. 2015:44). A certain behaviour-based safety often causes it. Behaviour-based safety is not always linked to the employees’ behaviour but can be the behaviour of the equipment and the way it is manufactured. This can lead to unnecessary stretching, bending, walking, lifting, and reaching. It is based on poor ergonomics in the plant. Suppose unnecessary motion is used to move a product
from one operation station to the next. In that case, either inventory will build up or the worker will use a great amount of time moving individual parts from one operation station to the next (Grossi et al. 2010:388). Lean manufacturing works in such a manner that it minimises excess motion so that a worker can assemble quality manufactured goods with the slightest amount of effort (Crociata et al. 2014:221).

❖ Defects

Defects are defective parts causing major cost issues in the company (Saleh 2011:5). Defects are one of the most important wastes to eliminate in a manufacturing process. A small minor defect can cause massive impacts on your inventory, inspection, scheduling and greatly affect your bottom line of the manufacturing process (Badran 2010:14; Pal & Kachhwaha 2013:389; Sang et al. 2013:36). For example, defects cause over-processing and production that would not have been necessary if the defect did not take place in the first place. Incidence of defects often slows down or stops the movement of an assembly line, causing those other processes in the production line has to wait until the defect in the process is determined (Chauhan et al. 2015:26). Some companies divide this waste into two different wastes, namely, defects and employees, so that more emphasis can be directed to this specific waste.

In addition to physical defects which directly add to the costs of goods sold, this may include errors in paperwork, provision of incorrect information about the product, late delivery, production to incorrect specifications, use of too many raw materials or generation of unnecessary scrap (Guerrero et al. 2013:223). Defects waste is a direct cost, and when a defect occurs, rework may be required; otherwise, the product will be scrapped (Scott 2011:13). Generation of defects will not only waste material and labour resources, but it will also create material shortages, hinder meeting schedules, create idle time at subsequent workstations and extend the manufacturing lead time (Tang et al. 2011:850). Defects waste lead to extra tools and equipment’s, extra workforce, stockpiling inventory, complex material flow, questionable quality, missed deliveries and low profits (Simboli, Taddeo & Morgante 2014:174). These wastes can be directly pointed towards employing the wrong staff to do a skilled work-related activity. It has been brought to company’s attention that by employing creative, skilled workers, they can eliminate a whole set of different
wastes (Kučerová et al. 2015:32). The purpose is to eliminate all of these wastes so that only value-added processes will exist in the different types of steel manufacturing processes.

❖ **Motion**

Motion includes any unnecessary physical motions or walking by workers which divert them from actual processing work (Manzouri et al. 2014:9181). For example, this might consist of walking around the factory floor to look for a tool, or even unnecessary or difficult physical movements due to poorly designed ergonomics, which slow down the workers (Demeter & Matyusz 2011:56). Motion waste involves poor ergonomics of production, where operators have to stretch, bend, and pick up when such actions could be avoided. Such waste is likely to lead to poor productivity and quality problems (Puvanasvaran et al. 2014:273). Motion waste leads to excessive reaching or bending, tools missing, and poor managerial control (Miafodzyeva & Brandt 2013:223).

Waste sources are all related to each other and getting rid of one source of waste can lead to either elimination of or reduction in others. Perhaps the most significant source of waste is inventory. Work-in-process and finished parts inventory do not add value to a product, and they should be eliminated or reduced. According to Forrester, Shimizu, Meier, Reyes, and Basso 2010:855) hidden problems can appear and action can be taken immediately when inventory is reduced. There is no question that the elimination of waste is an essential ingredient for survival in today's manufacturing world. Companies must strive to create high-quality, and low-cost products that can get to the customers in the shortest time possible. There are sets of tools developed at Toyota and can be utilised to eliminate or at least reduce the sources of waste (Khatri et al. 2011:12).

3.4.5 **Human Resource Concept**

The concept of human resources is discussed in this section.

- **Lean Human resource defined**

Lean in human resources is defined as driving waste out of human resources (HR) processes (Khan, Taha. Ghouri, Khan & Yong 2013:178). HR-enabled lean is how the human-resource processes and functions help create lean success throughout the organisation. Adopting lean principles well beyond core manufacturing has dramatically changed many other corporate internal functions, including product development, supply chain management, and more recently, accounting (Brown,
Jaskiewicz, McHenry, Meier & Zwinkels 2016:3). But in too many companies, HR remains untouched by their company’s commitment to lean. And for those who have engaged HR to help with lean transformation, the contribution has not reached its potential (Jurčević, Ivaković & Babić 2013:2). HR is also about people, culture, and leadership.

However, HR departments seldom seem to take an active role in lean transformations. How can steel manufacturing companies and their HR departments better engage the full human potential of lean? Many anecdotes from practitioner experience attest that the human side of lean is the hardest (Meiseberg 2013:140). While the survey of Khan et al. (2013:178) statistically confirmed much of this wisdom, it also revealed a few surprises. Their conclusion is that to sustain lean operations, the human resource’s function must support them, beginning with hiring people who are likely to be happy and to succeed in a lean working culture (Karuoya 2014:4).

Resource-based view suggests that resources that are valuable, rare, imperfectly imitable, or without an equivalent substitute can lead to sustainable competitive advantage for the firm. From this perspective, human capital can be described as the value gained by developing human resources that are valuable, rare, imperfectly imitable, or without an equivalent substitute (Chao & Croson 2013:78). Therefore, human capital can be leveraged as a strategic asset to improve organisational outcomes (Cohen 2011:18; Karuoya 2014:4). Many researchers have utilised their source-based theoretical lens to examine the relationship between human resource management and a variety of organisational outcomes, such as competitive advantage, financial performance, and operational performance, among others (Gong, Law, Chang & Xin 2009; Chao & Croson 2013; Shokri et al. 2016). Historically, the resource-based view has been extensively utilised to empirically test and predict many different dependent variables (Cohen 2011:18). Human capital theory suggests that investments in the organisation’s human resources can create significant operational and economic value (Bhaskar & Tilak 2013:27).

From an organisational perspective, human capital results from an organisation’s effort to invest in human resources by selectively hiring new employees, extensively developing, and training employees, effectively evaluating employee performance, and competitively rewarding employees based on performance (Ployhart & Moliterno 2011:21; Fraser, Gunawan & Goh 2013:91). Over the years, researchers have demonstrated that investments in human capital can significantly
influence organisational objectives and outcomes, such as increased productivity (Khan 2011:23), manufacturing performance (Karuoya 2014:4), operational performance (Dan & Yuxin 2011:14), organisational performance (Chao & Croson 2013:79), and individual performance (Meiseberg 2013:141). Brown et al. (2016:3) conclude that investments in human capital can create a long-term, sustainable competitive advantage for the organisation.

- **The role of human factors in supply chain management**

Past research suggests that an organisation's employees can be a source for sustained competitive advantage and can determine the ultimate success of their organisations (Karuoya 2014:8). Given the importance of people in organisations, most strategic human resource departments consider the management of the competencies and capabilities of these human assets as the primary goal (Dessler 2008:19). It is generally accepted that steel manufacturing firms can create a competitive advantage from human resources and their management practices. Effective human resource management will generate a higher capacity to attract and hold employees who are qualified and motivated for good performance, and also the benefits from having adequate and qualified employees are numerous (De Menezes, Wood & Gelade 2010:455). For example, higher profitability, less rotation, higher product quality, lower costs in manufacturing and a faster acceptance and implementation of the organisational strategy (Shub & Stonebraker 2009:33; Fraser, Gunawan & Goh 2013:91). Figure 3.3 summarises the roles and functions of human factors in supply chain management.
Organisational resources lead to a sustained competitive advantage when they are valuable, rare, and inimitable and have no substitute. Such departments tend to employ progressive human resource practices in which the emphasis is on assessing the knowledge, skills and abilities needed for the future and to institute staffing, appraisal and evaluation, incentive and compensation, and training and development programmes to meet those needs (Karuoya 2014:8). Ideally, these functions should fit together to meet the greater goal of strategic human resources supporting, managing, and maintaining high-commitment and high-performance employees, thus enhancing competitive advantage (Khan et al. 2013:179).

HRM philosophy emphasises employees’ ‘efficiency, effectiveness, productivity, and needs (Brown et al., 2016:4). Employees’ satisfaction motivates employees for capacity building and learning new technology required in the production process. The extensive use of HR practices indicates a significant investment in human capital (Jurčević et al. 2013:6). Basic microeconomics suggests that investments in human capital (employees) are justified when such investments are more than offset by future returns in the form of increased productivity (De Menezes et al. 2010:456). Thus, steel manufacturing firms could make greater use of such practices when employees are viewed as particularly vital to firm success (Shokri et al. 2016:851). Traditional literature on human resource activity identified and classified human resource activities into four categories, which includes: staffing, training, evaluation, and compensation (Dessler 2008; Karuoya 2014:9; Chao & Croson 2013:79). In a few cases, these categories are aggregated in a slightly different manner, and certainly there is overlap and interrelationship among them (Shub
& Stonebraker 2009:33). Generally, the relationship-based approaches to staffing, training, evaluation, and compensation are shown in the literature to be directly associated with greater supply chain integration and performance (Karuoya 2014:9).

- **The role of human resources in supply chains**

There are strong interdependencies between supply chain management and human resource management, and thus, it is difficult to identify precise boundaries. Furthermore, these boundaries are continuously moving to integrate supply chain and HR activities. The problem of logistics professionals is that managing companywide HR policies to effect *coordinated* change is often outside their management scope (Bhaskar & Tilak 2013:22). This removes the greatest point of leverage in accomplishing cross-functional integration for those who have such responsibility without commensurate authority. Moreover, it is extremely difficult to tailor coordinated HR policies that span functional departments; many logistics professionals lack knowledge and experience in this complex area. If logistics professionals are to be consistently effective, they must have:

- **Integrative vision** - the vision to craft integrative, cross-functional, and cross-company programs that enable product to flow rapidly and responsively through the company and the channel.

- **Human resources ability** - the ability to harness the power of HR policies to ensure that the programmes are implemented effectively throughout the company.

The economic power of cross-functional coordination is becoming widely recognised, and the first capability is now increasingly in evidence in our profession (Khan 2011:14). Unfortunately, however, the second is all too uncommon. This is the root cause of the classic logistics dilemma, and it is preventing many companies from achieving their objectives (Meiseberg 2013:140). Because efficient, responsive product flow is essential to strategic success in most companies, focused HRM must become a core element in the logistics professional's portfolio. It is suggested that logistics is a sub-function of the supply chain. While logistics may be involved to some extent in an increasing number of supply chain activities, it will never include the complete supply chain spectrum (Bhaskar & Tilak 2013:92). For example, functions such as sourcing, manufacturing, customer service and retailing involve logistics in their planning and scheduling in order to optimize the end-to-end supply chain, but their core operation is dependent upon the functioning
of HR. The ability to manage customer relationships, both internal to the organisation and external, and supplier relationships are fundamental to success in supply chain management (Jurčević et al. 2013:7; Karuoya 2014:11). The key elements that human resource management in supply chains must have been:

❖ Technology

While process and production technology change has been profound, information management systems and related technology have evolved at a more rapid pace and have had a more profound impact on job design and skill requirements. Technology is most commonly employed for inventory and warehousing management (Karuoya 2014:12). Looking forward, employers are considering employing technology for transportation, and customer and supplier relationship management. Not surprisingly, larger organisations have implemented more supply chain-related information systems than smaller ones. Interestingly, despite the number of organisations that indicate that technology is applied in their organisation, few indicate they currently have the requisite skills to fully employ technology. Organisations are continually updating their technology to improve efficiency and indicate that their ability to keep pace with technological change is a challenge (Meiseberg 2013:140).

❖ Skills and Education

Skill requirements do not vary significantly by company size or region, suggesting that supply-chain employees can move between regions easily. Employers indicate that communications and analytical skills are a requirement for all occupation categories across all sub-functions. Other common skill requirements include technology, interpersonal and customer service skills. These skills and knowledge include financial planning, forecasting, cost analysis, knowledge of international business practices, knowledge of laws and regulations, knowledge of logistics functions and the supply chain, optimisation of workflow, knowledge of transportation, general management and business, languages, tactical operational, contract administration and management, regulatory knowledge and negotiation skills, vendor relations/management, performance measurement and quality management, knowledge of currency markets and business implications, emerging emphasis on process and change management skills, and employee engagement (Jurčević et al. 2013:7; Karuoya 2014:11).
❖ Demand of a supply chain talent

Demand for specific supply chain positions is predominantly expected to remain constant, with some growth predicted for positions in logistics information systems tactical and operational, warehousing operational, customer service tactical and transportation operational (Meiseberg 2013:141). There was an overall increased reliance on knowledge-based positions (e.g., technical logistics knowledge, information technology knowledge, supply chain specialists) and customer service positions (sales, customer service, client management). Manager-level positions were commonly cited as difficult roles to fill (e.g., functional managers, general managers, project managers, etc.), with supervisor and analyst roles also identified as a challenge (Chao & Croson 2013:785).

❖ Training and career development

Employers indicate that technical development courses are essential for supply chain personnel to stay current. The most common means of employee development are on-the-job training and external courses. For the most part, employees indicate that they are satisfied with the training they have received and that it has met their needs (Fraser et al. 2013:93). The most common forms of support provided to employees are tuition reimbursement, time off for external courses and the provision of in-house training. Work/study programmes for supply chain employees are not widely used; however, all types are employed to some degree (De Menezes et al., 2010:455). Internal training tends to be focused on technical supply chain and logistics development, interpersonal and people management skills (e.g., supervisory skills, team building, negotiations, leadership, and coaching) and health and safety (Chao & Croson 2013:785; Karuoya2014:15; Shokri et al.2016:854).

The following section discusses information analysis as the enabler of lean culture and supply chain competitiveness (SCC).

3.4.6 Information analysis

Information analysis in lean manufacturing is the vital input into any active management strategy. Although this construct has received less attention in the literature as supply chain practice. Information separates active management from passive management (Grinold & Kahn 2014:1).
Information properly applied allows active supply chain managers to outperform their information less benchmarks (Back & Christiansson 2009:896). Analysis is a process of determining and isolating the most salient information conveyed by a given information sources and separating this information into its constituent elements on the basis of predetermined evaluative and other criteria (Bilgic & Getoor 2011:69). Generally, information analysis is the science of evaluating information content, and refining information to build portfolios (Bolton, Ockenfels & Ebeling 2010:23). In manufacturing, Verma and Seth (2011:6211) define information analysis as the process of breaking complex substances into smaller components in order to gain a better understanding of the supply chain. Information analysis works both for managers who use a non-quantitative process and for those who use a quantitative investment process (Eckermann, Karnon & Willan 2010:699).

The only requirement is that there is a process. Information is a fuzzy concept. Information analysis begins by transforming information into something concrete: investment portfolios (Eppel & Von Winterfeldt 2012:157). Then it analyses the performance of those portfolios to determine the value of the information. Information analysis can work with something as simple as an analyst’s buy and sell recommendations (Bhattacharjya, Eidsvik & Mukerji 2010:141); or it can work with alpha forecasts for a broad universe of stocks. Information analysis is not concerned with the intuition or process used to generate stock recommendations, only with the recommendations themselves (Verma & Seth 2011:6211). Information analysis determines whether information is valuable on the upside, the downside, or both. It can determine whether information is valuable over short horizons or long horizons (Keisler, Collier, Chu, Sinatra & Linkov 2013:3). It can determine whether information is adding value to the manufacturing process (Back & Christiansson 2009:896). Information analysis is a powerful tool. Alabi (2016:42) asserts that information analysis is a vital function in both private and public sectors alike. Analysts identify, obtain, analyse and synthesise information to provide insights and advice to policy makers on critical decisions to be made about the business, including supply chain competitiveness (Bansback, Ara, Ward, Anis & Choi 2009:25; Kumar et al. 2014:7). Alabi (2016:42) suggested information and communication as the most profound and influencing changes that affect the companies as well as the SCC. Conducting information analysis for an organisation should be a cultural activity associated with the company (Zarbo 2012:121). All the lean practices should be embedded into the organisational culture in order to practice lean processes.
3.5 LEAN CULTURE

3.5.1 Culture and organisational culture defined

The notion of culture can be approached from many perspectives, and in the specialty literature no unified definition can be found for it (Pall 2013:19). Probably most people would have an idea of what the word ‘culture’ would mean, its association field being that all nations, people or organisations have some kind of culture, and in its formation very many circumstances can play important roles. Hofstede (1994:2) defines culture as the “software of the mind” influenced primarily by “values and moral circle”. Hofstede, Neuijen, Ohayv and Sanders (1990:287) view culture as the collective programming of the mind distinguishing the members of one group or category of people from another; in this sense, consisting of systems of values, and values as the building blocks of culture that are deep-seated and enduring. Another definition of culture given by Alabi (2016:16) as the pattern of basic assumptions that a given group has invented, discovered, or developed, in learning to cope with its problems of external adaptation and internal integration, and that have worked well enough be considered valid, and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems.

As seen from the above definitions, culture is a community’s way of relating to the critical issues of life, comprising the typical processes and values along which they “dissect” reality, which is handed over from one generation to another. Culture is equally important to business organisations since every member is governed by systems of values and beliefs. Cultures can be described as strong or weak, depending on how much the members of the organisation are aligned with the organisational values, and to how much extent these values are shared by only a fraction, or by most of the members of the organisation (Pall 2013:19). Alabi (2016:18) argues that behaviours practice over decades have resulted in strong inwardly focused organisational cultures. Organisational culture is defined as the emergent result of the continuing interactions and negotiations about values, meanings and properties between the members of the specific organisation and with its environment (De Oliveira & Nisbett 2017:782). Kariuki (2013:84) defines organisational culture as a set of shared mental assumptions that guide interpretation and action in organisations by defining appropriate behaviour for various situations. Generally, organisations have subcultures as well as the dominant culture.
Firms with strong cultures generally perform better than those with weak cultures, but only when the cultural content is appropriate for the organisation’s environment (Mann 2014:19). Manufacturing firms should have adaptive cultures so that employees focus on the need for change and support initiatives and leadership that keeps pace with these changes for continuous improvement to occur. Continuous improvement is regarded as a lean manufacturing that depends on organisational culture (Graham-Jones & Al-Muhareb 2014:65). Zarbo (2012:121) explains that “a successful lean culture of continuous improvement is a work environment in which the leader can walk away, and empowered employees can sustain themselves in pursuing higher quality targets by implementing continuous process improvements”. Henry Ford (1926) said in his book “Today and Tomorrow” that “Quality is doing it right when no one is looking”. The proven success of Toyota has seen many organisations emulating and implementing the lean system in their organisations (Pall 2013:19).

3.5.2 Lean culture

One of the most prominent factors that could impact directly on a lean journey is the organisational culture and when culture is talked about; the role of leadership cannot be ignored, as lean processes requires a substantial leadership role from managers who fully understand the system and strive to gain benefit from it (Liker & Convis 2011:11; Wong & Cheah 2011:51; Losonci, Kása, Demeter, Heidrich & Jenei 2017:4). According to Miller (2011), lean culture is the inclusion and engagement of every employee in continuous improvement. Pakdil and Leonard (2014:4587) describe a lean culture as one of the four components of a successful lean implementation and explained that lean implementation consists of four components, namely, lean planning, lean concepts, lean tools, and lean culture. A lean culture will not develop unless the organisation’s leadership team is willing to be an example or a model of the new culture and behaviours (Cameron & Quinn 2011:37).

Creating a lean culture is to create an environment that supports four of the five predictors from this study: 1) teams developed and functioning to support the structure of lean; 2) communication processes that operate across boundaries; 3) clarity of all employees’ roles in the lean organisation; and 4) a process for calculating and communicating metrics is in place and followed by process owners (Khot 2010; Baird, Hu & Reeve 2011:790; Kanakana 2013). The core values that make up this culture are important factors in order to become lean. The desire for organisations to become
innovative has led them to focus on manufacturing concepts such as lean manufacturing, which are very important for firms to succeed in the competitive global environment.

The culture of an organisation and its applied strategies varies from one organisation to another, and the organisational culture plays an important role for successful implementation of lean concepts and in shaping the company to becoming an effective and competitive business (Al-Najem, Dhakal & Bennett 2012:120; Moyano-Fuentes & Sacristán-Diaz 2012:552). A lean culture encourages all workers to contribute ideas, responds quickly to suggestions for improvement, provides a collaborative learning environment, seeks perfection in its products, services and processes, and enjoys the visible support of all employees and leaders (Losonci et al. 2017:4).

In a timely manner and for a successful lean culture implementation, the four lean components as indicated earlier must be implemented to their fullest extent throughout the organisation (Zarbo 2012:122). According to Danese, Romano and Boscari (2017:469), manufacturing industries do not have to choose one element of the lean component and implement it because lean is a total system, and it represents a complete and comprehensive culture change in an organisation. A lean culture will not develop unless the organisation’s leadership team is willing to be an example or a model of the new culture and behaviours (Bortolotti, Boscari & Danese 2019:183). According to Boscari, Danese and Romano (2016:55) in an empowered lean culture organisation, employees can be proactive, energised, drive rapid continuous improvements, and bring in dramatic bottom-line results. Bortolotti and Boscari (2016:186) and Bortolotti et al. (2019:183) maintain that organisations or manufacturing industries that have successfully instilled a lean culture within the organisation and workforce will consistently realise the following:

- have more innovative, team-directed solutions;
- lower employee turnover;
- strive for better success at sustaining improvements; and
- strive for greater numbers of improvement actions.

According to a report, it is estimated that 80% of becoming a lean organisation is culture related. (Bortolotti & Boscari 2016:187) An organisation’s culture dictates how people work, their attitudes towards work and change, their relationships with each other and management, and the
way change is introduced, embraced and tackled (Heritage, Pollock & Roberts 2014:3). Therefore, a good “culture is a driver of company health” (Pakdil & Leonard 2014:4587).

3.5.3 Critical lean culture criteria model (CLCCM)
The Critical Lean Culture Criteria Model (CLCCM) consists of seven lean culture dimensions, namely: continuous improvement; processed focused; mutual respect and trust; employees’ involvement; consistency; mission; and adaptability (Salah & Sayed 2015:4). Each of these lean culture dimensions has different numbers of lean culture criteria, namely: root cause problem solving; standard work; leaders go to Gemba; daily accountability; visual controls; level out the workload; waste reduction; Kaizen training; mutual trust; mutual respect; training and learning; empowerment; motivation; teamwork; communications; visionary leadership; clear goals; customer focus; and supplier relationships, as shown in Figure 3.4.

This model would enable organisations to know if their culture is healthy enough to cope with lean by knowing the weaknesses and strengths of the culture (Gambi, Boer, Gerolamo, Jørgensen & Carpinetti 2015:1463). Furthermore, it allows leaders to know how far their organisations are from lean culture (Salah & Sayed 2015:4). The model is a simple method to help companies to simply measure and assess their lean culture criteria by developing a group of questions for each lean culture criterion to express the presence of each lean culture in the organisations (Kumar, Singh & Sharma 2014:06). Salah and Sayed’s (2015) study developed the questionnaire survey method to measure the current state of lean organisational culture. The results of the questionnaire survey were analysed using a computer programme to compute the mean score for the data collection by all respondents contributed to determining the weaknesses and strengths of the organisational lean culture. This should enable the organisations to implement lean system and eventually sustain it for a long time (Nahed 2014:28). The Critical Lean Culture Criteria Model (CLCCM) is illustrated in Figure 3.4 below.
3.5.4 Benefits of lean culture

To sustain long term lean practices is an ambitious goal and a proven way to achieve and maintain it, is through developing an effective lean culture, as suggested by Straub (2010:15). A lean culture encourages all workers to contribute ideas, respond quickly to suggestions for improvement, provide a collaborative learning environment, seek perfection in its products, services and
processes, and enjoy the visible support of all employees and leaders (Nahed 2014:27). Salah and Sayed (2015:5) explain further that the benefits of lean culture include retention of good employees, an improved bottom line, sales and revenue growth and sustainable improvements. Steel manufacturing firms can realise short-term gains by spending money on training and new equipment but without building a lean culture, sustaining long-term gains are unlikely. Therefore, lean culture is crucial in generating long-term results and continuous improvement. It is more than a technique; it’s a way of life (Straub 2010:16; Boer et al. 2015:1463).

3.5.5 Measuring Lean culture

Some of the characteristics of an organisation are intangible and, therefore, very difficult to gauge (Van der Merwe 2014:3). The scientific research project of Hofstede, Neuijen and Sanders (1990) has a link to “measurement of organisational culture’ and their findings show that “organisational culture can be measured quantitatively on the basis of answers completed by organisational members to written questions”, as cited by Van der Merwe (2014:3). Zurn and Mulligan (2013:4) maintain that measurement of organisational culture can be a strategically important addition to a tool kit as a firm continue to develop a competitive advantage. Sunjka and Murphy (2014:62) further illustrate that “measuring organisational culture can provide you with important information that will help guide your transformation and change processes”.

In his article “Can organisational culture be measured”, Longo (2012) explains that “It can be indeed hardly contended that beliefs, values, norms, assumptions and practical behaviour can quantitatively be measured”. The author further illustrates that each organisation usually develops its own culture and in the same way, each organisation is different from each other, and likewise, each organisational culture is different. According to Zarbo (2012:321), several studies and investigations have been carried out over the years to confirm ‘culture can be measured’. Also, Longo (2012:182) describes all the tools and instruments developed over the years to “measure culture” aimed at empowering employers to discover within which category their corporate culture falls following certain distinctive characteristics. However, culture can be measured either qualitatively or quantitatively. Van der Merwe (2011:38) describes either qualitative or quantitative approaches of measuring culture as based “on information gathered by means of questionnaires submitted to employees whose feelings, sensations and opinions are actually formed on the basis of the concept and idea of organisational or psychological climate, rather than
culture”. An organisational culture can be measured where two or more organisations can be compared (Imre, Jenei & Losonci 2013:120). Besides, Zarbo (2012:321) describe further that “analysis can be made in one or more points in time, for short or even for longer periods”. Methods of investigation used for organisation culture research could be qualitative or quantitative (Van der Merwe 2011:38). More so, research findings from both Hofstede et al. (1990:19) and Imre et al. (2013:121) are of great relevance to this research because the main aim of this study is to measure the prevailing lean culture using a quantitative research method. Conclusively, Salinas-Coronado, Aguilar-Duque, Tlapa-Mendoza and Amaya-Para (2014:13) come up with another question “Do the instruments really measure culture?” and emphasise that “a rigorous multi-method approach may reveal different nuances to the public face, but qualitative methods are more suited to explore peoples’ private beliefs, opinions and lived experiences.

Quantitative and qualitative approaches can be used in a complementary way to help develop a more detailed understanding of all the layers of culture within an organisation” (Mann 2014:18). This study measures lean culture quantitatively, using already validated measuring items adopted from different researchers. It is assumed that lean culture has a positive influence of supply chain competitiveness of the steel manufacturing companies.

The next section discusses supply chain competitiveness as an outcome variable of the study.

### 3.6 SUPPLY CHAIN COMPETITIVENESS

#### 3.6.1 Supply chain competitiveness defined

To understand the concept of supply chain competitiveness, it is imperative to conceptualise the definition of competitiveness. The competitiveness is the relative strength of an entity which is needed for competing in the competition against the direct and indirect competitors (Mukhtar 2015:1542). In this view, competitiveness can be divided into three categories with respect to the unit entity like competitiveness of nations, competitiveness of firms, and competitiveness of industries. Antai (2011:85) proposed a clear definition of supply chain competitiveness with the feature of explanation of the difference between competitiveness and competitive advantage with the argument that no clear definition of competitiveness is available in the literature.
The definitions available are confusing and lack coherency. Competitiveness is the stage in which firms strive for the creation of competence, efficiencies, and effectiveness to deliver value offerings for their customers. Competitiveness refers to the preparation for the competition by creating capabilities and capacities (Verma & Seth 2014:3). It has become common to describe economic strength of an entity with respect to its competitors in the global market economy in which goods, services, people, skills, and ideas move freely across geographical borders (Mukhtar 2015:1541). Competitiveness can be defined as the ability of firm to design, produce and or market products superior to those offered by competitors, considering the price and non-price qualities (Segarra-Moliner, Moliner-Tena & Sánchez-Garcia 2013:196).

Supply Chain Competitiveness (SCC) refers, in general way, to gain competitive advantages by one supply chain on the other (Sakuramoto, Di Serio & Bittar 2018:205). Mukhtar (2015:1541) defines SCC as the capability of supply chain to deliver value to the customer for the sake of competitive advantage. SCC is considered a substantial tool for gaining the competitive advantage. Due to speedy technological innovations, globalisation, widely used information technology, now, the supply chain competitiveness is necessary for firms to be the strategic focus (Wee & Wang 2013:79). The strategic focus of supply chain demands to make alliances, reengineer, renovate, or refine the operations and develop strategies. Supply chain competitiveness is the actual solution to survive in hyper-competitive market environment (Shang, Zhou & Van Houtum 2010:431).

Supply chain competitiveness (SSC) requires the integration and coordination of different supply chain components to make it a joint alliance for unified purpose (Bourlakis, Maglaras & Fotopoulos 2012:360). It is possible to achieve a sustainable level of an organisation’s supply chain competitiveness with joint efforts of manufacturer, suppliers, and distributors. SCC is composed of three components: “suppliers’ competitiveness”; “manufacturer competitiveness”; and “distributor competiveness” (Marsillac & Roh 2013:317).

Moreover, SCC can be achieved by efficient delivery, customer satisfaction, better quality of products, profitability, better responsiveness, shorter lead times, demand fulfilment, and optimal utilisation of facilities etc (Verma & Seth 2010:6209). Verma and Seth (2011:5) proposed a conceptual framework for supply chain competiveness. It is described that supply chain competiveness requires some input elements which then yield particular outcomes out of a supply
chain. SCC requires agility, coordination, collaboration, cooperation, synergy among partners, mass customisation, customer orientation, process orientation, demand management, strategic alliances as inputs (Sakuramoto et al. 2018:205). While supply chain competitiveness will yield outcomes like customer value, customer satisfaction, quickness in response to changes, innovation, improvement, profitability, and ultimately the competitive advantage. The global competitive environment is also conceptualised to have influence on the overall phenomena of supply chain competitiveness, like socio-economic forces, cultural forces, customer requirements, financial and capital forces, government policies, behavioural forces etc. (Anbanandam, Banwet & Shankar 2011:187).

Different researchers like Mukhtar (2015:1546) use the perspective of mass customisation to explain supply chain competitiveness. Verma and Seth (2011:6) describe the competitiveness of the supply chain with improved communication and information sharing. With the perspective of operations strategies and operational effectiveness, Wee and Wang (2013:79) articulated about the concept of tailored logistics to provide superior value to the customer.

A logistic system tailored with the needs of customers can create distinctiveness in serving customers. Tangible products should be delivered in the envelope of services. Distinction just on the base of product is not more yielding a competitive edge. Verma and Seth (2010:6210) argued about the best supply chain mode selection based on the nature of products; primary functional or primary innovative. The primary innovative nature of products, like fashion products, requires the supply chain process to be “market responsive” and a primary functional nature of a product requires the supply chain processes to be “physical efficient” (Marsillac & Roh 2013:317). Supply chain competitiveness is also addressed with the logic of supply chain members’ collaboration and supply chain synergy by information sharing, joint decision-making, sharing incentives, and benefits to gain supply chain competitive advantage (Lehoux, D'Amours & Langevin 2010:495; Anbanandam et al. 2011:85; Mukhtar 2015:1547). To achieve the desired unified objectives of all supply chain members and supply chain competitiveness, it is necessary for members to collaborate and integrate the resources inside and outside their firms’ boundaries (Segarra-Moliner et al. 2013:196).
Supply chains in today’s market environment have to be competitive enough to handle pressures like varying customer’s expectations, low-cost high-quality products to be delivered at the minimum time, and the most important is throat cutting competition on a worldwide scale. Recently, therefore, supply chain competitiveness has been accepted as one of the most important philosophies in the supply chain literature. Steel manufacturing firms have to consider the concept of competitiveness to survive in the global marketplace by fulfilling requirements of the customers for high-quality and low-cost products (Lin, Parlaktürk & Swaminathan 2014:19). Currently, the market environment is characterised by product innovations, decreasing product lifecycles, assorted customer’s tastes, rapid developments in technology, globalisation of business, and turbulence and volatility in world affairs (Verma, Seth & Singhal 2011:213).

SCC has emerged as an approach where the cost, quality and delivery requirements of the manufacturing firms are the objectives shared by every stakeholder in chain changes in the marketplace, such as increasing diversity and competition, which have stimulated theory and practices in supply chain competitiveness (Sakuramoto et al. 2018:205).

Steel manufacturing is an important sector of the South African economy that needs more focus on competitiveness, especially in supply chains. Steel manufacturing industries are attempting to move from the era of efficiency in the manufacturing processes to that of effectiveness in providing customised products to the consumers. These firms are realising the global competition and rapid changes in the demands of the ultimate customers (Chen 2018:3). Therefore to provide products of customer’s choice is becoming more and more difficult due to technology changes, rapid change in requirements, globalisation and many such forces (Verma, Seth & Singhal 2011:213). A simple manufacturing supply chain comprises of three components, i.e., the supplier, the focal organisation and the distributor as shown in Figure 3.5 (Verma & Seth 2014:3).

Figure 3.5: Three components of supply chain

Source: Mukhtar (2015:1541)
Manufacturing firms mainly operate in a dynamic supply chain consisting of a network of companies with interdependent entities. These business entities may have manufacturing plants or facilities which span beyond the national boundaries encompassing several countries around the globe. In the context of supply chain, when parties interact concerned with the flow of goods, information and financials, they have certain expectations and perceptions related to each other (Chen 2018:3). In this interaction, they are concerned with the best services provided while interacting with each other in forward and reverse flow to have supply chain competitiveness (Mukhtar 2015:1541).

### 3.6.2 Elements of supply chain competitiveness

As indicated earlier, SCC comprises competitiveness of the elements of supply chain, namely, supplier’s competitiveness, manufacturer’s competitiveness and distributor’s competitiveness as presented in Figure (Verma & Seth 2014:3).

![Figure 3.6: Elements of supply chain competitiveness](image)

**Source:** Verma and Seth (2014:3)

SCC has been described as a multidimensional and relative concept. The significance of different criteria of competitiveness changes with time and context (Shang, Zhou & Van Houtum 2010:430). If their utility is sustained in practice, theories and frameworks must be flexible enough to integrate the change with key strategic management processes. Thus, organisations need to manage their resources and processes more efficiently than their competitors (Ganeshkumar & Nambirajan 2013:399). In the subsequent sections, various important enablers for supply chain competitiveness are identified and described.
3.6.3 Enablers of supply chain competitiveness

Various researchers and practitioners have tried to identify and implement enablers in supply chains which can bring competitiveness in the supply chains i.e., supply chain competitiveness (Verma & Seth 2014:2). Various enablers have been identified, based on the literature review and consultation with eminent practitioners, academicians, and researchers. The most important select enablers are shown in the Table 3.5.

Table 3.5: Enablers of supply chain competitiveness

<table>
<thead>
<tr>
<th>No</th>
<th>Enabler</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Coordination</td>
<td>Cachon and Lariviere (2005); Kaur, Kanda and Deshmukh (2008); Wee and Wang (2013)</td>
</tr>
<tr>
<td>2</td>
<td>Supply Chain Collaboration</td>
<td>Barratt (2004); Mentzer (2008); Lorentz (2008); Anbanandam, Banwet and Shankar (2011)</td>
</tr>
<tr>
<td>3</td>
<td>Cost Efficiency</td>
<td>Mentzer (2008); Lehoux, D’Amours and Langevin (2010)</td>
</tr>
<tr>
<td>4</td>
<td>Quality Management</td>
<td>Min and Mentze (2000); Rajagopal (2010); Iyer (2011)</td>
</tr>
<tr>
<td>5</td>
<td>Supply Chain Flow Cycles Efficiencies</td>
<td>Mentzer (2008); Verma, Seth and Singhal (2011); Christophe (2012)</td>
</tr>
</tbody>
</table>

Source: Own Compilation (2020)

These enablers are further described in the following section.

- **Coordination**

Coordination refers to working together across functions of departments. Hence coordination takes place between the functions within a firm, in which tight control is involved under the same leadership (Wee & Wang 2013:79). The most important enablers to achieve coordination are management control and standardisation (Verma & Seth 2010:6209).

- **Supply Chain Collaboration**

Supply chain collaboration is defined as “two or more chain members working together to create a competitive advantage through sharing of information, making joint decisions, and sharing benefits which result from greater profitability of satisfying end customer needs than acting alone” Lorentz (2008:246). Supply chain synergy can be achieved by exploitation of the resources and
collaborative efforts (Anbanandam et al. 2011:82). Collaboration reduces inventory as well as personnel. It improves customer service and focuses on core competencies (Lehoux 2010:193). The supply chain collaboration consists of some key enablers, including top management commitment, information sharing, trust among supply chain members, long term relationships, risk and reward sharing (Iyer 2011:83).

Supply chain collaboration has two main types: vertical collaboration and horizontal collaboration (Anbanandam et al. 2011:83). Vertical collaboration includes the capability of supply chain partners to share resources and knowledge with suppliers, customers, and internal cross-functional collaboration (Ganeshkumar & Nambirajan 2013:399). Horizontal integration includes the collaboration between competitors and non-competitors to share the capabilities and knowledge. Collaboration is a phenomenon depending on the number of strategic elements like corporate focus, intra-organisational support, business case, and technology and some cultural elements (openness and communication, information exchange, mutuality and trust (Shang et al. 2010:430). These strategic and cultural dimensions make it possible to collaborate by strengthening collaboration culture and resource and commitments and to gain competitive advantage.

- **Cost efficiency**

Cost refers to the total cost of delivering satisfaction to the customers. It includes not only the cost of design to manufacture but also other costs such as service costs, logistics costs, information costs, etc. (Chen 2018:3). The cost efficiency concentrates on the key activities of the supply chain with a focus of reducing various components of cost so as to minimise the total cost of the product/service and thus resulting in better services and quality products to the customers (Christopher 2012:126).

- **Quality management**

Quality is the conformance with the predefined objectives (Verma & Seth 2011:7). Quality of the product depends on many aspects such as functions performed by the product, price of the product, use of TQM and six sigma concepts in the design and manufacture of the product and quality of raw material from the supplier (Mukhtar 2015:1541). If quality of the product is high, the more
likely the trust, satisfaction and demand fulfilment in terms of customer’s expectations and supply chain competitiveness (Lin, Parlaktürk & Swaminathan 2014:19).

- **Supply chain flow cycles efficiencies**

There are several flows in a supply chain such as product flow from suppliers to final customers, services flow to the customers, information flow among the chain elements, flow of financial resources, fund flow, and many more(Christopher 2012:126). Firms can achieve competitive advantages through understanding various supply chain flows and bottlenecks of these flows in their supply chain (Wee & Wang 2013:87). Considering the importance of these enablers, a conceptual model of supply chain competitiveness has been thought of and represented in Figure 3.7.

![SCC Model based on enablers](image)

**Figure 3.7: SCC Model based on enablers**

**Source:** Own compilation (2020)

The model highlights the importance of the enablers to achieve SCC. From Figure 3.7, it is evident that supply chain competitiveness can be achieved only when these enablers are performed in an integrated way of information flows in both directions, for example, forward and backward. All these enablers are impacting the supply chain performance and supply chain competitiveness if given due consideration.
3.7 HYPOTHESES DEVELOPMENT

As shown in Chapter One (see section 1.4) of the conceptual framework, the following sub-sections provide a literature on the relationships between the variables under investigation.

3.7.1 Just in time and lean culture

Just-in-time (JIT) is considered as a powerful tool to reduce waste and inefficiency, speed up the production process and delivery performance (Madanhire & Mbohwa 2016:184). Inman, Sale, Green and Whitten (2011:346) indicated that at both strategic and operational level, linkages exist among how the organisation views JIT and supply chain management as part of their operations strategy. The survey on a Chinese firm recorded that between 16-45% had inventories reduced, and 50-80% labour productivity increased due to the application of JIT (Masudin & Kamara 2018:14). Li, Li, Wu, Wu, Holsapple and Holsapple (2017:256) suggest that employees have a key role in implementing lean culture. However, without the employees' compliance, the JIT processes may not be achieved.

Social values and morals of employees are major enablers of JIT system (Sharma et al. 2015:1218). Simplified production processes such as eliminating excess inventories and excess large lot sizes create needless delay in customer time cycles. Masudin and Kamara (2018) investigated the links between the JIT practices, attempting, in particular, to determine how they are linked to lean culture. The results support the argument that JIT practices positively affect culture. Syed et al. (2018:105) also determined the association between JIT and culture. The findings show that the two variables are positively correlated. Hence this study proposes the following:

H1: There is a significant positive relationship between just in time and lean culture in the South African steel industry

3.7.2 Total quality management and lean culture

Recognition that quality and lean are a potent combination is not a new idea. TQM advocates for the establishment of a joint culture which aims at continuous improvement, customer orientation, and employees’ empowerment (Schonberger 2014:6). Some argue that TQM is a corporate culture characterised by increased customer satisfaction through continuous improvement, in which all employees in companies participate actively (Schonberger 2012:6; Zairi 2013:660). In Baird, Hu
and Reeve’s (2011:790) work, the perception of TQM is linked to the organisational climate. The organisational climate can be classified as part of organisational culture, since Panuwatwanich and Nguyen (2017:8), “have described culture as consisting of values and climate”. According to Viljoen (2015:31), a favourable working environment correlates with strong business performance and provides evidence that organisational culture directly impacts the business.

The concept of TQM is one of the key determinants for a successful lean culture (Gimenez-Espin, Jimenez-Jimenez & Martinez-Costa 2013:682). This has also been advocated by many other scholars (for example, Zairi 2013:660; Schonberger 2014:6; Panuwatwanich & Nguyen 2017:10). It was also found that the failure of the TQM implementation primarily derives from the lack of integration of TQM and culture change. To nurture TQM successful implementation, a number of researchers recommended the need of organisations for changing organisational culture (Baird et al. 2011:790; Gimenez-Espin et al. 2013:682). In doing so, steel manufacturing organisations need to be able to systematically define and assess their organisational culture based on a well-developed framework or model. It is against this background that this study posits the following:

H2: There is a significant positive relationship between TQM and lean culture in the South African steel industry.

3.7.3 Strategic partnership and lean culture

Many organisations are now forming strategic supply chain relationships in an effort to increase their competitiveness (Cadden, Humphreys & McHugh 2010:38). A range of benefits such as sharing costs, supplementing capabilities and integrating knowledge have been reported (McKay 2014:26). Although many organisations form supply chain relationships to assist with competitive advantage, many are failing (McFarlin 2017:14). In earlier conceptual studies, Henderson and Dhanaraj (2014:3) identified roughly one third of strategic supply chain relationships as outright failures. McFarlin (2017:14) call this failure to achieve the desired benefits ‘collaborative inertia’. It is suggested that this high rate of failure is due to incorrect governance (Caspar-Terizakis & Yu 2016:4), lack of complementarity (Vanags et al. 2018:337) and a lack of trust, co-operation and commitment between each supply chain partner (Cadden et al. 2010:38), which when analysed all translate into a ‘cultural clash’ (Salimova et al. 2014:109). This is further supported by Vanags et al. (2018:338), who suggested that relationships are not entities but processes and in order to develop and maintain successful long-term supply chain relations, they must be managed at the
process and not the strategic level. Therefore, shared values, beliefs, behaviours and norms of employees within and between each partner organisation (i.e., the culture) are critical to successful long term supply chain relationships. However, many relationships along the supply chain are not delivering the desired outcomes (McFarlin 2017:13). Caspar-Terizakis and Yu (2016:6) suggest that the key barrier to achieving these desired performance outcomes lies in organisational cultures being incompatible between the various partners operating strategic relationships along the supply chain.

Embedded in the theoretical ‘relational view’ of management, which supports the view that firms can gain and sustain competitive advantage by leveraging and accessing resources from outside the boundaries of the firm (Salimova et al. 2014:109). The authors propose a theoretically underpinned model whereby cultural compatibility between strategic supply chain relationships have the potential to lead to improved performance outcomes for each participant in the chain. The linkages and interdependencies between strategic supply chain relationships and organisational culture are evident in the literature (Cadden et al. 2010:38; McKay 2014:26; McFarlin2017:14). For example, rationalisation of the supply base should result in a deepening of relationships, which highlights the importance of shared values such as trust, co-operation between each supply chain partner organisation (Henderson & Dhanaraj 2014:5). In addition, the focus on strategic relationships has been shown to require compatible cultures (Bendiek & Kramer 2010:457). This study proposes a theoretical framework whereby it is posited that strategic supply chain relationships can only be truly successful if lean cultural fit is achieved. Hence the following hypothesis is posited:

H3: There is a significant positive relationship between strategic partnership and lean culture in the South African steel industry.

3.7.4 Waste elimination

To achieve waste elimination and continuous improvement, organisations a whole need to have the attitude, the culture and the capabilities at all levels within the organisation to achieve continuous improvement and sustain themselves in the future (Puvanasvaran et al. 2014:279). It is an organisation that does not require a management initiative, a customer initiative, a shareholder initiative to improve, but comes from the desire and the will of the people inside the organisation
(Tang, Chen & Luo 2011:868). This requires a commitment everywhere in the organisation to improve and eliminate those obstacles that delay, prevent or inhibit improvements (Miafodzyeva & Brandt 2013:225).

Culture determines how people think and behave in any workplace, therefore establishing a waste elimination culture within manufacturing is a necessary accompaniment to other waste elimination initiatives such as a waste management plan (Miafodzyeva & Brandt 2013:225). By establishing a waste elimination culture, the firm is creating an environment for bright ideas, increased efficiency and reduced operating costs. An open and inclusive culture will also contribute to staff morale as well as reduce the costs in manufacturing processes. Communication is a critical element of motivating staff to contribute to a waste elimination culture (Sacco & Crociata 2013:91). Sacco, Ferilli and Blessi (2014) assert that waste elimination and workers’ social values and beliefs are correlated, which shows that waste elimination and lean culture are associated variables. Hence this study posited the following:

**H4: There is a significant positive relationship between waste elimination and lean culture in the South African steel industry.**

**3.7.5 Human resource and lean culture**

Human resource and supply chain management importance have been recognised as a means of competitive advantage in different industries (Bhaskar & Tilak 2013). Hence integration of HR and SCM functions enable organisations to craft a unique strategy and will increase the firm’s supply chain performance. Human resource is the backbone of every organisation; likewise, supply chain management is also playing a significant role in the organisation performance. Therefore, human resource and supply chain has evolved to play an integrated supporting role in the creation of the value chain system of an organisation (Fraser, Gunawan & Goh 2013). Human resource allows the organisation to actively coach, motivate, and direct employees in a real-time manner that is not possible with a traditional human resource management system based on prioritised targets and goals that align with the organisational strategy (Marshall & Goldsby 2013:4). Establishing a lean organisational culture very much depends on the organisation’s ability to select, develop, engage, and inspire human resources through effective performance management strategies (Khan *et al.* 2013:180). According to Jurčević *et al.* (2013:7), the primary purpose of performance management is to instil in the employees a desire for continuous improvement, which
is the foundation of lean transformation. Selective hiring practices for new employees can allow the organisation to select individuals with the desired knowledge, skills and values to support the organisation’s long-term lean transformation strategy (Brown et al. 2016:63).

More importantly, it allows the organisation to weed out potential employees that would be detrimental to the success of lean transformation. Shub and Stonebraker (2009) investigated the impact of human resource practices on turnover, productivity, and corporate financial performance and found positive support for attracting and selecting the right employees in high performance companies. Khan et al. (2013:181) also found a positive impact of HRM practices on supply chain management success. Lean transformation success is directly dependent upon the extent to which human resources within the organisation actively support and participate in the lean transformation process; therefore finding, selecting, and investing in individuals that fit within the broader lean transformation strategy can lead to greater organisational culture success rates (De Menezes et al. 2010:455). Hence, the study posited the following hypothesis:

**H5: There is a significant positive relationship between HR and lean culture in the South African steel industry.**

### 3.7.6 Information analysis and lean culture

Alabi (2016:42) asserts that information analysis is a vital function in both private and public sectors alike. Analysts identify, obtain, analyse and synthesise information to provide insights and advice to policy makers on critical decisions to be made about the business including SCC (Kumar, Singh & Sharma 2014:7). The impact of different components of supply chain can be recognised in achieving SCC (Verma & Seth 2011:6211). The different components of supply chain have to be competitive enough so that the overall competitiveness can be achieved. Alabi (2016:42) suggested information and communication as the most profound and influencing changes that affect companies as well as the SCC. Conducting information analysis for an organisation should be a cultural activity associated with the company (Zarbo 2012:121). Hence it is within this background that this study proposes the relationship between information analysis and lean culture within the steel manufacturing industry.
H₆: There is a significant positive relationship between information analysis and lean culture in the South African steel industry.

3.7.7 Lean culture and supply chain competitiveness

Building lean culture guides and changes the way people think and act. Lean culture means the changing of employee’s behaviour, emotion and political process (Van der Merwe, Pieterse & Alourens 2014:133). Organisations have little chance to successfully implement lean unless paying attention to culture. Lean success, however, is largely dependent on the attainment of a lean culture (Nguyen & Mohamed 2011:209). Organisations adopt lean operations principles either as a defensive strategy to stay competitive, or as an offensive strategy to move ahead of competitors (Nordin, Deros & Wahab 2010:378). Irrespective of the reason for adopting a lean strategy, the actions required to become lean are the same, and the implementation process can be a lengthy one.

Badurdeen, Wijekoon and Marksberry (2011:57), however, affirm that a similar lack of attention to lean culture is also preventing South African steel manufacturers from realising the potential benefits of lean. Punnakitikashem, Buavaraporn and Chen (2012:5) conclude that lean culture is vital to the success of any lean implementation plan, and that future research is required to create and maintain lean culture. Exacerbating this problem is both the ill-defined nature of a lean organisational culture, as well as time constraints caused by increased competition. According to Van der Merwe (2014:132), manufacturing industries that have successfully instilled a lean culture within the organisation and workforce will consistently realise supply chain competitiveness, more innovative, team-directed solutions, lower employee turnover and better success at sustaining improvements, amongst others. Miller (2011:18) and Imre, Jenei and Losonci (2013:21) offered similar sentiments that lean cultured organisations offers many benefits including greater competitive advantage within their supply chains. Mann (2014:6) also found that lean culture is linked to supply chain competitiveness. It is against this background that this study developed the following hypothesis:

H₇: There is a significant positive relationship between lean culture and supply chain competitiveness in the South African steel industry.

3.8 CHAPTER SUMMARY
The main purpose of this chapter was to comprehensively review literature on the Deming theory underlying this study to understand its origin, purpose, and application. The chapter also provided a detailed discussion on the lean practices affecting lean culture and supply chain competitiveness. These lean practices are just in time, strategic partnership, total quality management, human resource and information analysis. In addition, the concept of lean culture was discussed in an attempt to understand its foundation and significance for the business environment. It also shed light on supply chain competitiveness within the steel manufacturing industry. The findings on supply chain competitiveness from past studies were presented in order to understand the value of the factors contributing to or affecting SCC. The next chapter presents the methodology and research design followed for this study.
CHAPTER 4
RESEARCH METHODOLOGY

4.1 INTRODUCTION

The preceding chapter provided a comprehensive literature review on supply chain practices, lean culture, and supply chain competitiveness. This chapter aims to outline the methodology that was used to test the hypotheses empirically. It is divided into six main sections. The first section presents the research reasoning, which puts attention to deductive and inductive scientific reasoning. The second section discusses the research paradigm or philosophy that supports this study. This is followed by the research approach and strategy employed in the study. As determined previously, this investigation is quantitative, involving the survey method as the data collection method. The fourth section provides details relating to the implementation of the research design, including the target population and sampling, questionnaire development and administration. The fifth section focuses on data analysis, while the last section concludes with a summary of ethical issues considered when conducting the study.

4.2 RESEARCH REASONING

Scientific thinking/reasoning refers to both thinking about the content of science and the set of reasoning processes that permeate the field of science, including induction, deduction, experimental design, causal reasoning, concept formation, hypothesis testing, and so on to achieve research goals (Babin & Zikmund 2016:330). Achieving the research goals permits one to use approaches and research methods that belong to either deductive or inductive reasoning (Creswell 2014:26). The main difference between them is that inductive reasoning aims to develop a theory while deductive reasoning aims to test an existing theory (Babin & Zikmund 2016:330). Inductive reasoning moves from specific observations to broad generalisations. The inductive approach is applicable when there is little to no existing literature on a topic; it is common to perform inductive research because there is no theory to test (Polit & Beck 2014:792). The inductive approach consists of three stages: observation, observing a pattern, and developing a theory. Hence inductive reasoning is commonly associated with qualitative research.

On the other hand, reasoning deductively means-testing these theories (Saunder, Lewis & Thornhill 2016:76). The deductive approach develops specific predictions through theories to
explain causal relationships between variables and is typically applicable to quantitative studies (Leedy & Ormrod 2015:121). Thus, Neuman (2006:59) acknowledged that this approach is suitable for quantitative research. Furthermore, it consists of four stages: existing theory, formulating hypotheses based on theory, collecting data to test the hypotheses, and analysing the results (Polit & Beck 2014:792). As such, the present conforms with the highlighted characteristics because theoretical propositions were outlined through a literature review, as presented in the previous chapter. Besides, the investigation seeks to test its hypothesised relationships by either validating or refuting the proposed associations between the selected constructs.

4.3 RESEARCH PARADIGMS

A paradigm is defined as “the basic belief systems or worldview that guides the investigator” (Guba & Lincoln 1994:105). It describes a framework for understanding and shaping both what we see and how we understand it (McDaniel & Gates 2013:42). Besides, research paradigms help researchers to reflect their primary assumptions concerning the world and the foundation of knowledge (Bryman 2012:27). According to Guba and Lincoln (1994:104), research paradigms are characterised through their ontology, epistemology, and methodology. Moreover, Bryman (2012:27) asserts that ontological questions in social research are related to the nature of reality. Ontology is associated explicitly with the question of whether reality can be perceived as objective or as subjective (Polit & Beck 2014:794).

On the other hand, epistemology is about “how you know something”, focusing on the relationship between the researcher and the reality (Veeck & Bush 2018:99). It addresses the fundamental question of whether the researcher is part of the reality being discovered or is external to it (Bryman 2012:27). Meanwhile, a methodology is about “how one goes about finding out reality”, for instance, undertaking the research (Babbie 2013:35). In general, researchers are usually guided by three major research paradigms, namely, positivism, phenomenology, and pragmatism (Malhotra, Nunan & Birks 2017:283). The following subsection describes in detail the common research paradigms used in marketing research, and contrasting them with their ontological, epistemological, and methodological perspectives.

4.3.1 Positivism

A positivist research paradigm is usually associated with a quantitative research approach that assume one true reality can be discovered by employing rigorous empirical study (Creswell
2009:81). Positivism assumes that nature is ordered and that reality exists independent of human observation. It emphasises the discrete, specific concepts and focuses on the objective and quantifiable evidence obtained. Positivism is associated with quantitative research.

4.3.2 Phenomenology
Phenomenology, referred to as constructive or interpretivist paradigm, assumes that researchers are allowed to develop subjective meanings from individuals’ experiences towards specific issues to understand a particular phenomenon (Babbie 2013:35). This paradigm grew out of the philosophy of Edmund Husserl’s phenomenology and Wilhelm Dilthey’s and other German philosophers’ study of interpretive understanding called hermeneutics (Veeck & Bush 2018:99). These research approaches intend to understand the world of human experience, suggesting that reality is socially constructed (Creswell 2014:32; Babin & Zikmund 2016:332). Phenomenology is, thus, linked to qualitative research.

4.3.3 Pragmatism
Pragmatism is based on the proposition that researchers should use the philosophical or methodological approach that works best for the research problem being investigated (Hothersall 2017:33; Gross 2018:42). It is often associated with mixed-methods or multiple methods (Creswell & Clark 2011:92), where the focus is on the consequences of research and the research questions rather than on the methods. It may employ either formal or informal rhetoric (Gross 2018:42; Burns, Veeck & Bush 2018:99). The pragmatic paradigm is thus associated with mixed-method research.

Based on the preceding discussion, this study employed a positivist paradigm as its underpinning philosophy because hypotheses were posited, and the study’s results are expected to be compared with the stated hypotheses. This is consistent with the objective of this study, which investigates the relationships between lean supply chain management (LSCM) practices, lean culture and supply chain competitiveness based on a theoretical framework with several quantifiable variables. Statistical methods are used to ascertain whether the framework fits the data.

4.4 RESEARCH APPROACH
Research may be categorised into two sets, namely, qualitative and quantitative research (Brown, Suter & Churchill 2018:205). Qualitative research is more useful for exploring new constructs or
themes in a phenomenon. In contrast, quantitative research is useful for testing objective theories by examining relationships between presumed variables or constructs (Babin & Zikmund 2016:332). It therefore involves data collection that is typically numerical and analysed using mathematical models (Creswell 2014:32). Quantitative research is an approach for testing objective theories by examining relationships among variables (Wiid & Diggines 2011:196). Table 4.1 discusses both characteristics and differences between the two research approaches.

**Table 4.1: Qualitative and quantitative research methods**

<table>
<thead>
<tr>
<th>Factors/Characteristics</th>
<th>Qualitative methods</th>
<th>Quantitative methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research objectives</td>
<td>Discovery and identification of new ideas, thoughts, feelings; preliminary insights on and understanding of ideas and objects</td>
<td>Validation of facts, estimates, relationships, predictions</td>
</tr>
<tr>
<td>Type of research</td>
<td>Normally exploratory designs</td>
<td>Descriptive and causal designs</td>
</tr>
<tr>
<td>Type of questions</td>
<td>Open-ended, semi-structured, unstructured, deep probing</td>
<td>Mostly structured</td>
</tr>
<tr>
<td>Type of execution</td>
<td>Relatively short time frames</td>
<td>Usually significantly longer time frames</td>
</tr>
<tr>
<td>Representativeness</td>
<td>Small samples, limited to the sampled respondents</td>
<td>Large samples, normally good representation of target populations</td>
</tr>
<tr>
<td>Type of analyses</td>
<td>Debriefing, subjective, content, interpretive, semiotic analyses</td>
<td>Statistical, descriptive, causal predictions and relationships</td>
</tr>
<tr>
<td>Researcher skills</td>
<td>Interpersonal communications, observations, interpretive skills</td>
<td>Scientific, statistical procedure translation skills; subjective interpretive skills</td>
</tr>
<tr>
<td>Generalisability of results</td>
<td>Very limited; only preliminary insights and understanding</td>
<td>Usually very good; inferences about facts, estimates of relationships</td>
</tr>
</tbody>
</table>

**Source:** Malhotra (2010:108)

The present study was based on the quantitative approach. This approach was chosen because the current study intends to test relationships between lean practices (just in time, TQM, strategic partnership, waste elimination, HR, information analysis), lean culture and supply chain competitiveness. Seven hypotheses were empirically tested to validate or refute (accepting or
rejcting) the hypotheses proposed. In addition, the quantitative approach was selected since it facilitates results that can be generalised to other contexts. In this case, it was expected that the results of the study can be generalised to other contexts of steel manufacturing companies throughout South Africa.

4.5 TIME HORIZON

Time horizons are crucial for research designs that are referred to (Malhotra, Nunan & Birks 2017:286). The research employs a cross-sectional or longitudinal design. A cross-sectional design involves the collection of information from any given sample of population elements only once (Malhotra 2010:211). The cross-sectional design could be single, multiple or cohort analysis cross-sectional design. A longitudinal design differs from a cross-sectional design in that the sample or samples remain the same over time (Burns, Veeck & Bush 2018:99). A longitudinal design is a fixed sample (or samples) of population elements measured repeatedly on the same variables (Polit & Beck 2014:796).

This study followed a correlational research design, specifically a single-cross sectional survey because data were collected only once from the sample elements (Burns, Veeck & Bush 2018:99). A correlational study determines whether two or more variables are correlated (Creswell 2014:32). The single cross-sectional study is quantitative in nature, meaning that it seeks to understand the sample structure and can thereafter recommend a final course of action (Malhotra 2010:108). There is only one sample of respondents in single cross-sectional designs, and information is obtained from this sample only once. The cross-sectional strategy was chosen on the basis that it provided inexpensive methods of collecting data over a large sample, and it pairs well with the quantitative. Also, the research investigated the hypothesised relationships in the present time only, without checking the trends of these relationships over a prolonged period.

4.6 RESEARCH DESIGN

A research design is defined as a plan or framework for formulating and addressing research objectives and hypotheses (Polit & Beck 2012:802). It enables a researcher to develop a specific structure to solve a significantly growing research problem, question, or opportunity (McDaniel & Gates 2013:42). It also ensures that the research will be relevant to the problem at hand and will use economic procedures (Malhotra 2010:182). Thus, a research design is a preliminary plan for conducting research. According to Zikmund and Babin (2016:116); Bloomberg and Volpe
(2016:42), research designs are divided into two four categories, namely, correlation, descriptive, causal-comparative and experiments. These research designs are discussed below.

### 4.6.1 Correlation

A correlation study involves collecting data to determine whether and to what degree a relationship exists between two or more quantifiable variables (Bloomberg & Volpe 2016:42).

### 4.6.2 Descriptive

The descriptive design involves collecting data to test hypotheses or answer questions about the status of the subject inquiry (Malhotra 2010:182).

### 4.6.3 Causal-comparative

Causal-comparative research attempts to determine the cause or reason for existing differences in behaviour or status of groups of individuals (Zikmund & Babin 2016:116).

### 4.6.4 Experiments

Experimental research includes true experiments as well as less rigorous experiments or quasi-experiments (Bloomberg & Volpe 2016:43).

In addition, experiments, surveys, case studies, action research, grounded theory, ethnography, and archival research are other strategies employed by researchers in achieving their goals (Saunders et al. 2016:68). Each design is linked to a specific research approach. This study followed a correlation and descriptive design since the attempt was to determine the relationships through hypotheses testing (Wiid & Diggines 2011:196). Furthermore, a survey was adopted to achieve the objectives and enhance the study's accuracy and validity. A survey strategy facilitates the collection of data from many respondents using questionnaires.

In order to achieve the objective of the study, its design involved a review of the literature as well as the empirical study.

### 4.7 LITERATURE REVIEW

A comprehensive literature review on relevant variables in this study was conducted with the sole determination of addressing its theoretical intentions (see Chapter One and Two). A literature
review is a comprehensive summary of previous research on a topic to understand how it relates to the present research (Brown et al. 2018:205). The review focused on the overview of steel manufacturing both international and locally, its contribution to South Africa’s economy, key players in the steel manufacturing sector as well as the policies and frameworks guiding the industry. Furthermore, key variables underlying this study, including lean practices (TQM, just in time, strategic partnership, waste elimination, human resource, and information analysis), lean culture and supply chain competitiveness, received attention. Relevant secondary sources consulted included hard copy and online peer-reviewed journals, books, peer-reviewed books, business magazines, relevant acts, and other governmental publications. Several databases (Science Direct, Sabinet, EBSCOhost, and Emerald), amongst others, were used as portals for accessing some of the literature, while some were accessed directly from other credible Internet sources.

4.8 EMPIRICAL RESEARCH

Empirical research necessitates the actual collection of primary data. This study's empirical design comprised a sampling process, the data collection procedure, and data analysis strategy.

4.8.1 Sampling Design

Once a particular research design is selected, the data collection needs to be determined. Pragmatic marketing research appreciates the notion that a sample rather than a census is a more feasible approach for data collection (Babin & Zikmund 2016:171). The development of a sampling plan is a particularly critical aspect of survey methodology as it provides a foundation for a sound measurement (McDaniel & Gates 2013:284). As recommended by Gupta (2011:88) and Clow and James (2014:227), specific steps were followed in developing the sampling procedure for the empirical study.

4.8.1.1 Defining the target population

It is suggested by Wiid and Diggines (2011:184) that at the inception of the sampling procedure, the researcher needs to clearly define the target population by responding to the question, “who do we want to investigate?” When defining the target population, elements such as the geographical boundaries, time and units are included (Sekaran & Bougie 2013:228). Babin and Zikmund
describe the target population as the total number of elements of a specific population that is relevant to the research project and is influenced by the study's objectives.

Based on the objective of this study, the target population of this study comprised supply chain and operations managers and practitioners from steel manufacturing companies based in Gauteng province. Confining the study to the province of Gauteng is justified by the fact that it is the most populated region (12 564 000 habitants) and includes the most heterogeneous racial and ethnic groups (Stats SA, 2019). Moreover, most steel manufacturers are in Gauteng province because of its large population. Steel manufacturing was chosen due to its contribution to its economic development. Besides, Gauteng was selected due to the permission that was granted to undertake this research at the steel manufacturing companies. In addition, Gauteng is regarded as the country's economic hub, which provides research areas for future avenues.

4.8.1.2 Identifying the sample frame

After the target population is defined, the researcher assembled a list of all eligible sampling units referred to as the sampling frame. Bryman and Bell (2007:182) define a sample frame as “a listing of all units in the population from which the sample is selected and each unit of analysis is included only once”. It consists of a set of directions for identifying the target population, including the different types of sample sources and the basis on which respondents are selected (Creswell 2014:31). Common examples of sample frames include, but are not limited to, customer lists and maps as well as physical sampling frames such as shopping malls and centers, amongst others (Berndt & Petzer 2011:173). For the purpose of this study, lists of the supply chain and operations practitioners in each of the visited companies were provided. The lists were obtainable from the HR databases of the steel manufacturing companies identified for this study.

4.8.1.3 Determining the sample size

Determining the appropriate sample size is important in academic research (Hair, Black, Babin & Anderson 2014:85). Hence a few factors are commonly considered when deciding on sample size. These include the available funds to cover the cost, time constraints, the heterogeneity of the population and the type of analysis the study seeks to undertake (Malhotra 2010:459). These factors were taken into consideration when determining the sample size of this study. Firstly, the
historical evidence approach was used in determining the sample size, which uses previous similar studies, as indicated in Table 4.2.

**Table 4.2: Previous studies in determining the sample size**

<table>
<thead>
<tr>
<th>Construct</th>
<th>Authors</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just in Time (JIT)</td>
<td>Bortolotti, Boscari &amp; Danese (2015)</td>
<td>311</td>
</tr>
<tr>
<td></td>
<td>Khuluse (2015)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Khuluse (2015)</td>
<td>250</td>
</tr>
<tr>
<td>Total Quality Management (TQM)</td>
<td>Sadikoglu and Olcay (2014)</td>
<td>242</td>
</tr>
<tr>
<td></td>
<td>Khuluse (2015)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Viljoen (2015)</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>115</td>
</tr>
<tr>
<td>Strategic Partnership (SP)</td>
<td>Bortolotti, Boscari and Danese (2013)</td>
<td>311</td>
</tr>
<tr>
<td>Human resource (HR)</td>
<td>Khan <em>et al.</em> (2013)</td>
<td>195</td>
</tr>
<tr>
<td></td>
<td>Sadikoglu and Olcay (2014)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>242</td>
</tr>
<tr>
<td>Waste Elimination (WE)</td>
<td>Al Dekheila <em>et al.</em> (2012)</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>Manzouri <em>et al.</em> (2014)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>Information Analysis (IA)</td>
<td>Saravanan and Rao (2006)</td>
<td>286</td>
</tr>
<tr>
<td></td>
<td>Masudin and Kamara (2018)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>304</td>
</tr>
<tr>
<td>Lean Culture (LC)</td>
<td>Khuluse (2015)</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td>Sarhan and Fox (2014)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>188</td>
</tr>
<tr>
<td>Supply Chain Competitiveness (SCC)</td>
<td>Ganeshkumar and Nambirajan (2013)</td>
<td>270</td>
</tr>
<tr>
<td></td>
<td>Sakuramoto, Di Serio and Bittar (2018)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>316</td>
</tr>
</tbody>
</table>

*Source:* Author’s compilation (2020)

Based on the historical evidence approach, the average, as indicated by Table 4.2 between 115 to 350 sample sizes, is deemed appropriate (Pallant 2013:78). Secondly, various multivariate statistical analysis techniques are used to analyse the data and test the hypotheses in this study. The main techniques include regression analysis. These analyses require a substantial amount of sample units. The algorithm underpinning multivariate studies (which is an essential analysis technique used in this study) is sensitive to the sample size. Hair, Black, Babin and Anderson (2014:120) suggest that the sample size should be determined by the number of constructs, number of measured items, as well as multivariate normality. Table 4.3 summarises the critical sample size prerequisites for conducting a regression analysis.

**Table 4.3: Sample requirements for Multivariate Studies**

<table>
<thead>
<tr>
<th>Minimum sample size required</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model complexity and basic measurement model characteristics</td>
<td></td>
</tr>
</tbody>
</table>
### Minimum sample size required

<table>
<thead>
<tr>
<th>Minimum sample size required</th>
<th>Conditions</th>
</tr>
</thead>
</table>
| Minimum 100                 | - Five or fewer constructs  
- More than three items each  
- High item commonalities (0.6 or higher) |
| Minimum 150                 | - Seven or fewer constructs  
- Modest communalities (0.5)  
- No under-identified constructs |
| Minimum 300                 | - Seven or fewer constructs  
- Lower communalities (below 0.45)  
- Multiple under-identified constructs |
| Minimum 500                 | - Large number of constructs  
- Lower communalities  
- Fewer than three measured items |

**Multivariate Normality**  
When data deviate from multivariate normality, the higher sample size is required

**Source:** Adapted from Hair et al. (2014)

Table 4.3 provides sample requirements for multivariate statistics such as regression analysis. Hair et al. (2014:30) suggest that for a complex model with more than seven constructs, as indicated in Table 4.3, the minimum sample size required is 150 or more. The proposed conceptual model in this study is not a complex model, given the eight constructs (seven hypotheses). In line with the recommendations shown in the table above, this study initially targeted a minimum of 400 respondents. However, a final sample size of 265 was used in the survey, based on the collected usable questionnaires. The methods and approaches used to collect data are explored in the following subsection.

#### 4.8.1.4 Sample procedure and technique

The sampling method is a way by which the sample units were selected. Burns et al. (2018:99) believe that sampling procedures and techniques should be chosen in a manner that ensures that the respondents in the level of analysis will be generalisable to the intended population. Two distinctive categories of sampling can be applied in research, namely, probability and non-probability sampling methods (Zikmund, Babin, Carrand & Griffin 2009:128; Malhotra 2010:215). A probability sampling procedure is one in which every member of the population has an equal chance of being selected (Grove, Burns & Gray 2013:362). Its major advantage is that it commonly results in the selection of a sample that is highly representative of the population (Polit & Beck 2018:166).
Meanwhile, non-probability sampling selection relies on the discretion of the researcher and the degree of sampling error cannot be determined (Tustin et al. 2010:345; Gerrish & Lathlean 2015:587). Although the lists of the intended target population were provided, a non-probability convenience sample was used in this study. The rationale behind using convenience sampling is that it was difficult to contact the respondents after the emergence of the COVID-19 pandemic since the country was placed in a series of lockdowns. In addition, convenience sampling is affordable, easy and the subjects are readily available and identified based on their in-depth knowledge (Malhotra 2010:459). Supply chain and operations managers and practitioners were contacted in person in order to complete the questionnaire. Convenience samples are sometimes regarded as accidental samples because elements may be selected in the sample simply because they just happen to be situated or administratively near to where the researcher is conducting the data collection (McDaniel & Gates 2013:284). The rationale behind using convenience sampling was that it is affordable accessible, and the subjects are readily available and identified based on their in-depth knowledge (Malhotra 2010:459).

4.9 DATA COLLECTION INSTRUMENT

Data collection was accomplished through a survey using a structured questionnaire in this study. A survey was carried out providing easy, quick, inexpensive, efficient and accurate information about the population (Babin & Zikmund 2016:179). The use of a self-administered questionnaire was employed because of its cost-effectiveness and ease to administer. According to Malhotra (2010:230) a questionnaire is a list of carefully structured questions that have been chosen after considerable testing to elicit reliable responses from a particular group of people. The questionnaire method is used for collecting primary data by asking a sample of respondents to answer a list of carefully structured questions chosen, after considerable testing, to elicit reliable responses (Berndt & Petzer 2011:173). The decision to make use of a questionnaire is influenced by the characteristics of the respondents the study intends to collect data from; the importance of reaching each targeted respondent; the importance of respondents’ answers not being contaminated or distorted; the size of the sample and the nature and the types of the questions (Saunders et al. 2016:116). In this study, a questionnaire was deemed suitable since a large, predetermined sample size of n=400 respondents were required to satisfy the sample-size requirements for quantitative research.
A questionnaire may be either open-ended or close-ended. Open-ended questionnaires require respondents to respond to a question using their own words, whereas the closed-ended questionnaire limits the respondents to choose from the list provided by the researcher (O’Sullivan, Rassel, Berner & Taliaferro 2017:86). In this study, questionnaire items were closed-ended except for section A, where two open-ended questions, which denote that the respondents were restricted to indicating their answers to the structured questions provided in the survey questionnaire. Gupta (2011:177) emphasises the importance of designing a questionnaire since questions have to be logically ordered and should not be arranged haphazardly. This is because the initial questions can affect a respondent’s willingness to answer a questionnaire. If the early questions are confusing, time-consuming or threatening the respond may refuse to participate (O’Sullivan et al. 2017:86).

In view of this, the questionnaire was designed systematically, taking care to ensure that respondents would be able to understand the questions and provide the information elicited quickly. The questionnaire was self-administered, which suggests that respondents were expected to complete it themselves and without additional assistance. This enabled respondents to be free and objective as they answered the questions without duress. Hair et al. (2014:132) proposed the following seven steps for designing a questionnaire:

Step 1: Confirm the research objectives.
Step 2: Select the appropriate data collection method.
Step 3: Develop questions and scaling.
Step 4: Determine layout and evaluate the questionnaire.
Step 5: Obtain initial client approval.
Step 6: Pre-test, revise, and finalise questionnaire.
Step 7: Implementing the final survey.

This study used a structured questionnaire consisting of a series of questions that respondents answered. The research questionnaire was partitioned into four sections comprising closed-ended questions.

Section A

This section comprised nine questions that elicited information on the demographic profile of the respondents. The questions elicited information on gender, age group, racial extraction, highest
educational qualifications, number of years at the company, position within the SC, years of experience in the position, and the respondent's department.

**Section B**

Section B was divided into sub-sections considering that it covered lean supply chain management practices, which are TQM (6 items), JIT (6 items), human resource (6 items), waste elimination (5 items), strategic partnership (6 items) and information analysis (5 items) with a set of questions to elicit responses to the above-mentioned variables. These questions were adapted from validated scales used in previous studies, as indicated in Table 4.4 below for sources, number of items and the psychometric properties. Hence the scale was considered reliable and useful in measuring information sharing in this study.

**Section C**

Section C of the questionnaire elicited responses to lean culture. Lean culture was measured using six questions adapted from Panuwatwanich and Nguyen (2017). The measurement scale was composed of six scale items and attained adequate composite reliability (CR) value of 0.896. This value confirms that the scale is reliable and is suitable for application in the current study.

**Section D**

Section D of the questionnaire comprised eight questions to elicit responses on supply chain competitiveness. Questions used in this section were adapted from a previous scale validated by Ganeshkumar and Nambirajan (2013). In their study, the scale proved to be internally consistent by attaining a CR of 0.759. Since it was reliable when applied in these studies, the scale was deemed suitable for use in the present study.

Table 4.4 below summarises the studies/researchers and psychometric properties used in designing the current study questionnaire.

**Table 4.4: Measurement scales, sources and reliabilities**

<table>
<thead>
<tr>
<th>No of Items</th>
<th>Construct</th>
<th>Authors</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Just in Time (JIT)</td>
<td>Bortolotti, Boscari &amp; Danese (2015:37)</td>
<td>0.892</td>
</tr>
<tr>
<td>No of Items</td>
<td>Construct</td>
<td>Authors</td>
<td>Reliability</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------</td>
<td>---------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>6</td>
<td>Total Quality Management (TQM)</td>
<td>Sadikoglu &amp; Olcay (2014:11)</td>
<td>0.901</td>
</tr>
<tr>
<td>6</td>
<td>Strategic Partnership (SP)</td>
<td>Bortolotti, Boscari &amp; Danese (2015:37)</td>
<td>0.860</td>
</tr>
<tr>
<td>6</td>
<td>Human resource (HR)</td>
<td>Bortolotti, Boscari &amp; Danese (2015:37)</td>
<td>0.845</td>
</tr>
<tr>
<td>5</td>
<td>Waste Elimination (WE)</td>
<td>Manzouri et al. (2014:9189)</td>
<td>0.862</td>
</tr>
<tr>
<td>5</td>
<td>Information Analysis (IA)</td>
<td>Saravanan &amp; Rao (2006:746)</td>
<td>0.937</td>
</tr>
<tr>
<td>6</td>
<td>Lean Culture (LC)</td>
<td>Panuwatwanich &amp; Nguyen (2017)</td>
<td>0.896</td>
</tr>
<tr>
<td>8</td>
<td>Supply Chain Competitiveness (SCC)</td>
<td>Ganeshkumar &amp; Nambirajan (2013:406)</td>
<td>0.759</td>
</tr>
</tbody>
</table>

**Source:** Compiled by author

**4.9.1 Response options**

Section A of the questionnaire made use of dichotomous and multiple-choice questions, except for A8 and A9, which required the respondent to write down their positions and department. Response options used in sections B to D of the questionnaire were presented in the form of a Likert-type scale format. According to Grove, Burns and Gray (2013:362), a Likert-type scale is a psychometric and bipolar scale that measures both negative and responses in questionnaires. A Likert scale was used in this study due to its compatibility with questionnaires as well as its ability to measure the opinions and attitude of people objectively (Malhotra 2010:256). In addition, it reduces the development of response bias amongst the respondents, facilitates the standardisation and comparability of questions amongst the respondents, and its questions are easy to code and analyse directly from the questionnaires (Grove et al. 2013:362). This study made use of a seven-point Likert-type scale ranging from 1= strongly disagree to 7= strongly agree. The median “4” position on the scale was labelled as “neutral” since it was considered more appropriate to allow respondents the freedom to state their actual views regarding any item without being arbitrarily forced to take either the negative or positive position. A seven-point scale was preferred ahead of a five-point scale as it facilitates the collection of a broader spectrum of responses (Babin & Zikmund 2016:76).

**4.10 DATA COLLECTION PROCEDURES**
Several methods can be used to distribute questionnaires in a research survey, such as telephonic, electronic, postal, drop and collect, group-administered and online surveys. All the methods mentioned above have merits and demerits. Due to the outbreak of COVID-19, questionnaires were distributed to steel manufacturing companies using two methods in this study. The first one was the drop and collect method, which involved the face-to-face distribution and collection of hard copies of the questionnaires to and from the respondents who were available at work. The researcher personally delivered the questionnaires to the respective workstations of the respondents. The second method involved email surveys due to the pandemic (Covid-19), forcing people to work from home. Emails were suitable since some of the respondents are geographically dispersed in the constituencies to be covered in this study. Many of the respondents were working from home, thereby making it challenging to deliver questionnaires by the hard copy format to them. Email addresses for such respondents were collected from their departments and used as a reference point for contacting them.

The response rate in quantitative studies can be increased by considering several factors such as the timing, ensuring that the questionnaire distribution period is convenient for the respondents, making a good first impression, areas of response are adequate and indicated; motivating potential respondents by providing them with reasons as to why the study is important and why they should respond; following up and sending reminders (O’Sullivan et al. 2017:86). The respondents were given two weeks to complete the survey; the date of collection was further communicated either by email or during the drop off period. As part of adhering to research ethics, respondents were not offered any incentives for participating in the study since the covering letter outlined the ethical considerations.

Data collection activities took place within the Gauteng province, focusing on the Vaal region between April and July 2020. The researcher undertook the data collection process for four months.

The researcher distributed a total number of 400 questionnaires. They were then screened after data collection. However, some of the questionnaires were not returned, while some were incomplete due to a few reasons. After systematically screening all questionnaires and getting rid of incomplete ones, a total of 265 were found usable, representing a 66.3 percent response rate.
4.11 PROCEDURES FOR DATA ANALYSIS

Data analysis is a process of inspecting, cleansing, transforming and modelling data to discover useful information, informing conclusions and supporting decision-making to achieve the research objectives (Clow & James 2014:227). The collected data is subjected to a data preparation process to ensure that they are ready for the actual analysis. After data preparation procedures have been completed, the data will be analysed using descriptive statistics (including tests for normality of data) exploratory factor analysis. Descriptive statistics and exploratory factor analysis were analysed using the Statistical Packages for the Social Sciences (SPSS version 26.0). Before the analysis, the data preparation process followed, as discussed in the next subsection.

4.11.1 Data Preparation

The process of data preparation involved checking the data for accuracy before entering it into the computer to transform it (Brown & Moore 2012:3). Data preparation is an important prerequisite during data analysis because it ensures that only accurate data are entered into the analysis system and that corrective action is taken to address any existing anomalies in the data before the actual analysis is performed (Malhotra 2010:266). There are four phases of data preparation, which the researcher employed in this study, namely, data capturing, data editing, coding and cleaning. These phases were employed to ensure that the data collected were complete and ready for analysing (Polit & Beck 2017:739). The discussion of these four phases follows in the next subsections.

❖ Data capturing

Data capturing as a method of transferring coded information from the questionnaires or coding sheet directly into the computer by keypunching. In this study, the researcher, using the Microsoft Excel program, performed data capturing Malhotra (2010:459).

4.11.1.1 Data editing

Data editing is the process of checking completeness, consistency, comprehensibility, uniformity, and legibility of data and making the data ready for coding and transfer to storage (Gerrish & Lathlean 2015:587). Typical anomalies that may exist in data in questionnaires include omissions, inconsistencies, incompleteness, illegibility and any other identifiable errors (Burns & Bush 2014:214). In this study, each collected questionnaire was evaluated to ensure that it had been filled out entirely and befittingly. In the process of editing, unsatisfactory questionnaires were
discarded, as advised by Malhotra (2010:260). In the case of item non-response, the researcher had some available options, such as using a neutral value where data was inserted to make it consistent and readable (Brown & Moore 2012:3). This was a preliminary form of data field editing, which the researcher undertook during data preparation.

4.11.1.2 Data coding

Coding is the process of assigning and classifying a code to represent a specific response to a specific question with a numeric score or character symbol (McDaniel & Gates 2014:108). Assigning numerical symbols permits the transfer of data from the questionnaire to the computer. Codes are generally considered numbered symbols; however, they are more broadly defined as rules for interpreting, classifying, and recording the data (Babin & Zikmund 2016:162). In this study, the collected questionnaires were assigned values/numbers and entered on the Excel spreadsheet. For instance, 265 questionnaires were collected; each questionnaire was allocated a specific and unique number ranging between 1 and 265.

Additionally, all responses to questions were allocated a specific code. For instance, two responses, namely “male” and “female” were expected for the categorical variable “gender”. Male was allocated a code 1 while female was coded 2, which ensured that only the codes 1 and 2 were entered in the Excel document to facilitate data analysis. The process of allocating codes was applied to all questions in the questionnaire and their respective codes.

4.11.1.3 Data cleaning

Data cleaning is the most crucial part of the data preparation process (McDaniel & Gates 2014:400). It involved error checking and treatment of missing responses, the substitution of neutral value, substituting imputed response, and a case-wise and pair-wise deletion (Malhotra 2010:461). It is an important step in ensuring that the final data set is used sufficiently consistent and accurate to facilitate its objective statistical analysis. A typical example of such irregularities is missing entries that may have been a result of human error during the entering of data in the Excel document. Another inconsistency might be the entering of wrong digits, such as, for example, entering a 6 on a five-point Likert-type scale. To check for and correct such errors, the columns and rows of the Excel spreadsheet where the collected data had been entered was analysed several times. Should any errors be identified, corrections were made by referring to the actual
numbered questionnaire and then re-entering the missing/erroneous data using the correct code. This process was repeated until no missing and wrong entries could be found on the data set.

4.11.2 Tests for Normality of Data
In measuring normality, Field (2013:172) points out that for a large sample size such as the one in this study, the central limit theorem stipulates that the assumption of normality has little effect on the analysis of data. Although the central theorem provides a studied theoretical background for the issue of normality in this study, the skewness and kurtosis of each item in the model is presented in Chapter Five. There are numerous tests for normality of data, such as the Jarque-Bera test, Lilliefors corrected K-S test, Lilliefors corrected K-S test, Anscombe-Glynn kurtosis test, Anscombe-Glynn kurtosis test, Anscombe-Glynn kurtosis test, Anscombe-Glynn kurtosis test, D’Agostino-Pearson omnibus test and the D’Agostino’s K-Squared test (Malhotra 2010; Fields 2013; Pallant 2013). However, in this study, normality of data will be tested using the D’Argostino’s K-squared test. The D’Agostino’s K-squared test, which is a goodness of fit measure, seeks to determine if a sample is drawn from a normally distributed population (Field 2013:188).

In this test, the sample skewness and kurtosis was computed. Skewness is a measure of the lack of symmetry, while kurtosis determines whether the data are either heavily tailed or light-tailed, relative to a normal distribution (Hair, Black, Babin & Anderson, 2014:85). While various rules of thumb had been applied to measure skewness, this study adopted -2 to +2, as proposed by Field (2013:172) to be the acceptable range to prove the normal distribution of data. The expected kurtosis value for any univariate normal distribution is 3 (Burns & Groove 2011:305); hence values closer to this threshold were adopted in this study. The D’Argostino’s K squared test was performed with the aid of the SPSS software concurrently with descriptive statistics analysis. Hashim (2012) suggests that the data is non-normal if about 80% of the data presented skewness and kurtosis above the recommended threshold of -3 to +3.

4.11.3 Descriptive Statistics
Descriptive statistics are the most elementary statistical forms of data analysis. As its name indicates, descriptive statistics describe a variable's basic characteristics, including central tendency, distribution, and variability (Zikmund & Babin 2010:77). Descriptive statistics involve summarising and organising the data to ensure that they may be easily understood. The results of
the descriptive statistics apply to the sample under consideration and cannot be inferred to the entire population from which the sample is drawn (unless the study is a census). In this study, descriptive statistics included tabulations (frequency tables), mean, standard deviation, cross-tabulations. Frequency tables, including frequencies and percentages, were used to help describe the socio-demographic characteristics of the sample. Means and standard deviations, respectively, provided information on the average and how the continuous variables are spread out.

**4.11.3.1 Frequencies**

The most fundamental of descriptive techniques is the construction of frequency distributions. Frequency distribution is a mathematical distribution to obtain a count of a number of respondents associated with different values of one variable and to express these counts in percentage terms (Malhotra & Peterson 2006:429). Frequencies are a form of descriptive statistics that show the number of times a particular value occurs in each category of measurement (Carlson & Winquist 2014:201). In this study, statistical frequencies were first applied in the analysis of the demographic profile of respondents. For example, the frequencies indicated how many male or female scores are. Secondly, the frequencies were applied in determining the perceptions of respondents towards each research construct. For example, the frequencies revealed how many respondents agreed or disagreed with each of the items in a construct. The frequencies were presented in a frequency table that showed the variable, its categories/response options, the actual number/score occurring (n) and the percentage (%) of that score against the total sample. Some of the frequencies were also shown using specially designed graphs (for example, histograms) and charts (for example, bar and pie charts).

**4.11.3.2 Mean Scores**

Mean, or average is the average arithmetic value of the responses on a variable (McDaniel & Gates 2013:284). The sum of the scores in distribution is divided by the total number of scores (Zikmund & Babin 2013:91). In this study, the mean score was first applied to establish the most important score amongst a set of items in a specific construct. For example, for a construct under consideration in this study, the item with the highest mean is the most important. Secondly, the mean score was applied to establish the most dominant construct when compared with the others under consideration in the study.
4.11.3.3 Standard deviation

The standard deviation is the square root of the calculated variance on a variable (Churchill et al. 2010:430). The sample standard deviation conveniently measures the variation in responses for continuous measures (Malhotra 2010:281; Polit & Beck 2018:166). A low SD implies that the data is closer to the mean, whereas a higher SD suggests that measures are widely dispersed (spread out) from the mean over a wider range of values (Polit & Beck 2018:166). In this study, the SD was used further to confirm whether data were normally distributed. A normal distribution is assumed when the values of the data are dispersed evenly around one representative value (Babin & Zikmund 2016:82). Hence, the analysis of SD concurrently values was useful in further ascertaining the data distribution.

4.11.4 Exploratory Factor Analysis

Exploratory factor analysis (EFA) is a statistical technique that is used to reduce data to a smaller set of summary variables and to explore the underlying theoretical structure of the phenomena (Henseler, Dijkstra, Sarstedt, Ringle, Diamantopoulos, Straub, Ketchen, Hair, Hult & Calantone 2015:205). It is used to identify the structure of the relationship between the variable and the respondent (Brown & Moore 2012:3). This study has several latent variables under consideration, namely TQM, JIT, strategic partnership, waste elimination, human resources, information analysis, lean culture and supply chain competitiveness. The proposed factor structure of these variables is as presented through the items under each item in the questionnaire, and these items are the observed variables. However, it is necessary to establish whether the collected data are consistent with the factor structure proposed in the research model, and this is achieved by applying EFA. For instance, as presented in the model, TQM is one factor. However, after applying EFA, it could be that the actual factor structure in this study using the collected data may reveal more than one factor for TQM variable. It is thus necessary to conduct EFA before further analyses, to determine the factor structure of the data collected for this study. Also, EFA is necessary since the items used in the questionnaire were borrowed from various previous studies. This makes it necessary to perform EFA to establish the validity of the measurement scales being used in the questionnaire in the current research context.

In determining the factor structure of the variables in this study, it was considered necessary first to check whether the data collected were factorable, as proposed by Field (2013). To check for the
factorability of the data, Bartlett’s Test of Sphericity and a Kaiser Meyer Olkin (KMO) test of Sampling Adequacy was performed. Bartlett’s test establishes whether the correlation matrix is an identity matrix. If the variables are unrelated, they would be deemed unsuitable for EFA. A significant p-value less than 0.05 indicates that the variables in the correlation matrix are related, and hence factor analysis is useful for this data. The KMO tests whether the sample is large enough, and this will be indicated by a value greater than 0.5 (Field 2013).

Three criteria were applied in the EFA procedure. The first is that only items that have factor loadings greater than 0.5 were retained in the study (Hair et al. 2014:134). The second criterion is that only factors with eigenvalues greater than 1(one) are retained as prescribed through the Guttman-Kaiser rule (Kaiser 1960; Larsen & Warne 2010; Henseler et al. 2014:152). Also, Cartell’s Scree Plot criteria is applied where all factors that are above the breaking point are retained (Malhotra 2010; Burns & Bush 2014:214; Feinberg, Kinnear & Taylor 2013:128). The EFA procedure was performed on SPSS using Varimax Rotation which is the most popular method of rotation. Correlation analysis is discussed in the next section.

- **Correlation Analysis**

Correlations describe the relationships between the different variables used in a study (Chock 2010;13). A correlation attempts to measure the strength and direction of a relationship between variables and highlights the significance and impact of the specific variable in the study (Cogtay, Deshpande & Thatte 2017:70). In this study correlation analysis was employed to check the relationship amongst variables and the results are shown in the next chapter under section 5.5. Correlation analysis is often presented as an absolute value score between 0 and 1 (Shiu et al. 2009:553). A correlation of -1.00 indicates a perfect negative correlation, 0 indicates no relationship at all and +1.00 indicates a perfect positive correlation. The threshold for evaluating Pearson correlation coefficients is reflected in table 4.5, used to determine the strength of the relationship between the variables, as suggested by Choudhury (2009:27).

**Table 4.5: Strength of the correlations/relationships**

<table>
<thead>
<tr>
<th>Size of $r$</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>± (0.5 to 1.0)</td>
<td>Strong relationship</td>
</tr>
<tr>
<td>± (0.3 to 0.5)</td>
<td>Moderate relationship</td>
</tr>
<tr>
<td>Size of $r$</td>
<td>Interpretation</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>± (0.1 to 0.3)</td>
<td>Weak relationship</td>
</tr>
<tr>
<td>± (0.0 to 0.1)</td>
<td>Very weak or no relationship</td>
</tr>
</tbody>
</table>

**Source:** Choudhury (2009:27)

- **Regression Analysis**

Regression analysis is a statistical measurement used to determine the linear relationship between two or more variables. Regression analysis attempts to determine the strength of a relationship between one dependent variable and a series of independent variables (Bartel, 2014:36). However, regression is better suited for determining prediction or causality based on the idea that correlation does not imply causality (Forsman *et al.* 2011:356). In this study regression analysis was used to assess if any predictive relationships existed among the independent and dependent variables, as shown in next chapter, section 5.6.

**4.11.5 Reliability**

Reliability is a degree to which the measuring instrument is consistent and dependable over time (Feinberg, Kinnear & Taylor 2013:128). It is the degree to which the measurement instrument is free from measurement error (McDaniel & Gates 2013:215). Hence through reliability, biases and errors are minimised, and consistent results are achieved. According to Malhotra (2010:731), there are various methods employed to test for reliability, which include the split-half reliability coefficient and the Kuder-Richardson Formula 20 (K-R 20), the Composite reliability test, the Cronbach alpha test and item-to-total correlations. In this study, reliability was tested using the Cronbach alpha test and inter-item correlations.

**4.11.5.1 Cronbach alpha**

Cronbach’s alpha is a measure of internal consistency reliability test score that is the average of all possible split-half coefficients resulting from a different splitting of the scale items (Sekaran & Bougie 2013:228). In other words, it is the correlation of each item in a measurement scale with the sum of all the other items. A high Cronbach alpha represents a great extent of applicability across the items in the scale (Malhotra 2010:734). In applying the Cronbach alpha coefficient, the
current study employed the guidelines presented in Table 4.5 that are put forward by Cronbach (1951).

**Table 4.6: Rules of Thumb for the Cronbach Alpha**

<table>
<thead>
<tr>
<th>Cronbach Alpha Value</th>
<th>Internal Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha \geq 0.9$</td>
<td>Excellent</td>
</tr>
<tr>
<td>$0.8 &lt; \alpha \leq 0.9$</td>
<td>Good</td>
</tr>
<tr>
<td>$0.7 &lt; \alpha \leq 0.8$</td>
<td>Acceptable</td>
</tr>
<tr>
<td>$0.6 &lt; \alpha \leq 0.7$</td>
<td>Questionable</td>
</tr>
<tr>
<td>$0.5 &lt; \alpha \leq 0.6$</td>
<td>Poor</td>
</tr>
<tr>
<td>$\alpha &lt; 0.5$</td>
<td>Unacceptable</td>
</tr>
</tbody>
</table>

*Source: Cronbach (1951)*

The table reveals that the minimum acceptable alpha value is 0.7, and the rule of thumb, as indicated in Table 4.6, used in this study. It is, therefore, expected that the alpha values for all measurement scales used in the study are above the 0.7 thresholds.

### 4.11.5.2 Item-total correlations

Item-total correlations are a psychometric measure used to judge the reliability and consistency of measurement scales (Field 2013:189). The measure is applied to test whether any item in a scale is consistent with the behaviour of the other items on the same scale (Burns & Bush 2014:214). Any inconsistent items are garbage items that must be discarded. Usually, the discarding of such inconsistent items leads to the improvement of reliability in a process called scale purification. To meet the cut-off level of reliability, the study adopted Nunnally’s (1978:88) recommendation that the item-total correlation of each item should be above 0.3.

### 4.11.6 Validity

Validity is the extent to which a measurement produces true meaning or score of the variable under investigation (Hair *et al.* 2017: 142). It is also the degree to which the instrument measures the construct it purports to measure (Burns & Bush 2014:216). Validity can be enhanced through suitable instrumentation, meticulous sampling, and appropriate statistical data handling (Feinberg *et al.* 2013:128). Although there are various types of validities, this study tested for three primary forms, namely, face, content and construct (convergent and discriminant) validities.
4.11.6.1 Face validity

Face validity is a type of validity measure, which a measuring scale seems to measure what it is supposed to measure (Schreiber et al. 2010:324). It thus assesses what the questionnaire superficially appears to measure. In this study, face validity was established through a review of the questionnaire by one faculty member. The faculty member is the promoter of the study, and his research interests centred around supply chain management. After reviewing the questionnaire, feedback was provided to improve the questionnaire in terms of its structure, wording and technical aspects.

4.11.6.2 Content validity

Content validity is the extent to which the scale items represent the universe of the task at hand (Maree 2007:217). To ascertain content validity, a pilot study with 50 respondents who were supply chain role players at the steel manufacturing companies was conducted after implementing the suggestions from the expert review of the questionnaire. A pilot study involves a trial run of the questionnaire with a smaller number of respondents. It is essential in that it improves the quality of the entire questionnaire by ensuring that the information requested in the survey is presented and understood without any ambiguity by the respondents (Burns & Bush 2014:214). The sample size for the pilot study was determined using the suggestion by some scholars (Dhurup 2004:249; Henseler & Sarstedt 2013; Hair et al. 2017), that the sample size for a pilot study should be at least 10 per cent of the project sample size. Since this study had a predetermined sample size of n=400 respondents, 50 cases were deemed adequate for the pilot sample size. Again, the questionnaire was modified using the feedback obtained from the pilot sample.

4.11.6.3 Construct Validity

Construct validity is the extent to which a measure confirms hypotheses created from a theory-based upon the concepts under study (McDaniel & Gates 2013:78). It has traditionally been defined as the experimental demonstration that a test is measuring the construct it claims to be measuring (Malhotra 2010:736; Polit & Beck 2018:206). This study tested for construct validity using the exploratory factor analysis technique and correlation analysis. A detailed discussion of these tests is presented in section 5.5
4.11.7 Common method bias

The effect of method bias is a major potential validity and reliability threat to behavioural and applied research, including research in supply chain discipline (Jakobsen & Jensen 2015; MacKenzie & Podsakoff 2012; Fuller, Simmering & Atinc 2016; Antonakis 2017). While the potential threat is widely acknowledged, it is rarely corrected in research findings (Vieluf, Monseur, Baye & Lafontaine 2019:28). A common factor that can stymie research rigour is common method bias. CMB basically occurs in survey research when all data (independent variables, dependent variables and mediating and moderating variables) are collected using the same method, potentially resulting in the artificial inflation of relationships (Jordan & Troth 2020:5). The first mention of CMB has been attributed to Campbell and Fiske (1959) who identified that a portion of the variance in their study (outlining a multi-trait multi-method matrix) may have been due to the methods used.

Common method bias refers to variance that is attributed to the measurement method rather than to the construct of interest (Chiew, Mathies & Patterson 2019:109). The term method refers to “the form of measurement at different levels of abstraction, such as the content of specific items, scale type, response format, and general context” (Friske 1982:81). Method bias is thought to arise for several reasons including social desirability tendencies, dispositional mood states or inclinations on the part of the respondent to acquiesce or respond in a lenient, moderate or extreme way (Podsakoff, MacKenzie & Podsakoff 2012:540). A primary cause is the response tendencies that raters can apply uniformly across measures. It is therefore critical to address CMB.

Failure to address CMB can lead to incorrect judgments about the adequacy of a scale’s reliability and convergent validity (MacKenzie & Podsakoff 2012:544). It can also lead to the underestimating of corrected correlations in meta-analysis because the reliability estimates may be artificially inflated due to method variance (Jordan & Troth 2020:9), while Podsakaff, Podsakoff and MacKenzie (2017:3) maintain that failure to address CMB can result in a bias of the parameter estimates of the relationships between two different constructs. This form of bias can inflate or deflate the estimates of the relationship between the two constructs (Yetton, Sharma & Crawford 2011:2). There is a combination of procedural and statistical strategies available to the researchers to address CMB (Spector, Rosen & Richardson 2019:855; Vieluf, Monseur, Baye & Lafontaine 2019:28).
Common method bias can be addressed using various approaches such as Harman’s one factor test (Chang, Witteloostuijn & Eden 2010:181; Jakobsen & Jensen 2015:5; Fuller et al. 2016:3192). In this study, it was addressed using four methods, namely, research purpose and instructions given to respondents, application of Harman’s single factor, improve scale item clarity by avoiding double barrel questions and balance positive and negative items. A discussion on how these methods were applied to address common methods variance is provided in section 5.10.

4.12 ETHICAL CONSIDERATIONS

In general, ethics are the moral principles of right or wrong that govern how people should behave in different contexts. In the context of research, ethics refer to standards of behaviour that govern or guide your conduct towards the rights of people who become subjects of the research process or those affected by it (Saunders et al. 2016:239). These are accepted norms of conduct that distinguish between right and wrong, and acceptable or unacceptable behaviour (Parveen & Showkat 2017:2). Ethics are central to the research process. Researchers need to take care of various ethical issues at different levels of this process. The reality is that there are ethical concerns at every step of the research process (Parveen & Showkat 2017:3). Therefore, every research study should be conducted morally and soundly, and sensitive results must be reported in such a way that does not harm the relationship between the parties involved (Akaranga & Makau, 2016:102).

In this study, four ethical research principles were considered, namely, informed consent, protection from harm, confidentiality as well as permission to conduct the study. As suggested by Hammersley and Traianou (2012:56), these four are the main ethical concerns relevant to a quantitative study, such as the present research.

4.12.1 Informed Consent

Informed consent is the provision of sufficient information and assurance to individuals participating in the research on the implications of the research process and outcomes (Saunders et al. 2016:244). This is done to enable potential participants to come up with fully informed decisions free of any pressure and coercion. Fouka and Mantzorou (2011:3) highlight that informed consent involves providing enough information to the targeted respondents, which enables them to make decisions to participate in the study or turn down the request to participate. In this study, respondents were made aware of the aims of the study and how it was to be conducted. This enabled the selected respondents to realise the extent of the consent, enabling
them to participate voluntarily and in informed decisions (Dongre & Sankaran 2016:2). In this case, respondents were provided with necessary information on the study and critical SCM issues. Besides, a covering letter explaining the study's aims was attached to the questionnaire and a consent form to show voluntary participation in the research. Furthermore, respondents were made aware of the right to withdraw from the study at any given time with no adverse consequences.

4.12.2 Ensuring confidentiality

Identities of individuals and organisations participating in the research should remain anonymous and given deserving strict confidentiality (Sunders et al. 2016:244). In this study, respondents were requested to avoid writing names on the questionnaires to ensure confidentiality and anonymity. This was to ensure that the study valued the respondents’ right to privacy.

4.12.3 Protection from harm/or victimisation

Harm or victimisation comes in several forms, which may result in emotional, psychological or sociological distress if the information given is not adequately handled. It depends mainly on the amount and nature of the information given out by respondents (Fouka & Mantzorou 2011:5). In this regard, Pillay (2014:78) highlights that in any research, it is vital to protect respondents from any form of harm or victimisation. To ensure that this was observed in this study, all respondents were fully informed and assured that the research was for academic purposes only. Furthermore, all completed questionnaires were always kept in a safe lockable place.

4.12.4 Ensuring permission is obtained

An ethics committee at an institution of higher learning is responsible for all aspects of ethical review and approval (Saunders et al. 2016:242). During this study, ethical clearance was obtained from the Higher Degrees Ethics Committee of the Vaal University of Technology. The survey questionnaire was examined and then approved by the research committee before it was distributed to respondents. Permission to collect data was sought from the relevant authorities at the steel manufacturing companies before the data were collected.

4.12.5 Research integrity

Research integrity has to do with conducting research that is consistent with accepted standards (Burns & Bush 2010:93). Researchers can be tempted to falsify data, alter results or withhold important information. The integrity of the present study was ensured by the involvement of
academics in the process of analysing the data. Not only did the academic supervisors monitor the whole process, but also independent statisticians were involved throughout the research process.

4.12.6 Beneficence
This principle requires the researcher to maximise the benefits that the research will afford to the participants in the research study (Chauke 2014:80; Chauke 2018:199). During the fieldwork, the researcher prioritised that the research was not for the researcher’s direct financial benefit. Respondents were advised that the data would be used only for academic purposes and that the aggregated report would be available for their access at the Vaal University of Technology upon request. Conversations were intended to build mutual trust. The researcher continuously reminded participants to ensure they did not divert into confrontations

4.13 CHAPTER SUMMARY
This chapter aimed to comprehensively discuss the research methodology employed in this study. The chapter first examined the researched reasoning and paradigms selected for this study. It emerged that the study is based on deductive reasoning and the positivist paradigm. The chapter also outlined the research approach, time horizon, design and strategy. The discourse indicated that the study is based on a quantitative approach, used a descriptive design, was based on a correlational cross-sectional method and used a survey strategy. It further discussed the literature review and sampling design. On the latter, it was shown that the sample would be composed of supply chain and operations practitioners drawn from the steel manufacturing companies in Gauteng province, South Africa. A final sample of n=265 respondents was selected using a non-probability-based convenience technique. It further revealed that the measurement instrument was a survey questionnaire that was distributed using emails and the drop and collect method. The study also tested for reliability and various types of validities. Various ethical considerations were followed as the study sought to maintain the standards of professionalism. The next chapter discusses the data analysis, interpretation and discussion of the empirical results of the study.
CHAPTER 5

DATA ANALYSIS AND DISCUSSION OF THE EMPIRICAL RESULTS

5.1 INTRODUCTION

The previous chapter presented an overview of the methodology and research methods used in the study. It also provided a detailed description of the sample selection and composition as well as questionnaire design, layout and questions construction. The procedures followed in collecting, capturing, processing and analysing the data were also elaborated upon. In addition, statistical techniques applied to determine the reliability and validity of the research instrument of the study were provided. The current chapter presents and discusses the empirical results. Firstly, the research hypotheses posited are recapped. Secondly, the results from the data analyses are presented and discussed.

As proposed in Chapter One, three forms of research were formulated in this study and are recapped in Table 5.1.

Table 5.1: Research objectives

<table>
<thead>
<tr>
<th>Primary Objective</th>
<th>Theoretical objectives</th>
<th>Empirical Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>To develop and test a framework for lean practices, lean culture and supply chain competitiveness within the South African steel industry.</td>
<td>To explore literature on South African steel industry;</td>
<td>To examine the influence of just in time on lean culture in the South African steel industry;</td>
</tr>
<tr>
<td></td>
<td>To analyse literature on the theories underlying supply chain competitiveness;</td>
<td>To determine the influence of TQM on lean culture in the South African steel industry;</td>
</tr>
<tr>
<td></td>
<td>To review literature on lean practices;</td>
<td>To determine the influence of strategic partnership on lean culture in the South African steel industry;</td>
</tr>
<tr>
<td></td>
<td>To analyse literature on lean culture; and</td>
<td>To investigate the relationship between waste elimination and lean culture in the South African steel industry;</td>
</tr>
<tr>
<td></td>
<td>To examine literature on supply chain competitiveness.</td>
<td>To ascertain whether human resource influences lean culture in the South African steel industry;</td>
</tr>
</tbody>
</table>
To determine the influence of information analysis on lean culture in the South African steel industry;
To determine the influence of lean culture on supply chain competitiveness in the South African steel industry; and
To develop a model encompassing lean practices, lean culture and supply chain competitiveness, which is applicable to South African steel industry.

Source: Own compilation (2021)

5.2 DESCRIPTIVE STATISTICS

Prior to conducting the descriptive analysis, preliminary analyses were conducted to ensure that there was no violation of assumptions of normality, linearity and multi-collinearity, and a screening process involving examination of missing data, unengaged responses and outliers was undertaken. Cases with more than 10% missing data in the questionnaire were deleted as suggested by Maree (2015:197). The imputation method in SPSS used for replacing missing data was the median of nearby points. The descriptive tables and box plots retrieved from the SPSS output helped to detect and handle outliers. After screening and cleaning the data, the final sample size included 265 steel manufacturing employees. The following section provides an overview of the sample characteristics that have been used in the preliminary data analysis.

5.2.1 Demographic profile of the respondents

In section A of the questionnaire, respondents were asked to provide their biographical information. From the SPSS version 26, the outputs were retrieved and analysed. Information about respondents’ gender, age group, racial group, highest education level, employment period, experience as a SC professional, employment type, department and position held are discussed in this section. The demographic profile of the respondents is presented in Table 5.2.

Table 5.2: Demographic characteristics of the sample

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>163</td>
<td>61,5</td>
</tr>
<tr>
<td>Female</td>
<td>102</td>
<td>38,5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>265</td>
<td>100,0</td>
</tr>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 years and below</td>
<td>29</td>
<td>10,9</td>
</tr>
<tr>
<td>26–33 years</td>
<td>75</td>
<td>28,3</td>
</tr>
<tr>
<td>34–41 years</td>
<td>84</td>
<td>31,7</td>
</tr>
<tr>
<td>Category</td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td>42– 49 years</td>
<td>53</td>
<td>20,0</td>
</tr>
<tr>
<td>50+</td>
<td>24</td>
<td>9,1</td>
</tr>
<tr>
<td>Total</td>
<td>265</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Racial groups

<table>
<thead>
<tr>
<th>Racial groups</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black-African</td>
<td>127</td>
<td>47,9</td>
</tr>
<tr>
<td>White</td>
<td>75</td>
<td>28,3</td>
</tr>
<tr>
<td>Coloured</td>
<td>36</td>
<td>13,6</td>
</tr>
<tr>
<td>Indian</td>
<td>27</td>
<td>10,2</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>0,0</td>
</tr>
<tr>
<td>Total</td>
<td>265</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Highest qualification

<table>
<thead>
<tr>
<th>Highest qualification</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matric</td>
<td>25</td>
<td>9,4</td>
</tr>
<tr>
<td>Certificate</td>
<td>37</td>
<td>14,0</td>
</tr>
<tr>
<td>Diploma</td>
<td>111</td>
<td>41,9</td>
</tr>
<tr>
<td>Degree</td>
<td>69</td>
<td>26,0</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>23</td>
<td>8,7</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
<td>0,0</td>
</tr>
<tr>
<td>Total</td>
<td>265</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Employment period in the organisation

<table>
<thead>
<tr>
<th>Employment period in the organisation</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 year</td>
<td>11</td>
<td>4,2</td>
</tr>
<tr>
<td>1 – 2 years</td>
<td>35</td>
<td>13,2</td>
</tr>
<tr>
<td>3 – 5 years</td>
<td>70</td>
<td>26,4</td>
</tr>
<tr>
<td>6 – 9 years</td>
<td>61</td>
<td>23,0</td>
</tr>
<tr>
<td>10 years or more</td>
<td>88</td>
<td>33,2</td>
</tr>
<tr>
<td>Total</td>
<td>265</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Experience as a supply chain management professional

<table>
<thead>
<tr>
<th>Experience as a supply chain management professional</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 year</td>
<td>23</td>
<td>8,7</td>
</tr>
<tr>
<td>1 – 2 years</td>
<td>55</td>
<td>20,8</td>
</tr>
<tr>
<td>3 – 5 years</td>
<td>80</td>
<td>30,2</td>
</tr>
<tr>
<td>6 – 9 years</td>
<td>57</td>
<td>21,5</td>
</tr>
<tr>
<td>10 years or more</td>
<td>50</td>
<td>18,9</td>
</tr>
<tr>
<td>Total</td>
<td>265</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Type of employment

<table>
<thead>
<tr>
<th>Type of employment</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent</td>
<td>188</td>
<td>71,0</td>
</tr>
<tr>
<td>Contract</td>
<td>52</td>
<td>19,6</td>
</tr>
<tr>
<td>Internship</td>
<td>25</td>
<td>9,4</td>
</tr>
<tr>
<td>Total</td>
<td>265</td>
<td>100,0</td>
</tr>
<tr>
<td>Category</td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td>Department where you are based</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply chain</td>
<td>91</td>
<td>34,3</td>
</tr>
<tr>
<td>Manufacturing/production</td>
<td>48</td>
<td>18,1</td>
</tr>
<tr>
<td>Procurement</td>
<td>73</td>
<td>27,6</td>
</tr>
<tr>
<td>Operations</td>
<td>25</td>
<td>9,4</td>
</tr>
<tr>
<td>Storage/warehousing</td>
<td>28</td>
<td>10,6</td>
</tr>
<tr>
<td>Total</td>
<td>265</td>
<td>100,0</td>
</tr>
<tr>
<td>Your position in the organisation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procurement Clerk/administrator</td>
<td>70</td>
<td>26,4</td>
</tr>
<tr>
<td>Procurement manager</td>
<td>35</td>
<td>13,2</td>
</tr>
<tr>
<td>Supply chain director</td>
<td>16</td>
<td>6,0</td>
</tr>
<tr>
<td>SC Supervisor/advisor</td>
<td>16</td>
<td>6,0</td>
</tr>
<tr>
<td>Stock controller</td>
<td>35</td>
<td>13,2</td>
</tr>
<tr>
<td>Buyer/purchasing assistant</td>
<td>31</td>
<td>11,7</td>
</tr>
<tr>
<td>Quality coordinator</td>
<td>21</td>
<td>7,9</td>
</tr>
<tr>
<td>Process leader/controller</td>
<td>12</td>
<td>4,5</td>
</tr>
<tr>
<td>System operator</td>
<td>18</td>
<td>6,8</td>
</tr>
<tr>
<td>Supply chain analyst</td>
<td>11</td>
<td>4,2</td>
</tr>
</tbody>
</table>

**Source:** Own compilation (2021)

**Figure 5.1: Gender Distribution**

Figure 5.1 reveals a remarkably high percentage of male respondents (61.4%). The high gender differences could be that male respondents were more willing to participate in the study. In
addition, prior studies on steel manufacturing (for example, Schoonberger 2014; Dixit, Dave & Singh 2015; Vanags, Albeltna& Zvirgzdina 2018; Masudin & Kamara 2018) have found that male gender dominates the steel industry owing to the nature of work.

**Figure 5.2: Age Distribution**

In terms of age groups, the majority of the respondents were between the age of 34 – 41 years with 31, 7% (n=84), followed by 28, 3% between the age of 26 – 33 years. The age group of 42 or above constituted 29, 1% (n=77), while the remainder of the percentage was recorded on the age of 25 years or below. It can be deduced that steel manufacturing is well represented in terms of age owing to the balanced distribution of respondents’ age composition.
Figure 5.3: Race Distribution

Regarding ethnic extraction, it can be noted from Figure 5.3 that the majority of the respondents were Black-African with (47.9%), followed by Whites (28.3%). This could reflect the percentage of people who are working at the steel manufacturing industries where the survey was conducted. Another reason could be that the organisations where data was collected is located within the Black and White dominant residential areas. Asians and mixed-race were represented by 13.6% and 10.2% respectively.

Figure 5.4: Qualification Distribution
The findings identify that majority (7.6%) of respondents were well educated with Diploma, Degree and Postgraduate qualifications. A considerable proportion of the respondents were also those who have either matric or a certificate (23.4%).

![Experience Distribution](image1)

**Figure 5.5: Experience Distribution**

Over 33, 2% of the respondents have been employed by their organisations for over 10 years, followed by 3 – 5 and 6- 9 with a combined 49, 4% employment duration. It was, however, impressive that up to 70, 6% of respondents had a minimum of three years as supply chain professionals, which is enough to understand the processes as well as the dynamics associated with the SCM profession.

![Employment Type Distribution](image2)

**Figure 5.6: Employment Distribution**
Regarding the employment type, 71% of the respondents were permanently employed, followed by 19, 6% who are on contract and only 9, 4% were on internship.

Figure 5.7: Department Distribution

Figure 5.7 shows that n=163, that is (61, 5%) of the respondents were from the supply chain management/procurement department, followed by 18% from manufacturing/production and 10, 6% were from storage and warehousing department as well as 9, 4% from operations.

In terms of the positions held, the majority of the respondents (26, 4% were procurement clerks/administrators, 13, 2% were procurement managers, 6% were supply chain directors and supervisors/advisors, respectively, 13, 25% of the respondents were stock controllers, 11, 7% were buyers, while the remainder were quality coordinators (7, 9%), process controllers (4, 5%), system operators (6, 8%) and supply chain analysts (4, 2%). The study’s results validate the broadness of the supply chain profession and its importance.

The descriptive statistics of the variables under investigation is presented in the next section.

5.3 Exploratory factor analysis (EFA)

Prior to conducting the EFA, sample size requirements as well as common methods bias were checked. In general, it is recommended that in order to have a good factor analysis, a minimum of 300 cases should be maintained, whereas Hair et al. (2013) recommend a minimum of five observations for each variable (5:1 cases) under study, implying that a sample size of 265 is reasonable since it represents an item to case ratio of 1:7.425.
Initially, a Harman one-factor score test was conducted by running the preliminary EFA on the sample data, whereas the unrotated factor solution was examined to determine the number of factors that are necessary to account for the variance in the variables. The single factor that emerged yielded one general factor accounting for approximately 24.89 percent of the covariance among the measures, concluding that common method variance is not a problem.

**Table 5.3: Factor analysis results**

<table>
<thead>
<tr>
<th>Construct and items</th>
<th>KMO &amp; Bartlett’s test</th>
<th>% Variance explained</th>
<th>Communalities</th>
<th>Factor loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Just in time</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JIT1</td>
<td>.873(p&lt;0.000)</td>
<td>63.229</td>
<td>.636</td>
<td>.797</td>
</tr>
<tr>
<td>JIT2</td>
<td></td>
<td></td>
<td>.674</td>
<td>.821</td>
</tr>
<tr>
<td>JIT3</td>
<td></td>
<td></td>
<td>.552</td>
<td>.743</td>
</tr>
<tr>
<td>JIT4</td>
<td></td>
<td></td>
<td>.745</td>
<td>.863</td>
</tr>
<tr>
<td>JIT5</td>
<td></td>
<td></td>
<td>.609</td>
<td>.780</td>
</tr>
<tr>
<td>JIT6</td>
<td></td>
<td></td>
<td>.579</td>
<td>.761</td>
</tr>
<tr>
<td><strong>Total quality management</strong></td>
<td>.934(p&lt;0.000)</td>
<td>86.693</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TQM1</td>
<td></td>
<td></td>
<td>.853</td>
<td>.924</td>
</tr>
<tr>
<td>TQM2</td>
<td></td>
<td></td>
<td>.893</td>
<td>.945</td>
</tr>
<tr>
<td>TQM3</td>
<td></td>
<td></td>
<td>.886</td>
<td>.941</td>
</tr>
<tr>
<td>TQM4</td>
<td></td>
<td></td>
<td>.883</td>
<td>.940</td>
</tr>
<tr>
<td>TQM5</td>
<td></td>
<td></td>
<td>.860</td>
<td>.927</td>
</tr>
<tr>
<td>TQM6</td>
<td></td>
<td></td>
<td>.827</td>
<td>.909</td>
</tr>
<tr>
<td><strong>Strategic partnership (SP)</strong></td>
<td>.786(p&lt;0.000)</td>
<td>79.500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP3</td>
<td></td>
<td></td>
<td>.588</td>
<td>.725</td>
</tr>
<tr>
<td>SP4</td>
<td></td>
<td></td>
<td>.794</td>
<td>.879</td>
</tr>
<tr>
<td>SP5</td>
<td></td>
<td></td>
<td>.826</td>
<td>.864</td>
</tr>
<tr>
<td>SP6</td>
<td></td>
<td></td>
<td>.783</td>
<td>.834</td>
</tr>
<tr>
<td><strong>Waste Elimination (WE)</strong></td>
<td>.895(p&lt;0.000)</td>
<td>78.430</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WE1</td>
<td></td>
<td></td>
<td>.762</td>
<td>.873</td>
</tr>
<tr>
<td>WE2</td>
<td></td>
<td></td>
<td>.821</td>
<td>.906</td>
</tr>
<tr>
<td>WE3</td>
<td></td>
<td></td>
<td>.816</td>
<td>.903</td>
</tr>
<tr>
<td>WE4</td>
<td></td>
<td></td>
<td>.756</td>
<td>.869</td>
</tr>
<tr>
<td>WE5</td>
<td></td>
<td></td>
<td>.767</td>
<td>.876</td>
</tr>
<tr>
<td><strong>Human Resource (HR)</strong></td>
<td>.830(p&lt;0.000)</td>
<td>55.217</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HR1</td>
<td></td>
<td></td>
<td>.719</td>
<td>.845</td>
</tr>
<tr>
<td>HR2</td>
<td></td>
<td></td>
<td>.818</td>
<td>.903</td>
</tr>
<tr>
<td>HR3</td>
<td></td>
<td></td>
<td>.756</td>
<td>.866</td>
</tr>
</tbody>
</table>
An exploratory factor analysis was then performed using principal axis factoring by applying an orthogonal method of rotation termed, Varimax, which helped to evaluate the construct validity. The suitability of data for factorability was ascertained after examining the large Kaiser-Meyer Olkin test statistic (KMO = 0.819) as well as the Bartlett sphericity test, which showed a significant result with a large chi-square value ($\chi^2=8 105.213; p<0.01$). In this main factor analysis procedure, no restriction was placed on the number of factors to be extracted. Instead, the eigen values ‘greater than one criterion’ as well as the threshold of a cumulative percentage of variance in excess of 60
percent (Malhotra et al. 2017) were applied. In this regard, all the items loaded on its six unique lean principles based on Kaiser’s eigenvalue rule (eigen values of 1.00) as well as the scree plot point of tailing off. Most of the items loaded as expected with their factors, except for items SP3 -SP6 as well as HR5 which were deleted since they yielded weak and insignificant loadings on any of the extracted factors (below 0.40; p >0.001). The six lean principles remained unchanged, and the labelling remained the same (i.e., Just in Time, Total Quality Management, Strategic partnership, Human resources, Waste elimination and Information analysis), respectively. Just in time (JIT) had KMO of 0.873 and all items explained 63.2 percent of variance. Total quality management (TQM) had a KMO of 0.934 and explaining 86.6 percent of variance. Strategic partnership had KMO of 0.786 explaining 79.5 percent of variance. Waste elimination had KMO of 0.895 with 78.4 percent of variance explained. Human resources had a KMO of 0.830 explaining 73.3 percent of variance, while information analysis had KMO of 0.831 with 79.8 percentage of variance. Lean culture and supply chain competitiveness had KMO of 0.909 and 0.939 with 73.7 and 76.5 percentage of variance, respectively. All factor loadings were between 0.3 and 1.0 as well as communalities of between 0.6 and 1.00, showing satisfactory measures.

The interpretability of variables was enhanced by rotating factors to load into factors as observed by Malhotra (2010:283). In obtaining an orthogonal rotation of factors, the most proved successful method in analytic approach and the frequently used and reported option is the Varimax method (Zikmund & Babin 2013:347). Factor clarification depends on factor rotation, showing the relationship of items to factors by maximising the loadings on one factor and minimising loadings on all the others. The formula which was applied is the principal components method of extraction with Varimax orthogonal factor rotation. The factor loadings of 0.400 and above were regarded significant with factor loading matrix presenting loadings beyond 0.4. The criterion of Hair et al. (2017:239) was exceeded, which indicates that factor loadings that are regarded to achieve the lowest standard are greater than ± 0.300, loadings that are regarded significant are of ± 0.400, and loadings that are regarded more significant are of ± 0.500 and greater. The results further validate several studies which identified JIT, TQM, SP, HR, WE and IFS as lean practices (Hosseini et al. 2018:2; Van der Walt 2012:3; Kumar et al. 2014:06).
5.3.1 Descriptive statistics of the constructs: Means and standard deviations

All the constructs in this study were measured using a seven-point Likert scale, such that 1, 2 and 3 denote the degree to which respondents strongly disagree, disagree and somewhat disagree to the statements about the variables, 4, refers to a neutral choice and, 5, 6 and 7 meant that respondents agree, strongly agree and somewhat agree to the statements, respectively. Descriptive statistics of all the lean practices, lean culture and supply chain competitiveness obtained from the analysis are summarised in Table 5.3.

Table 5.4: Mean and standard deviation of constructs

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Descriptions of Items</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Just in time: Overall</strong></td>
<td></td>
<td>265</td>
<td>5.5874</td>
<td>0.97270</td>
</tr>
<tr>
<td>JIT1</td>
<td>We have located our machines to support JIT production flow</td>
<td>265</td>
<td>5.56</td>
<td>1.205</td>
</tr>
<tr>
<td>JIT2</td>
<td>Our suppliers deliver to us on a just-in-time basis</td>
<td>265</td>
<td>5.43</td>
<td>1.289</td>
</tr>
<tr>
<td>JIT3</td>
<td>We receive daily shipments from most suppliers</td>
<td>265</td>
<td>5.41</td>
<td>1.414</td>
</tr>
<tr>
<td>JIT4</td>
<td>We can depend upon on-time delivery from our partners</td>
<td>265</td>
<td>5.63</td>
<td>1.177</td>
</tr>
<tr>
<td>JIT5</td>
<td>Our suppliers are linked with us by a pull system</td>
<td>265</td>
<td>5.71</td>
<td>1.152</td>
</tr>
<tr>
<td>JIT6</td>
<td>Continuous improvement programmes been implemented in the materials handling control function to improve JIT</td>
<td>265</td>
<td>5.78</td>
<td>1.112</td>
</tr>
<tr>
<td><strong>Total Quality Management: Overall</strong></td>
<td></td>
<td>265</td>
<td>5.7692</td>
<td>1.16227</td>
</tr>
<tr>
<td>TQM1</td>
<td>Our TQM supports continuous improvement and innovations</td>
<td>265</td>
<td>5.77</td>
<td>1.242</td>
</tr>
<tr>
<td>TQM2</td>
<td>Our TQM is reliable</td>
<td>265</td>
<td>5.75</td>
<td>1.221</td>
</tr>
<tr>
<td>TQM3</td>
<td>Our TQM is competent and flexible</td>
<td>265</td>
<td>5.82</td>
<td>1.228</td>
</tr>
<tr>
<td>TQM4</td>
<td>Our TQM is effective and competitive</td>
<td>265</td>
<td>5.76</td>
<td>1.228</td>
</tr>
<tr>
<td>TQM5</td>
<td>Our TQM focuses on quality data and reporting</td>
<td>265</td>
<td>5.75</td>
<td>1.281</td>
</tr>
<tr>
<td>TQM6</td>
<td>Our TQM oversee supplier quality management</td>
<td>265</td>
<td>5.76</td>
<td>1.290</td>
</tr>
<tr>
<td><strong>Strategic partnership: Overall</strong></td>
<td></td>
<td>265</td>
<td>5.3292</td>
<td>0.96792</td>
</tr>
<tr>
<td>SP3</td>
<td>We provide a fair return to our suppliers</td>
<td>265</td>
<td>5.45</td>
<td>0.908</td>
</tr>
<tr>
<td>SP4</td>
<td>Our organisation shares proprietary information with its supply chain partners.</td>
<td>265</td>
<td>5.18</td>
<td>1.161</td>
</tr>
<tr>
<td>SP5</td>
<td>We include our key suppliers in our planning and goal-setting activities.</td>
<td>265</td>
<td>5.34</td>
<td>1.183</td>
</tr>
<tr>
<td>SP6</td>
<td>Our key suppliers provide input into our product development projects</td>
<td>265</td>
<td>5.34</td>
<td>1.215</td>
</tr>
<tr>
<td>Constructs</td>
<td>Descriptions of Items</td>
<td>N</td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-----</td>
<td>--------</td>
<td>----------------</td>
</tr>
<tr>
<td>Waste Elimination: Overall</td>
<td>Waste reduction is focused on the functional areas within the company</td>
<td>265</td>
<td>5.9064</td>
<td>.93711</td>
</tr>
<tr>
<td>WE1</td>
<td>This company analyses internal processes to minimise waste</td>
<td>265</td>
<td>5.89</td>
<td>.987</td>
</tr>
<tr>
<td>WE2</td>
<td>Our supply chain partners are working together to eliminate waste</td>
<td>265</td>
<td>5.92</td>
<td>1.016</td>
</tr>
<tr>
<td>WE3</td>
<td>We understand end-to-end processes and work together to eliminate waste throughout the supply chain</td>
<td>265</td>
<td>5.89</td>
<td>1.138</td>
</tr>
<tr>
<td>WE4</td>
<td>We eliminate waste by avoiding over production</td>
<td>265</td>
<td>5.94</td>
<td>1.111</td>
</tr>
<tr>
<td>Human resources: Overall</td>
<td>Our employees receive training to perform multiple tasks</td>
<td>264</td>
<td>5.80</td>
<td>1.011</td>
</tr>
<tr>
<td>HR1</td>
<td>Employees at this plant learn how to perform a variety of tasks</td>
<td>265</td>
<td>5.65</td>
<td>1.041</td>
</tr>
<tr>
<td>HR2</td>
<td>The longer an employee has been at this plant, the more tasks they learn to perform</td>
<td>265</td>
<td>5.64</td>
<td>0.987</td>
</tr>
<tr>
<td>HR3</td>
<td>Employees are cross trained at this plant, so that they can fill in for others, if necessary</td>
<td>265</td>
<td>5.53</td>
<td>1.087</td>
</tr>
<tr>
<td>Information Analysis: Overall</td>
<td>Our information analysis team is reliable.</td>
<td>265</td>
<td>5.69</td>
<td>1.099</td>
</tr>
<tr>
<td>IS1</td>
<td>Our information analysis team adds value to the manufacturing process</td>
<td>265</td>
<td>5.64</td>
<td>1.065</td>
</tr>
<tr>
<td>IS2</td>
<td>Our information analysis team is a vital input into our active management strategy</td>
<td>265</td>
<td>5.62</td>
<td>1.168</td>
</tr>
<tr>
<td>IS3</td>
<td>Our information analysis team provides oral and written information regularly</td>
<td>265</td>
<td>5.38</td>
<td>1.024</td>
</tr>
<tr>
<td>IS4</td>
<td>We act upon the recommendations of the information analysis team</td>
<td>265</td>
<td>5.45</td>
<td>1.065</td>
</tr>
<tr>
<td>Lean culture: Overall</td>
<td>Our organisation reduces process set-up time (time required to prepare or refit equipment/workstation for production).</td>
<td>265</td>
<td>5.59</td>
<td>1.098</td>
</tr>
<tr>
<td>LC1</td>
<td>A problem is viewed as an opportunity to improve</td>
<td>265</td>
<td>5.60</td>
<td>1.036</td>
</tr>
<tr>
<td>LC2</td>
<td>Our organisation produces only what is demanded by customers when needed (e.g., JIT).</td>
<td>265</td>
<td>5.54</td>
<td>1.206</td>
</tr>
<tr>
<td>LC3</td>
<td>We are able to respond quickly to customers’ changing demands</td>
<td>265</td>
<td>5.68</td>
<td>1.090</td>
</tr>
<tr>
<td>LC4</td>
<td>We consider the impact of decisions on the rest of the organisation</td>
<td>265</td>
<td>5.69</td>
<td>1.150</td>
</tr>
<tr>
<td>Constructs</td>
<td>Descriptions of Items</td>
<td>N</td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------</td>
<td>----</td>
<td>------</td>
<td>---------------</td>
</tr>
<tr>
<td>LC6</td>
<td>We believe that reducing waste makes us more competitive</td>
<td>265</td>
<td>5.83</td>
<td>1.052</td>
</tr>
<tr>
<td>Supply chain competitiveness: Overall</td>
<td></td>
<td>265</td>
<td>5.8877</td>
<td>0.98420</td>
</tr>
<tr>
<td>SCC1</td>
<td>Manufacturing lead times are shorter</td>
<td>265</td>
<td>5.92</td>
<td>1.077</td>
</tr>
<tr>
<td>SCC2</td>
<td>Our deliveries are on time</td>
<td>265</td>
<td>5.89</td>
<td>1.030</td>
</tr>
<tr>
<td>SCC3</td>
<td>We have fewer or no shipping errors</td>
<td>265</td>
<td>5.83</td>
<td>1.123</td>
</tr>
<tr>
<td>SCC4</td>
<td>There is minimal customer complaint</td>
<td>265</td>
<td>5.89</td>
<td>1.129</td>
</tr>
<tr>
<td>SCC5</td>
<td>There is an improvement in order item fill rate</td>
<td>265</td>
<td>5.89</td>
<td>1.160</td>
</tr>
<tr>
<td>SCC6</td>
<td>We have a customer response time</td>
<td>265</td>
<td>5.89</td>
<td>1.116</td>
</tr>
<tr>
<td>SCC7</td>
<td>Sale forecast matches the demand</td>
<td>265</td>
<td>5.85</td>
<td>1.194</td>
</tr>
<tr>
<td>SCC8</td>
<td>We have improvement in inventory turns</td>
<td>265</td>
<td>5.94</td>
<td>1.176</td>
</tr>
</tbody>
</table>

Source: Own compilation (2021)

5.3.1.1 Lean principles

The lean principles proposed to be affecting supply chain competitiveness through lean culture included just in time, total quality management, strategic partnership, human resource, information analysis and waste elimination using a seven-point scale.

➢ Just in time

Respondents were requested to give their perception regarding the JIT within the steel manufacturing environment. According to results in Table 5.3, the overall mean for just in time (JIT) was 5.587 with a standard deviation of 0.972, which is close to the ‘agree’ point on the Likert Scale. This shows that the respondents indicated that JIT systems and practices were being implemented effectively in the steel manufacturing firms in Gauteng province.

➢ Total quality management

This measured whether TQM is applied as a lean practice in steel manufacturing affecting supply chain competitiveness. Table 5.3 shows that the respondents fairly agreed with an overall mean value of 5.769 and a standard deviation of 1.162. The results suggest that the respondents fairly agreed with the total quality management scale statements. This entails that TQM practices are well affected within the steel manufacturing industry in Gauteng province.
➢ **Strategic partnership**

Regarding strategic partnership as a tool for creating SCC, respondents were requested to give their views regarding the importance of SP in supply chain environment. According to Table 5.3, SP recorded a mean score of 5.329, the lowest of all the constructs and the standard deviation of 0.967, indicating they somewhat agreed about this lean practice and its importance.

➢ **Waste elimination**

Waste elimination was measured with five positive worded statements also using a seven-point Likert scale. The overall mean as shown Table 5.3 was 5.906, which is the highest and standard deviation of 0.937. The results suggest that the respondents agreed with the statements defined in this study and comprehended that waste elimination is minimised throughout the steel manufacturing industries in Gauteng.

➢ **Human resource**

This measured whether HR influences lean culture in the steel manufacturing affecting supply chain competitiveness. Table 5.3 shows that the respondents fairly agreed, with an overall mean value of 5.650 and Standard deviation of 0.897, which is the lowest. The results suggest that the respondents fairly agreed with the statements with a little degree of variation in responses.

➢ **Information analysis**

Respondents were requested to give their views regarding the application and use of informational analysis as a lean tool influencing SCC through lean culture within the steel manufacturing environment. According to results in Table 5.3, the overall mean for information analysis was 5.556 with a standard deviation of 0.968. This shows that respondents agreed with most of the statements on information analysis and shows that information is analysed within the steel industries in Gauteng.
5.3.1.2 Lean culture

The respondents agreed to all the statements measuring lean culture with the means ranging from 5.54 to 5.89, while the overall mean score was 5.655. The standard deviation recorded was 0.984, indicating that the respondents agreed to the statements. Thus, it illustrated that lean culture is observed within the steel manufacturing industries in Gauteng.

5.3.1.3 Supply chain competitiveness

Supply chain competitiveness was measured with eight positive worded statements also using a seven-point Likert scale. The overall mean as shown Table 5.3 was above 3, suggesting that respondents agree regarding the SCC in their organisations with the mean score of 5.887 and Std. Dev o 0.984.

The descriptive statistics of the constructs show that all the constructs had a mean above the mid-point 3, thus indicating that respondents agreed with the statements with little degree of variation in responses. The standard deviation often closely attached to the mean because it is a measure designed to resolve the average distance of interpretations from the measurement of the arithmetic mean interpretation. Therefore, there was a greater degree of variation in responses concerning TQM than with JIT, SP, WE, HR, IA, LC and SCC. This suggests that there was more agreement amongst respondents concerning JIT, SP, WE, HR, IA, LC and SCC compared to TQM.

5.3.2 Assessment of data normality

In measuring normality, Field (2013:172) points out that for a large sample size such as the one in this study, the central limit theorem stipulates that the assumption of normality has little effect on the analysis of data. Although the central theorem provides a studied theoretical background for the issue of normality in this study, the skewness and kurtosis of each construct and item are presented in the Table 5.5.

Table 5.5: Assessment of Data Normalcy

<table>
<thead>
<tr>
<th>Research Construct</th>
<th>Sample Size (n)</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Statistic</td>
<td>Std. Error</td>
</tr>
<tr>
<td>JIT</td>
<td>265</td>
<td>-1.052</td>
<td>.150</td>
</tr>
<tr>
<td>TQM</td>
<td>265</td>
<td>-1.120</td>
<td>.150</td>
</tr>
<tr>
<td>SP</td>
<td>265</td>
<td>-.849</td>
<td>.150</td>
</tr>
</tbody>
</table>
### Table 5.5: Research Constructs and Sample Size

<table>
<thead>
<tr>
<th>Research Construct</th>
<th>Sample Size (n)</th>
<th>Skewness Statistic</th>
<th>Skewness Std. Error</th>
<th>Kurtosis Statistic</th>
<th>Kurtosis Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>WE</td>
<td>265</td>
<td>-1.390</td>
<td>.150</td>
<td>2.088</td>
<td>.298</td>
</tr>
<tr>
<td>HR</td>
<td>265</td>
<td>-1.157</td>
<td>.150</td>
<td>2.226</td>
<td>.298</td>
</tr>
<tr>
<td>IS</td>
<td>265</td>
<td>-1.032</td>
<td>.150</td>
<td>.716</td>
<td>.298</td>
</tr>
<tr>
<td>LC</td>
<td>265</td>
<td>-1.089</td>
<td>.150</td>
<td>1.780</td>
<td>.298</td>
</tr>
<tr>
<td>SCC</td>
<td>265</td>
<td>-1.711</td>
<td>.150</td>
<td>4.470</td>
<td>.298</td>
</tr>
</tbody>
</table>

**JIT** = Just in time, **TQM** = Total quality management, **SP** = Strategic partnership, **WE** = Waste elimination, **HR** = Human resource, **IS** = Information sharing, **LC** = Lean culture and **SCC** = Supply chain competitiveness.

### Source: Own compilation (2021)

The value for skewness and kurtosis between -2 and +2 is considered acceptable to prove normal univariate distribution (Field 2013:172). Table 5.5 indicates that overall, the items of the scales have satisfactory skewness and kurtosis values. The Skewness values ranged from -0.848 to -1.711, while Kurtosis ranged from 0.658 to 4.470. It can therefore be said confidently that the assumption of normality is met. Chauke (2019:211) suggests that the data is non-normal if about 80% of the data presented skewness and kurtosis above the recommended threshold of -3 to +3. The data was distributed normal in this study and the conceptual model was not complex. This thus required the use regression model to test the proposed relationships.

### 5.4 CORRELATION ANALYSIS

In this study, Pearson correlations were applied in testing for the strength and direction of relationships between the research constructs. The results are presented in Table 5.6.

#### Table 5.6: Correlation analysis of the constructs

<table>
<thead>
<tr>
<th>Correlations</th>
<th>JIT</th>
<th>TQM</th>
<th>SP</th>
<th>WE</th>
<th>HR</th>
<th>IS</th>
<th>LC</th>
<th>SCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>JIT</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TQM</td>
<td>.639**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td>.537**</td>
<td>.639**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WE</td>
<td>.554**</td>
<td>.538**</td>
<td>.564**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HR</td>
<td>.430**</td>
<td>.388**</td>
<td>.442**</td>
<td>.479**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS</td>
<td>.451**</td>
<td>.659**</td>
<td>.552**</td>
<td>.593**</td>
<td>.433**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC</td>
<td>.513**</td>
<td>.614**</td>
<td>.561**</td>
<td>.591**</td>
<td>.413**</td>
<td>.752**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SCC</td>
<td>.451**</td>
<td>.446**</td>
<td>.491**</td>
<td>.540**</td>
<td>.420**</td>
<td>.585**</td>
<td>.712**</td>
<td>1</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
Source: Own compilation (2021)

Table 5.7 shows that the relationship between lean practices (JIT, TQM, SP, WE, HR, IS), lean culture and supply chain competitiveness is significantly positive.

- Correlations Between the Six Predictors and Lean Culture

There was a significant and strong positive correlation between JIT and LC (r=0.513; p=000). This result suggests that JIT and LC increase together, such that LC increases as JIT increases, and the reverse is also true. TQM and LC (r=0.614; p=000) results from respondents showed an increase together meaning there was a strong positive correlation from the data received from respondents. SP and LC had a strong and positive correlation (r=0.561; p=000), depicting significant correlation. Results from WE and LC (r=0.591; p=000) highlight the significance and strong positive relationship. A moderate relationship was depicted from HR and LC (r=0.413; p=000). The highest results received were between IS and LC (r=0.752; p=000) which showed a significant and strong positive relationship.

Overall, these results suggest that lean culture increases as each of the six (JIT, TQM, SP, WE, HR, IS) lean practices considered in this study improve within the steel industry. Consistently, several previous studies also reached the same conclusion. The first is a study by Danese, Romano and Boscari (2017:469), concluded among multi-plant companies, which shows that a lean culture was established as lean practices were implemented. Another study by Bortolotti and Boscari (2019:183), conducted in manufacturing industries, also shows that organisations that have implemented lean supply chain practices maintain a positive approach to business continuity and results.

In accordance with study objectives outlined in Chapter One, it was imperative to examine the correlations between lean practices (just in time, total quality management, strategic partnership, waste elimination, information analysis and human resources), lean culture and supply chain competitiveness. Therefore, it was necessary to employ correlation analysis among the mentioned constructs to determine the strength of the underlying relationship. The Pearson correlation coefficient (r) was used to measure the degree of linear association between the variables as proposed by Malhotra (2010:562).
Correlations Between the Lean Culture and SCC

Table 5.7 shows there was a positive and significant correlation between Lean culture and Supply chain competitiveness ($r=0.712$; $p=0.000$) by improving lean supply chain practices (JIT, TQM, SP, WE, HR, IS and LC), the supply chain competitiveness of the organisation could significantly and positively improved. In general, the data showed that there is a significant and positive correlation between independent variables of lean supply chain practices and supply chain competitiveness within the steel industry in Gauteng, South Africa. These results are consistent with a study by (Salah & Sayed 2015:3). Additionally, Losonci et al. (2017:4) also found that lean culture implementation has a positive correlation on supply chain competitiveness. Last but not least, a study by Antai (2011:85) indicates that lean practices and supply chain competitiveness have a significant positive relationship that yields a better competitive position with the market.

5.5 REGRESSION ANALYSIS

In the present study, regression analysis was used to assess if any predictive relationships existed among the independent and dependent variables.

Table 5.8 reports the regression analysis between lean practices and lean culture. The predictor that was held constant was lean practices (JIT, TQM, SP, WE, HR) (independent variable), the dependent variable that was entered into the prediction model was lean culture. On the examination of the relationship between lean practices and lean culture rating, the adjusted $R^2=0.483$, indicating that lean practices combined explained 48.3 percent of variance on lean culture.

Table 5.7: Regression analysis on lean practices and lean culture

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Adjusted R2</th>
<th>Beta (β)</th>
<th>t-value</th>
<th>p-level</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent: Lean Culture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predictors:</td>
<td>.483</td>
<td>.050</td>
<td>.089</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>(Constant):</td>
<td></td>
<td>.309</td>
<td>4.740</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>JIT</td>
<td></td>
<td>.147</td>
<td>2.360</td>
<td>.019</td>
<td></td>
</tr>
<tr>
<td>TQM</td>
<td></td>
<td>.279</td>
<td>4.677</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tol</td>
</tr>
<tr>
<td>WE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.511</td>
</tr>
</tbody>
</table>
### Constructs

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Adjusted R2</th>
<th>Beta (β)</th>
<th>t-value</th>
<th>p-level</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR</td>
<td>.073</td>
<td>1.383</td>
<td>.168</td>
<td>.549</td>
<td>1.822</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.708</td>
<td>1.412</td>
</tr>
</tbody>
</table>

R=0.702; R² = .493; F = 50.413; mean = 5.6541; Mean square =23.429; standard deviation=.66613 Eigenvalue = 5.927; n= 265; p<0.000

**Source:** Own compilation (2021)

### 5.5.1 Regression analysis: Five predictors of lean practices towards lean culture.

#### Just in time towards lean culture

In the regression analysis, JIT exerted no influence on lean culture and was statistically insignificant (β=0.050; t=0.089; p=0.419). The p-value for JIT is greater than the common alpha level of 0.05, which indicates that the impact of JIT does not influence lean culture. By implication, implementation of the JIT solutions within the steel industry is not linked to any in the establishment of a lean culture, nor does not predict its improvement. This result contradicts previous studies by Wyk and Naidoo (2016:237) in the electronics manufacturing industry that showed that adoption of JIT has an effect on the extent to which lean thinking and the minimisation of waste becomes entrenched within the organisation. Sharma, Dixit and Qadri (2015:1218) also established the importance of JIT within lean manufacturing processes. Furthermore Masudin and Kamara (2018:12) deduced that just in time (JIT) philosophy advocates the elimination of waste by simplifying lean production processes.

The atypical result above can be attributed to JIT being a predictor more reliable on inventory management and not on lean culture; however, it plays a vital role in supply chain competitiveness as a whole. As afore-mentioned, JIT should be executed carefully so that it doesn’t generate lost time due to unpredictable events within supply chain, hence the insignificant outcome.

#### Total quality management towards lean culture

TQM showed positive and significant results towards lean culture (β=0.309; t=4.740; p=0.000). This shows that respondents within the steel industry in Gauteng believed that TQM is a predictor for promoting lean culture. The empirical evidence from this research highlights that TQM is a
significant predictor of lean culture. This study is in alignment with a previous study by Sreedharan, Raju, Rajkanth and Nagaraj (2016:686) on lean six sigma awareness in the manufacturing industries. (Cherrafi et al. 2016:829) claimed that effective TQM requires lean system among people, machines, and information, stressing a system approach to quality.

TQM ensures that production equipment are well maintained and free of errors, and that all key stakeholders know how to promptly resolve any defects. Companies that implement TQM will have a positive influence on lean culture within the steel industry in Gauteng province as prescribed by the results.

❖ **Strategic partnership towards lean culture**

The study showed that strategic partnership has a positive relationship and significant impact towards lean culture. This provides a critical piece of empirical evidence for supply chain competitiveness ($\beta=0.147; t=2.360; p=0.019$). Janet, Wilbrodah, Mbithi and Douglas (2015:65) stated that strategic partnership and lean culture yields better understanding amongst key stakeholders among supermarkets in Kenya. Salimova (2013:26) Research University and its strategic partners: alliance of stakeholders, also got similar results showing the importance of strategic partnership being the cornerstone for the competitiveness of the department. To sum up, strategic partnership responding to supply chain competitiveness will have ositive results and guarantees significance, which is a reason this research study gathers and submits that strategic partnership and lean culture will positively serve as a channel with impact on of lean culture practices, hence the significant result of ($p=0.019$).

❖ **Waste elimination towards lean culture**

Waste elimination exerted a significant positive relationship and a significant impact towards lean culture. As depicted by the results ($\beta=0.279; t=4.677; p=0.000$). Crociataa, Agovino and Saaco (2015:40) support the afore mentioned results on waste recycling and elimination and behavioural culture. Demeter and Matyusz (2011:54) came to conclude that waste elimination plays a vital role for lean culture implementation in the manufacturing industry.

Waste elimination helps reduce overspending on acquiring inventory for any organisation and therefore utilises resources appropriately. The positive results between WE and LC suggest that
introduction of waste elimination processes within a lean culture will yield positive and significant results within the steel manufacturing industries in Gauteng province.

❖ **Human resource towards lean culture**

The human resource results showed an insignificant relationship towards lean culture (β=0.073; t=1.383; p=0.168). It is assumed from Bhaskar and Tilak (2013:92) that human resource plays a positive and significant role in the implementation of lean culture through employee engagement. Khan *et al.* (2013:178) got similar results confirming that employee engagement will have an influence on lean culture implementation; however, impact can be subjected to employee assumptions hence the results of this research highlight the same outcome. Employees are the most important resource of the four resources required to bring about success in any form of organisation. It can be concluded that employees who continuously learn and enhance their skills become the organisations key assets. The fact that human resource did not influence lean culture in this study implies that for better adaptation of lean culture, organisations within the steel industry in Gauteng need to investigate human resource and align them to lean culture.

Multicollinearity refers to a situation in which two or more of the independent variables are correlated, which leads to inaccurate predictions between the independent and dependent variables (Thompson, Kim, Aloe & Becker 2017:88). Tolerance values measure the significance of the relationship between one independent variable and another independent variable and should be: T>0.5. (O’Brien, 2017:673) VIF is a measure of the impact of collinearity amongst the variables under consideration in a regression model and should ideally be: VIF<10 (O’Brien, 2017:673). In the current study, tolerance and VIF values for all independent variables were within recommended limits and did not indicate any serious multicollinearity threat. In the first multiple regression analysis, JIT, TQM, SP, WE and HR were tested to determine if they were predictors of attitude towards lean culture. It was found that JIT (Tol = .511, VIF = 1.958), TQM (Tol = .460, VIF = 2.175), SP (Tol = .503, VIF = 1.990) and WE (Tol = .549 VIF = 1.822) were significant predictors of lean practices towards lean culture. However, HR (Tol = .708, VIF = 1.412) did not predict lean practices towards lean culture as per Table 5.9.
Table 5.8 reports the regression analysis between lean culture and supply chain competitiveness. The predictor and independent variable held constant was lean culture, and the dependent variable was supply chain competitiveness.

**Table 5.8: Regression analysis on lean culture and supply chain competitiveness**

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Adjusted R²</th>
<th>Beta (β)</th>
<th>t-value</th>
<th>p-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent: Supply Chain Competitiveness</td>
<td>.505</td>
<td>.712</td>
<td>16.343</td>
<td>0.000*</td>
</tr>
<tr>
<td>Predictors: (Constant): Lean Culture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R=.712; R² = .507; B = .739; F = 270.065; mean = 5.8877; Mean square =129.556; standard deviation=.70053; Eigenvalue = 1.986; n= 265; p<0.000

**Source:** Own compilation (2021)

The rating (adjusted) of the relationship between the constructs was R²=0.505, indicating that lean culture explained 50.5 percent of variance on supply chain competitiveness.

The beta coefficient of lean culture (β=0.712; t=10.108; p=0.000) suggests that there is a strong positive relationship between lean culture and supply chain competitiveness. In addition, the results suggest that for each 1-unit increase in the lean culture variable, the supply chain competitiveness variable will increase by 0.72 units. The independent variable was lean culture, whereas the dependent variable was supply chain competitiveness. Thus, steel manufacturing firms with lean culture are more likely to achieve supply chain competitiveness.

The results are in line with Vanichchinchai’s (2019:6) observations from manufacturing industries in Thailand that lean practices have a positive and direct influence on supply chain performance (which include competitiveness and customer satisfaction). According to Van der Merwe (2014:132), manufacturing industries that have successfully instilled a lean culture within the organisation and workforce will consistently realise supply chain competitiveness, more innovative, team-directed solutions, lower employee turnover and better success at sustaining improvements amongst others.

Supply chain practices can streamline processes and network with internal and external stakeholders through lean supply chain management which yields a competitive advantage as
depicted by the result of this research. Hence, if applied well within the steel industry in Gauteng, lean culture will have a positive and direct influence on supply chain competitiveness.

5.6 THE LINK BETWEEN THE RESULTS OF THE STUDY TO DEMING THEORY

This section discusses the linkage of the results of this study to the research theory, which is the Deming theory. The Deming theory was discussed in detail in Chapters Three. As mentioned previously in these chapters, the theory is believed to have emerged in 1968. It aims to assist organisations in adopting new ways of thinking about supply chain management practices. Techniques that emerged from this theory include TQM, continuous improvement and lean manufacturing (Deming 1986:23; Koskela, Tezel & Patel 2019:1381).

The results of this study confirmed the existence of a relationship between TQM and waste elimination ($\beta=0.309; t=4.740; p=0.000$) and ($\beta=0.279; t=4.677; p=0.000$). The results showed a strong and significant impact on the relationship, which can be associated with TQM being a management technique utilised most organisations that are continually improving their systems (Rungtusanatham & Schroeder 1994:473). According to Deming (1982:12), the manufacturing process is somehow linked to system developments and proper implementation.

This study also shows that strategic partnership highlights a relationship with lean culture, (Janet, Wilbrodah, Mbithi & Douglas 2015:65), ($\beta=0.147; t=2.360; p=0.019$). Although the relationship was confirmed, the relationship is weak and negative, and this can be attributed to the lack of proper SP structures in the steel industry organisations in Gauteng.

Employees are the most important asset in any organisation; without well-trained employees the success of an organisation becomes impossible. The study shows that there is a relationship between HR and supply chain competitiveness. According to Khan (2010:47), Deming created a framework to develop knowledge in the workplace and can be used to guide long term business plans and aims.

The results show that lean culture influences supply chain competitiveness and there is a significant impact. This is highlighted by Manzouri and Rahman (2013:34) that adoption of lean culture has a direct impact on a supply chain, which leads to manufacturing processes being effective and mitigating unnecessary processes within it. It is therefore evident that sound leadership and proper systems leads to a competitive supply chain.
5.7 RESULTS OF THE HYPOTHESES TESTING

The conceptual framework articulated in section 1.4 was tested to study the relationship strength between dependent and independent variables through regression analysis. The framework and hypotheses outcomes are reported in Figure 5.8 and Table 5.6, respectively.

![Conceptual Framework Diagram]

**FIGURE 5.8: CONCEPTUAL FRAMEWORK**

Figure 5.8 reveals how the relationship and significance of the independent variables on lean culture influence or positively impact supply chain competitiveness. The green colour indicates that all variables yielded positive results against the available theories.

Table 5.1 shows a rundown of the results from this research and states the decision relating to the hypotheses formulated for this study.
Table 5.1: Hypotheses decisions

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Relationship</th>
<th>Beta coefficient</th>
<th>t-value</th>
<th>p-value</th>
<th>Supported/not supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>JIT → LC</td>
<td>0.50</td>
<td>0.89</td>
<td>0.419</td>
<td>Supported</td>
</tr>
<tr>
<td>H2</td>
<td>TQM → LC</td>
<td>0.309</td>
<td>4.74</td>
<td>0.000*</td>
<td>Supported</td>
</tr>
<tr>
<td>H3</td>
<td>SP → LC</td>
<td>0.147</td>
<td>2.360</td>
<td>0.019</td>
<td>Supported</td>
</tr>
<tr>
<td>H4</td>
<td>WE → LC</td>
<td>0.279</td>
<td>4.677</td>
<td>0.000*</td>
<td>Supported</td>
</tr>
<tr>
<td>H5</td>
<td>HR → LC</td>
<td>0.073</td>
<td>1.383</td>
<td>0.168</td>
<td>Not supported</td>
</tr>
<tr>
<td>H6</td>
<td>LC → SCC</td>
<td>0.712</td>
<td>16.343</td>
<td>0.000*</td>
<td>Supported</td>
</tr>
</tbody>
</table>

JIT = Just in time, TQM = Total quality management, SP = Strategic partnership, WE = Waste elimination, HR = Human resource, IS = Information sharing, LC = Lean culture and SCC = Supply chain competitiveness.

Source: Own compilation (2021)

In the above table, H1 was supported since JIT Influenced LC. H2 was supported since there was a positive and significant relationship between TQM and LC. There was a positive relationship between SP and LC, and hence H3 was supported. H4 was positive and significant since the relationship between WE and LC, p-value being below 0.05. H5 was not accepted due to the lack of an influence of HR on LC. H6 was strongly supported with a Beta-value of 0.712, indicating a positive and significant relationship between LC and SCC.

The next section discusses internal consistency and validity test results for the measurement scales.

5.8 RELIABILITY AND VALIDITY OF MEASUREMENT SCALES

The concept of reliability and validity is of paramount importance when analysing constructs under investigation. For this purpose, the questionnaire items’ internal consistency or scale reliability coefficients were assessed based on the Cronbach’s alpha coefficient. Table 5.2 reports the reliability outcomes of each of the six constructs.
5.8.1 Scale Reliability

In this study, internal consistency reliability was tested using the Cronbach alpha coefficient. Guidelines for interpretation of the Cronbach alpha coefficient have been mentioned in Chapter Three (3.11.1). The results for the reliability tests for all measurement scales employed in this study are shown in Table 5.2.

Table 5.2: Scale reliability

<table>
<thead>
<tr>
<th>Construct</th>
<th>Question items</th>
<th>No. of items</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just in Time</td>
<td>• We have located our machines to support JIT production flow&lt;br&gt;• Our suppliers deliver to us on a just-in-time basis&lt;br&gt;• We receive daily shipments from most suppliers&lt;br&gt;• We can depend upon on-time delivery from our partners&lt;br&gt;• Our suppliers are linked with us by a pull system&lt;br&gt;• Continuous improvement programmes been implemented in the materials&lt;br&gt;• handling control function to improve JIT</td>
<td>7</td>
<td>0.881</td>
</tr>
<tr>
<td>Total Quality Management</td>
<td>• Our TQM supports continuous improvement and innovations&lt;br&gt;• Our TQM is reliable&lt;br&gt;• Our TQM is competent and flexible&lt;br&gt;• Our TQM is effective and competitive&lt;br&gt;• Our TQM focuses on quality data and reporting&lt;br&gt;• Our TQM oversee supplier quality management</td>
<td>6</td>
<td>0.969</td>
</tr>
<tr>
<td>Strategic partnership</td>
<td>• We consider quality as our number one criterion in selecting suppliers&lt;br&gt;• We maintain cooperative relationships with our suppliers&lt;br&gt;• We provide a fair return to our suppliers&lt;br&gt;• Our organisation shares proprietary information with its supply chain partners&lt;br&gt;• We include our key suppliers in our planning and goal-setting activities&lt;br&gt;• Our key suppliers provide input into our product development projects</td>
<td>6</td>
<td>0.884</td>
</tr>
<tr>
<td>Construct</td>
<td>Question items</td>
<td>No. of items</td>
<td>Cronbach’s alpha</td>
</tr>
<tr>
<td>--------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
</tbody>
</table>
| Waste Elimination       | • Waste reduction is focused on the functional areas within the company  
                           • This company analyses internal processes to minimise waste  
                           • Our supply chain partners are working together to eliminate waste  
                           • We understand end-to-end processes and work together to eliminate waste throughout the supply chain  
                           • We eliminate waste by avoiding over production | 5            | 0.930            |
| Human Resource          | • Our employees receive training to perform multiple tasks  
                           • Employees at this plant learn how to perform a variety of tasks  
                           • The longer an employee has been at this plant, the more tasks they learn to perform  
                           • Employees are cross trained at this plant, so that they can fill in for others, if necessary  
                           • At this plant, each employee only learns how to do one job  
                           • Resources are available for employee development | 6            | 0.928            |
| Information analysis    | • Our information analysis team is reliable.  
                           • Our information analysis team adds value to the manufacturing process  
                           • Our information analysis team is a vital input into our active management strategy  
                           • Our information analysis team provides oral and written information regularly  
                           • We act upon the recommendations of the information analysis team | 5            | 0.936            |
<table>
<thead>
<tr>
<th>Construct</th>
<th>Question items</th>
<th>No. of items</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
</table>
| Lean Culture                  | • Our organisation reduces process set-up time (time required to prepare or refit equipment/workstation for production).  
                               | • A problem is viewed as an opportunity to improve  
                               | • Our organisation produces only what is demanded by customers when needed (e.g., JIT).  
                               | • We are able to respond quickly to customers’ changing demands  
                               | • We consider the impact of decisions on the rest of the organisation | 5             | 0.928 |
| Supply chain Competitiveness  | • Manufacturing lead times are shorter  
                               | • Our deliveries are on time  
                               | • We have fewer or no shipping errors  
                               | • There is minimal customer complaint  
                               | • There is an improvement in order item fill rate  
                               | • We have a customer response time  
                               | • Sale forecast matches the demand  
                               | • We have improvement in inventory turns | 8             | 0.956 |

**Source:** Own compilation (2021)

As indicated in Table 5.10, Cronbach alpha coefficient values ranged from 0.691 to 0.956 for all the scales. The values are above the 0.70 benchmarks for acceptable internal consistency reliability (Field 2013).

**5.8.2 Validity**

As mentioned in Chapter 1.8 validity clarifies how well the collected data shelters the actual scope of the investigation. (Malhotra et al. 2017:361). In this study, three forms of validity were determined, that are:

1) Face validity/content validity.
2) Construct validity.
3) Predictive validity.
❖ **Face and Content validity**

Face validity indicates the researcher’s subjective assessments of the presentation and relevance of the measuring instrument as to whether the items in the instrument appear to be significant, rational, and clear-cut. Face and content validity of the instrument were assessed by the faculty research and ethics committee of Vaal University. In addition, a supply chain expert participated by evaluating the linguistic errors, survey timing and questionnaire format. After a preliminary test, a pilot study was carried out. The results of the pilot study are indicated. All scales attained average item correlations above the recommended threshold of 0.3; Cronbach alpha values above 0.7 minimum threshold recommended.

❖ **Construct validity**

Construct validity highlights how well the hypotheses translated from theory into a functioning and operational reality (Malhotra *et al.* 2017:362). Therefore, the construct validity resultstest of construct validity will give a better understanding of the quality measures used. As an indicator of construct and convergent validity, the significant loadings (0.321 to 0.973), strong communalities (0.535 to 0.948) and item-to-total correlations (0.818 to 0.966) inferred a large variance (above 40 percent) is captured by each of the measures applied in the survey.

❖ **Predictive validity**

The questionnaire is predictively valid if the test precisely predicts what is supposed to predict. (Malhotra *et al.* 2017:362). Table 5.8 on regression analysis between lean practices and lean culture shows predictors were constant, the adjusted $R^2=0.483$. Under correlations, the Pearson correlation coefficient ($r$) was used to measure the degree of linear association between the variables as proposed by Malhotra (2010:562). It is, therefore, evident that the data in the predicted what it was supposed to predict.

**5.9 Addressing Common Method Bias**

The following procedural or statistical methods were used to control method biases in this study:
Questionnaire items were sources from different sources

The measurement items in this study of the predictor and criterion variables were obtained from different sources. When measures of the predictor and criterion variables are obtained from different sources, researchers can reasonably infer that this serves as a procedural control for rater characteristics as a source of CBM (Jordan & Troth 2020:11). The measures that had demonstrated adequate psychometric properties such as reliability and appropriate factor structure were selected and used as one clear ‘gold standard’ way to help control for CMB (Spector et al. 2019:855).

Research purpose and instructions given to respondents

One of the easiest ways to increase the probability of response accuracy is to develop a good research information coversheet and set of instructions (Hair Jr, Wolfinbarger & Money 2015:36). Podsakoff et al. (2012:540) argue that the motivation to be more accurate increases if participants know how the information will be used or how it will benefit them or the organization (e.g., improve working conditions). In this study, respondents were informed that the data would be analysed as an aggregate as this encouraged potential respondents to participate and provide honest responses. In addition, respondents were promised feedback which also motivated greater accuracy. Similarly, the survey was kept short and minimised redundant measures and overlap, which helped participants to give more accurate responses (Vieluf et al. 2019:29).

Application of Harman’s single factor test

This is the most common statistical approach used to test for CMB (Chang, Witteloostuijn & Eden 2010:181; Jakobsen & Jensen 2015:5; Fuller et al. 2016:3192). The test indicates problematic CMB if an exploratory factor analysis (EFA) loads all items from each of the constructs onto a single factor, suggesting the factor accounts for a large amount of share variance among the variables due to the method (Podsakoff & Organ 1986; Podsakoff, Podsakoff & MacKenzie 2003:881). If not, the claim is that CMB is not a pervasive issue. In this study, EFA was ran by loading all the variables and examined the unrotated factor solution to determine the number of factors that account for the variance in the variables. All the factors loaded on its different dimensions of lean practices, proving that CMB was not problematic. Harman’s single factor test requires that all the variables (dependent and independent) being tested are placed in a factor
analysis. Emergence of a single factor (or large amount of variance that can be explained by one factor) is taken as evidence that common source bias is present (Podaskoff et al. 2003:889). Therefore, if a substantial amount of common method variance is present either (a) a single factor will emerge from the factor analysis or b) one general factor will account for much of the covariance among the measures (Antonakis 2017:6). If neither is the case, it is taken as evidence that common method bias is not a major issue (Chang et al. 2010:181), which this study demonstrated.

❖ Improve scale item clarity by avoiding double-barrel questions

Ambiguous scale items are difficult to understand and interpret (Yetton et al. 2011:4). Some causes of ambiguity include the use of unspecified terms such as ‘occasionally’ and ‘somewhat’, words with multiple meanings and multiple ideas linked together in an item. Unfortunately, these characteristics are too common in management research surveys. According to Podsakoff et al. (2012:541), this leads to respondent uncertainty about how to respond and increases the likelihood that their natural response tendency will influence them (e.g., extreme, acquiescent, mid-point scorers). In addressing the issue of scale item clarity, this study kept questions concise and simple to avoid double-meaning items.

❖ Balance positive and negative items or include reversed coded items

Reversing the wording of some of the items to balance the positively and negatively worded items helps if it does not mean altering the content validity or conceptual meaning of the scale or confusing the respondent (Hair Jr et al. 2015:36). Although there is a debate over the use of negatively worded items in scale construction (Chiew et al. 2019:110), using reverse coded items can break the patterns established by CMB and require participants to focus on the actual questions being asked (MacKenzie & Podsakoff 2012:543). However, this study avoided reverse wording or coding and placed emphasis on balancing both positive and negative statements to solicit enough information and to encourage respondents to read the questions, thus providing honest and accurate responses.
❖ Pre-testing the questionnaire

Lastly, a pre-test was conducted to improve and refine item wordings. The researcher conducted a pre-test of the questionnaire to identify and correct deficiencies and to ensure that the questionnaire communicated the information correctly and clearly to the respondents. Pre-testing was undertaken for clarity and appropriateness of the questionnaire (Williams & McGonagle 2016:339). It was tested using 10 supply chain practitioners who were not included in the final sample. The primary purpose of the pre-test was to establish the appropriateness of the Likert scale format and the reliability of the scales. Respondents were requested to comment, indicate any difficulty or any ambiguity that they encountered in reviewing the questionnaire. The comments or inputs received were mostly regarding wording of the questionnaire, which further validated that the findings addressed CMB. Some items were eliminated, modified and refined on the basis of the feedback received before commencement of the main survey.

5.10 CHAPTER SUMMARY

This chapter presents and discusses the results obtained from the statistical analysis of this study’s data. SPSS was used to analyse the collected date to achieve the study's aim. The objective of the study was to examine the influence of lean practices on lean culture and supply chain competitiveness. In order to achieve this aim, different statistical techniques were employed. Firstly, the chapter started by presenting the descriptive statistics, which comprised means, demographic profile and characteristics of respondents. Exploratory factor analysis was also performed to determine the dimensions/ factors affecting lean culture and SCC. The reliability and validity analysis were done to check the accuracy of the measuring instrument, while validity assessment was performed to check the construct, convergent and discriminant validity of the instrument and data set.

Several observations were made from the analysis conducted. Correlation analysis was performed to determine the association between different variables of the study. First, the measuring instrument demonstrates satisfactory reliability and validity measures after a few weak items were removed. In terms of internal consistency, all constructs have composite reliability values more than 0.7. All item loadings are greater than recommended 0.5 and 0.4 and are significant at the level of 0.001, demonstrating indicator reliability. The measurement model also demonstrated
satisfactory convergent and discriminant validity by having correlated variables with values greater than 0.2 except where justification was provided; all manifest variables loaded on their respective latent variable. Correlation analysis was performed to determine the association between different variables of the study. Regression analysis was performed to determine the relationships between lean practices, lean culture, and supply chain competitiveness.

The next chapter provides an overview of the study, conclusion, and recommendations for future avenues.
CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

The primary objective of this research was to investigate the relationships between lean supply chain management (LSCM) practices, lean culture and supply chain competitiveness in the steel industry in Gauteng province. The preceding chapter presented and discussed the results obtained from the data analyses. This concluding chapter commences by providing an overview of the study. Thereafter, the key findings and conclusions are presented, followed by recommendations on how supply chain competitiveness can be enhanced through the findings obtained on the lean supply chain management practices. It continues by highlighting the theoretical and practical contributions of the study. Limitations of the study and suggestions for future research areas are discussed before presenting final concluding remarks.

6.2 OVERVIEW AND THE OBJECTIVES OF THE STUDY

In order to draw the relevant recommendations and conclusion on this study, it is imperative to use the inputs obtained over the previous five chapters in the study.

Chapter One. The prime objective, is stated in Chapter One, revisited in section 6.2.1, followed by the theoretical objectives reviewed in section 6.2.2 and the empirical objectives in section 6.2.3. The aim of Chapter One was to lay out the orientation of the study by providing the background of the study, problem statement, research objectives formulation as well as the research design and methods. The proposed research model and hypotheses development were also presented under section 1.4. Statistical analysis techniques were presented as well as ethical principles adhered to in this study. The theoretical objectives formulated under Section 1.3 were used in structuring Chapter Two and Three respectively (literature review).

Chapter Two. An overview of the steel manufacturing industry globally was given, provided in section 2.2. The global steel manufacturing industry focused on the top 50 steel-producing countries and top 50 steel-producing companies. The aforementioned discussion was followed by an overview of the steel manufacturing industry in the South African context. The role of the steel manufacturing sector to the national economy (section 2.4.1), employment opportunities (2.4.2),
steel as a strategic industry (2.4.3), steel as an index of power (2.4.4), Steel as economic nerve trigger (2.4.5), and foreign exchange earner (2.4.6) were also presented. The characteristics of the steel manufacturing sector was provided (see section 2.5), followed by the manufacturers of steel companies in South Africa as well as the challenges faced by steel manufacturing companies (Section 2.6). The chapter concluded with a brief discussion on policy and legal framework on steel manufacturing within the South African setting.

Chapter Three provided a comprehensive literature review on Deming theory of total quality management, lean practices and supply chain competitiveness. It commenced by presenting the 14 principles of the Demining theory of TQM and its application in supply chain management (section 3.2). A detailed discussion on lean practices and lean culture was provided in section 3.3 and 3.4 respectively. The chapter further discussed supply chain competitiveness in section 3.5 and concluded with hypotheses development under section 3.6.

Chapter Four presented the research design and methodology followed in the study. It provided the research reasoning (section 4.2), research paradigm (section 4.3), research approach (section 4.4), time horizon (section 4.5), research design (4.6), literature review (4.7), empirical design (section 4.8), data collection (Section 4.9), data collection procedure (section 4.10), procedure for data analysis (section 4.10) as well as ethical consideration (section 4.12).

Chapter Five presents the empirical results from primary research. It provided the descriptive statistics in section 5.2, followed by exploratory factor analysis (section 5.3). The reliability and validity assessment findings were provided in section 5.4. It concluded by providing the findings of the correlation and regression analysis (see section 5.5 and 5.6) respectively.

The theoretical and empirical objectives are revisited in the next section in order to demonstrate the attainment of the objectives within the framework of the study.

6.2.1 Overview of the main objective

Even though there is adequate literature on supply chain management globally, including in South Africa, supply chains have to be competitive enough to handle pressures like varying customer’s expectations, low-cost high-quality products to be delivered at the minimum time and the most important is throat-cutting competition on a worldwide scale in todays market environment. As
with every manufacturer, understanding the various reasons why supply chain is competitive remains complex. While models and theories provide important explanations on how to enhance supply chain competitiveness, their facts are fragmented, lacking an integration of all LSCM determinants or models. For better comprehension, this study has integrated the diverse lean practices empirically found as drivers of lean culture and supply chain competitiveness into a conceptual model. Specifically, the main aim of this present study was to investigate the relationships between lean supply chain management (LSCM) practices, lean culture and supply chain competitiveness in the steel industry.

The next section details the conclusions based on theoretical objectives and reports on how they were achieved.

6.2.2 Conclusions based on the theoretical objectives
The theoretical objectives, as set out in Chapter One under section 1.4, are outlined and reviewed. For online businesses and researchers to make informed decisions and derive value from this study, all research objectives have to be addressed based on the data generated from the survey in order to ensure that the initial purposes of the study were achieved.

❖ Conclusions based on the literature review on the South African steel industry
This objective was achieved in Chapter Two from the literature review, which found that the steel industry serves as the backbone of industrialisation of our great country, South Africa when all the necessary parameters are put in place. It should also be noted that it contributes to all the facets of the economy, including its important role in economic development and growth. The steel manufacturing industry is one of the most important sectors contributing to the highest GDP growth in South Africa. The top five steel-consuming industries together contribute R600-billion to GDP (15% of the total) and employ more than eight million people. It is thus a vital part of economic growth for the country. The steel manufacturing industry is playing a significant role in the national economy and in the economies of other African states, including Egypt, Mozambique, Tanzania, Zambia, Kenya, Uganda, Namibia, the DRC, Ghana and Ethiopia and serves as a means of job creation for many South Africans. The role of this industry in the economy has been identified and documented. In every 1 000 tonnes produced locally, the steel sector adds R9.2
million to GDP, provides three jobs directly and indirectly enables domestic procurement to the value of R5.3 million, of which R500 000 is with small and medium enterprises, and contributes R130 000 in tax to the fiscus. Steel making represents 1.5% of GDP (1.1% directly, 0.4% indirectly) and accounts for 190 000 jobs in the primary and immediate downstream industries, with 100 000 more jobs through suppliers, such as those transporting raw materials and steel.

❖ **Conclusions based on literature review on the Deming theory**

This study used the Deming theory as a cornerstone to examine LSCM practices effecting lean culture and SCC. Deming is considered by many to be the father of the total quality management (TQM) movement. The theory is based on the simple concept that continual improvement can help increase quality while decreasing costs. Deming theory suggests that the manufacturing process is a series of related processes, and when viewed as an entire system, opportunities to improve efficiencies are more easily identified. Deming’s theory rests upon fourteen points of management identified as the system of profound knowledge as presented in Table 3.1 of Chapter Three. Deming created this framework to develop knowledge in the workplace and can be used to guide long term business plans and aim including supply chain competitiveness.

❖ **Conclusions based on the literature review on the LSCM practices and culture**

In order to achieve this aim, LSCM practices identified and investigated in this study were JIT, TQM, strategic partnership, human resources, waste elimination and information analysis. This objective was achieved in Chapter Three of the dissertation. Organisations pursuing lean implementation can be successful by focusing on culture. It was noticed that an understanding of the culture profile can lead to improvements in the current performance of the company. In addition, lean practices have been found to be the predictors of lean culture, which ultimately impact supply chain competitiveness. The lean culture of the organisation has a powerful effect on improving its performance and long-term effectiveness in such areas as waste elimination, strategic partnerships, just in time system, total quality management. Despite the limited impact of human resources on lean culture, other studies have found it to be a determinant of lean culture in different settings.
Conclusions based on supply chain competitiveness

This objective was achieved in Chapter Three under section 3.5, focusing on the definition, components, benefits, measurement and the models explaining the concept. It was found that SCC is possible with joint efforts of the manufacturer, suppliers, and distributors, and SCC comprises three components – “suppliers’ competitiveness”, “manufacturer competitiveness”, and “distributor competitiveness”. SCC can be achieved by efficient delivery, customer satisfaction, a better quality of products, profitability, better responsiveness, shorter lead times, demand fulfilment, optimal utilisation of facilities, to name a few. The enablers of supply chain competitiveness include coordination, supply chain collaboration, cost efficiency, quality management, and supply chain flow cycles efficiencies.

6.2.3 The achievement of empirical objectives

The empirical objectives, as set out in the first chapter are the following:

- to assess the level of implementation of LSCM practices in the steel industry in Gauteng province;
- to examine extent of the lean culture in the steel industry in Gauteng province;
- to determine the level of SCC in the steel industry in Gauteng province;
- to determine the influence of LSCM practices on the lean culture in the steel industry in Gauteng province; and
- to determine the influence of lean culture on supply chain competitiveness in the steel industry in Gauteng province.

These objectives were formulated into hypotheses as delineated in the conceptual model, and empirically tested. The results, which are in Chapter Five, are summarised in the next section.

The level of implementation of LSCM practices in the steel industry in Gauteng province

The lean principles included just in time, total quality management, strategic partnership, human resources, information analysis and waste elimination. Based on the descriptive findings, it could be noted that steel manufacturing firms are implementing these practices in their organisation. The overall mean score of the lean practices was 5.6564, which also recorded a standard deviation of
0.9680. The descriptive statistics of the LSCM show that all the practices had a mean above the mid-point 3(mean= 5.587, 5.769, 5.329, 5.906, 5.650 and 5.556), thus indicating that respondents agreed with the statements with little degree of variation in responses. This is evident in the responses that steel manufacturing firms are implementing the LSCM practices. Regarding standard deviation, there was a greater degree of variation in responses concerning TQM (St. D= 1.162) than with JIT (St. D=0.972), SP (St. D=0.967), WE (St. D=0.937), HR (St. D=0.897), and IA (St. D=0.968). This suggests that there was more agreement amongst respondents concerning JIT, SP, WE, HR and IA compared to TQM. This provides evidence of the high level of implementation of lean practices in steel manufacturing firms in Gauteng. These findings are in line with other studies on lean implementation in supply networks suggested that many companies are implementing lean practices to enhance their supply chain effectiveness, with the view that the transfer process of lean practices in multi-plant companies is critical.

❖ To examine the extent of the lean culture in the steel industry in Gauteng Province

This objective was achieved in Chapter Five by descriptive statistical findings. The respondents agreed to all the statements measuring lean culture with the means ranging from 5.54 to 5.89, with the standard deviation of 0.984, indicating that the respondents are in agreement with the extent to which lean culture is being practised in steel manufacturing firms. Several researchers suggest that creating a lean culture includes how to apply best practices to the organisation, further asserts that leadership is responsible for designing the whole system within which the work is done, and everyone is responsible for continuous improvement each day, within that system. It is not surprising to discover that many steel manufacturing firms are practising lean supply chain management, including lean culture.

Some researchers suggest that organisations have achieved remarkable results by “going lean”. They have done so by lowering costs, inventory, defects, lead times, increased efficiency, customer satisfaction, profit, market share and morale. These authors further state that lean is not easy to implement and even harder to sustain and 70%-98% of lean transformations fail. The culture of an organisation and its applied strategies, varies from one organisation to another, and the organisational lean culture plays an important role for successful implementation of lean concepts and in shaping the company to becoming an effective and competitive business.
To determine the level of SCC in the steel industry in Gauteng province

Supply chain competitiveness was measured with eight positive worded statements to determine its level in the steel manufacturing industry. The overall mean as shown Table 5.3 (see Chapter Five) was 5.887, suggesting that respondents are in agreement regarding the SCC in their organisations with Std. Dev of 0.984. The findings suggest that there is a high level of supply chain competitiveness in the steel manufacturing industry. Some researchers validate these findings by suggesting that supply chain is competitive in many industries because the executives are rethinking the current upstream supply chain model by identifying the competencies required for their current and future competitiveness and implementing a vertical integration of these competencies.

To determine the influence of LSCM practices on the lean culture in the steel industry in Gauteng province

In order to achieve this objective, different statistical analysis was conducted. Firstly, the EFA was performed to determine the lean supply chain practices affecting lean culture. All the items loaded on its six unique lean principles based on Kaiser’s eigenvalue rule (eigen values of 1.00) as well as the scree plot point of tailing off, suggesting that these lean principles were empirically tested and validated. The influence of LSCM practices on lean culture was determined by using a regression model. The predictor variable that was held constant was lean practices (HR, TQM, WE, JIT, SP) (independent variable). The dependent variable that was entered into the prediction model was lean culture. On the examination of the relationship between lean practices and lean culture rating, the adjusted $R^2= 0.483$, indicating that lean practices combined explained 48.3 percent of variance on lean culture.

JIT ($\beta = 0.5$), TQM, ($\beta =0.309$), SP ($\beta =0.309$), WE ($\beta =0.279$) all predicted lean culture. The study, therefore, concludes that their implementation within the steel industry has a positive effect on lean culture. However, HR ($\beta =0.073$) did not influence C, implying that human resource practices do not contribute to lean culture in the steel industry. The findings are validated in the literature by several researchers. For example, other researchers found that waste reduction/elimination influences lean culture in manufacturing firms in Cairo, Egypt. It was found that HR practices have an impact on supply chain management including lean culture in 195 manufacturing and service
sectors in Malaysia. Furthermore, total quality is a description of the culture, attitude and organisation of accompanying that strives to provide customers with products and services that satisfy their needs. The culture requires quality in all aspects of the company’s operations, with processes being done right for the first time to eradicate defects waste from operations. Therefore, it should be an organisational culture to practice total quality management.

In general, companies should use a variety of mechanisms in their search for possible partnership opportunities, such as existing contact networks (suppliers, research partners), specialised industry organisations, associations and conferences. The acquisitions of strategic partnerships influence the lean culture of the organisation, investigating the impact of Just in Time (JIT) on lean culture using two case studies from South African perspectives. These authors found that JIT contribute positively on the lean culture of the organisation.

Regarding information analysis, Alabi (2016:1) suggested that information and communication are the most profound, and influence changes that affect companies as well as the SCC. Conducting information analysis for an organisation should be a cultural activity associated with the company. Hence the impact of information analysis on lean culture is observed.

❖ To determine the influence of lean culture on supply chain competitiveness in the steel industry in Gauteng province

This objective was achieved by applying a regression modelling between lean culture and supply chain competitiveness. The predictor and independent variable held constant was lean culture, and the dependent variable was supply chain competitiveness, as depicted in Table 5.9 (see Chapter Five). The rating (the adjusted) of the relationship between the aforementioned constructs was R2=0.505, indicating that lean culture explained 50.5 percent of variance on supply chain competitiveness.

The beta coefficient of lean culture (β=0.717) suggested a strong positive relationship between lean culture and supply chain competitiveness. Thus, steel manufacturing firms with lean culture are more likely to achieve supply chain competitiveness. Organisations adopt lean operations principles either as a defensive strategy to stay competitive or as an offensive strategy to move ahead of competitors. Manufacturing industries that have successfully instilled a lean culture
within the organisation and workforce consistently realise supply chain competitiveness. Lean culture is linked to supply chain competitiveness.

6.3 RECOMMENDATIONS TO ENHANCE SUPPLY CHAIN COMPETITIVENESS

This study offers relevant insights to improve supply chain through lean culture by uncovering the LSCM practices influencing supply chain competitiveness. The recommendations proposed in this section are primarily addressed to policy makers, decision-makers and supply chain practitioners in the steel manufacturing sector.

6.3.1 Recommendations regarding lean supply chain management practices

The results of this study revealed that LSCM practices are key variables that shape the lean culture of steel manufacturing firms. Not only are just in time (reductions in setup times, controlling material flows, and emphasising preventive maintenance), total quality management, strategic partnership, human resource, waste elimination and information analysis central practices/factors in the mechanism explaining supply chain competitiveness but they have a strong impact on lean culture in the steel manufacturing firms.

6.3.2 Recommendations with regards to just in time

Considering the importance of just in time, it is essential for South African steel manufacturing firms to focus on global quality control with a continuous improvement mentality, that is, defects in products, in raw materials, in components or in services provided by suppliers or to customers would bring about a waste of resources at a high cost. Besides quality, the JIT principles prioritise customer satisfaction which can drastically condition the way in which products are manufactured, processed and distributed.

6.3.3 Recommendations regarding total quality management

With TQM, steel manufacturing firms need to practise continuous process of improvement for individuals, groups of people, and whole firms; and encompasses a set of four principles (delight the customer, management by fact, people-based management, and continuous improvement) and eight core concepts (customer satisfaction, internal customers are real, all work is process, measurement, teamwork, people make quality, continuous improvement cycle, and prevention).
6.3.4 Recommendations based on strategic partnership

This study shows that supply chain practitioners prefer that suppliers are part of the team when discussing solutions or improvement of the manufacturing process. This also improves quality as goods and services are designed on a fit for purpose basis.

6.3.5 Recommendations regarding waste elimination

Regarding waste elimination, waste affects every part of the manufacturing and weakens the supply chain and is damaging and expensive. While much attention has previously been paid to re-use, recycling, and waste management, steel manufacturers now need to promote the importance of waste elimination in improving supply chain competitiveness.

❖ Promote recycling waste programmes

It’s important to make recycling programmes clearly visible for the employees to adopt. For example, a three bins system where waste can be categorised by plastic waste, general waste like food and steel waste. This helps on waste segregation and minimises the time to sort the waste, and rebates can be for the waste collected.

❖ Promote waste re-use

Steel can be remelted and remanufactured into a completely new product, so where possible, this should be explored, and implemented as soon as the research is done which would mitigate risks.

6.3.6 Recommendations regarding human resource management

Considering the importance of human resource, it is essential for steel firms to provide training and career development to the employees to stay current and proactive. A reward system needs to be developed and managed, not only on output but should also consider employee engagement.

6.3.7 Recommendations regarding information analysis

In addition, information analysis separates active management from passive management and if properly applied, allows active supply chain managers to outperform their information fewer benchmarks. It is therefore recommended that efforts need to be devoted to information analysis in order to stay current and influence change in the organisation. All these principles are directly associated with lean culture and need to be sustained.
❖ Quality data capturing

Data is invalid when captured without due diligence, the cornerstone of the process. Team members that are capturing the information need to pay attention to details and skills so that careless errors are minimised at all costs.

6.3.8 Recommendations regarding lean culture

The findings point to the need to place emphasis on how to enhance SCC. According to the conceptual model developed in this study, this can be achieved through improving lean culture and paying attention to continuous training and development.

❖ Continuous improvement on diversity

Once employees are trained in more job functions, their scope of understanding broadens, and they are willing to do more. Culture is equally important to the business organisation since a system of values and beliefs governs every member.

❖ Recognise stewardship

Lean culture is one of the most prominent factors that could directly impact lean journey. The role of leadership cannot be ignored, as lean processes require a substantial leadership role from managers who fully understand the system and strive to gain benefit from it. Hence company executive and supply chain managers need to portray good leadership styles that would enable the business to adapt to lean manufacturing process, including supply chain competitiveness.

6.3.9 Recommendations regarding supply chain competitiveness

It can be noted from these study findings that supply chain competitiveness is influenced/enhanced by LSCM principles and lean culture therefore steel manufacturing firms must devote resources to lean practices such as JIT, TQM, SP, HR, WE, IA and develop a culture which would allow a lean culture to win within their organisations. Having looked at recommendations for enhancing supply chain competitiveness, the next section provides the concluding remarks of this study.

6.4 CONTRIBUTIONS OF THE STUDY TO THEORY AND PRACTICE

The theoretical and practical contributions are detailed in the subsections below.
6.4.1 Theoretical contributions

This study proposed and empirically tested a conceptual model that incorporated LSCM practice (just in time, total quality management, human resource, strategic partnership, waste elimination and information analysis) as antecedents of lean culture in the steel manufacturing industry. In addition, supply chain competitiveness was also incorporated as an outcome of lean culture. This model's uniqueness is its holistic stance that posits six LSCM practices which directly impact lean culture and ultimately supply chain competitiveness. Given that the model testing process provided evidence of high levels of reliability and validity and could explain up to 48.2% of lean culture and 50.5% of supply chain competitiveness, it can be used as a basis for future research in other emerging countries. Prior studies into lean practices have been fragmented and contradictory results have emerged from various cultures and countries. There was, therefore, a call to consolidate the various LSCM practices and determine their impact in different cultures such as South Africa. This study has revealed levers that can help reduce the supplier-demand gap in the steel manufacturing sector. The resultant conceptual model proposed in this study would improve the supply chain model related to the steel manufacturing industry, and researchers studying the supply chain for other industries could use the model.

6.4.2 Practical contributions

In an effort to respond to a concrete supply chain challenge, this study has made significant practical contributions, discussed in the details below.

Steel producers in South Africa, such as ArcelorMittal South Africa (AMSA), Scaw Metals Group, Cape Gate (Pty) Limited, Columbus Stainless, and South Africa Steelworks (SA Metal) and their extensive networks are putting much effort into promoting the distribution and consumption of their steel production in South Africa. However, their internal processes which include the supply chain is letting them down (Department of Trade and Industry 2020:3).

Knowing more about the factors enhancing lean culture and improving supply chain competitiveness would help these firms create the right strategies to strengthen, enhance, and manage their supply chains. This study not only provides this much-needed information but indicates the extent to which steel manufacturing's lean supply chain management practices affect
lean culture and supply chain competitiveness. This would guide the steel manufacturing firms to appropriately allocate their resources to improve their supply chain competitiveness.

This study would also be useful for businesses and decision-makers because it would provide insights into lean supply chain management grey areas and help improve their business performance in South Africa and Africa as a whole.

6.5 LIMITATIONS OF THE STUDY AND RECOMMENDATIONS FOR FUTURE RESEARCH

In assessing the findings of this study, it should be noted that the study is by no means without limitations, which offer avenues for future research. These are discussed below.

The first limitation is that the study was confined to only steel manufacturing companies in Gauteng province, specifically Southern Gauteng, where there is a market leader of steel producer in the country (Arcelor Mittal South Africa). Studies show that market leaders are more proactive in their business operations than their followers (Mukhtar 2015:1542; Merih 2016:6; Vanags, Ābeltiņa & Zvirgzdiņa 2018:337), and as a result, and they may have been practising lean manufacturing for a longer period. Whether the findings of this study might apply to less affluent provinces or geographical areas where there are small and emerging steel makers needs further study. Doing so would help increase the external validity of findings. Another limitation is related to the research methodology employed. A survey using self-administrated questionnaires was employed in this study. While self-reporting may rightly gauge the LSCM practices influencing lean culture, the report on these practices may need implicit studies or experimental methods.

The third limitation relates to the fact that the study was cross-sectional in nature. This means that the reported results relate to only a particular point in time. To some extent, applying a cross-sectional design implies that the study has focused on reported lean practices, lean culture and supply chain competitiveness instead of emphasising observed changes in these variables over time. Future research can apply a longitudinal survey and/or observation research focusing on uncovering LSCM practices affecting lean culture and SCC over a long period of time. For example, researchers can track the frequency of supply chain competitiveness should the firms improve their JIT, TQM, strategic partnership, waste elimination, human resources and information analysis. Furthermore, the proposed model incorporated some and not all of the lean
practices influencing lean culture and supply chain competitiveness. Future research could incorporate other factors that may influence the outcome variables. At the moment, the following recommendations are made to improve supply chain competitiveness.

6.6 CONCLUDING REMARKS

The purpose of this study was to investigate the relationships between lean supply chain management (LSCM) practices, lean culture and supply chain competitiveness in the steel industry in Gauteng province. It tested a conceptual model that incorporated LSCM practices (predictor variables) lean culture (mediator variable) to understand the factors influencing supply chain competitiveness (outcome variable). It made theoretical contributions by developing and testing the conceptual model and improving the understanding of steel manufacturing’s supply chain. Practical contributions exposed areas where decision/policymakers and businesses could improve their efforts in enhancing supply chain competitiveness in the steel manufacturing industry.

The study opens up avenues for future research to expand the findings obtained and deal with the limitations. While the factors driving lean culture can be useful in improving supply chain performance, corresponding efforts should be made to increase the ineffective supply chains in South Africa and other parts of the globe.
REFERENCES


MCKAY, K. 2014. How to create strategic partnerships that are a win-win. Available at: https://www.entrepreneur.com/article/234425


Dear Respondent,

You are requested to participate in an academic research study conducted by Mr. Sizwe Khoza, a master’s student from the Department of Logistics at Vaal University of Technology. The purpose of the study is to gather information on Lean practices and supply chain competitiveness in the steel industry in Gauteng, South Africa. You have been chosen to participate in the study based on your experience of working in the public sector. I therefore believe that you will provide relevant information.

Please note the following:

1. This study will provide an anonymous survey. Your name will not appear on the questionnaire and the answers you give will be treated as strictly confidential. You cannot be identified in person based on the answers you give.

2. Your participation in this study is very important to us. You may, however, choose not to participate and you may also stop participating at any time without any negative consequences.

3. Please answer the questions in the attached questionnaire as completely and honestly as possible. This should not take more than 10 minutes of your time.

4. The results of the study will be used for academic purposes only and may be published in an academic journal. We will provide you with a summary of our findings on request.

5. Please contact my supervisors, Prof Chengedzai Mafini, chengedzaim@vut.ac.za or Dr L. Okoumba welbyl@vut.ac.za if you have any questions or comments regarding the study.

You have an option of signing this letter to indicate that:
- You have read and understand the information provided above.
- You give your consent to participate in the study on a voluntary basis.

____________________  ____________
Respondent’s signature (Optional)        Date
APPENDIX B
SURVEY QUESTIONNAIRE

Thank you for participating in this important research endeavor. We are interested in assessing lean practices, lean culture, and its relationship with supply chain competitiveness in the steel manufacturing sector in Gauteng. There are various sections to this questionnaire. Please complete all sections of the questionnaire and answer the questions honestly.

SECTION A: DEMOGRAPHIC PROFILE

This section has questions that focus on your background information. Please indicate your answer by crossing (X) in the appropriate block or by filling in your answer.

<table>
<thead>
<tr>
<th>A1</th>
<th>Your gender</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>Your Age Group</td>
<td>25 years and below</td>
<td>26-33 years</td>
</tr>
<tr>
<td>A3</td>
<td>Race</td>
<td>Black-African</td>
<td>White</td>
</tr>
<tr>
<td>A4</td>
<td>Highest Qualification</td>
<td>Matri...</td>
<td>Certificate</td>
</tr>
<tr>
<td>A5</td>
<td>Employment period in organisation</td>
<td>Less than 1 year</td>
<td>1-2 years</td>
</tr>
<tr>
<td>A6</td>
<td>Experience as a supply chain management professional</td>
<td>Less than 1 year</td>
<td>1-2 years</td>
</tr>
</tbody>
</table>
SECTION B: LEAN SUPPLY CHAIN MANAGEMENT PRACTICES

We would like to find out a little more about your views regarding the implementation of lean supply chain management practices in the steel industry. Lean supply chain management practices consist of six factors under consideration, which are Just in time (JIT), total quality management (TQM), Strategic partnership, Waste elimination, Human resource, and information analysis. Please indicate the extent to which you agree or disagree by ticking the corresponding number between 1 (Strongly disagree) and 7(Strongly agree). A rating of (4) point represents a neutral view of the statement.

<table>
<thead>
<tr>
<th>LEAN SUPPLY CHAIN MANAGEMENT PRACTICES</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neutral</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>JIT1  We have located our machines to support JIT production flow</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>JIT2  Our suppliers deliver to us on a just-in-time basis</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>JIT3  We receive daily shipments from most suppliers</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>JIT4  We can depend upon on-time delivery from our partners</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>JIT5  Our suppliers are linked with us by a pull system</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>JIT6  Continuous improvement programmes been implemented in the materials handling control function to improve JIT</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

TOTAL QUALITY MANAGEMENT
<table>
<thead>
<tr>
<th>TQM1</th>
<th>Our TQM supports continuous improvement and innovations</th>
<th>1 2 1 2 3 4 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>TQM2</td>
<td>Our TQM is reliable</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>TQM3</td>
<td>Our TQM is competent and flexible</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>TQM4</td>
<td>Our TQM is effective and competitive</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>TQM5</td>
<td>Our TQM focuses on quality data and reporting</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>TQM6</td>
<td>Our TQM oversee supplier quality management</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

**STRATEGIC PARTNERSHIP**

<table>
<thead>
<tr>
<th>SP1</th>
<th>We consider quality as our number one criterion in selecting suppliers.</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP2</td>
<td>We maintain cooperative relationships with our suppliers</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>SP3</td>
<td>We provide a fair return to our suppliers</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>SP4</td>
<td>Our organisation shares proprietary information with its supply chain partners.</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>SP5</td>
<td>We include our key suppliers in our planning and goal-setting activities.</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>SP6</td>
<td>Our key suppliers provide input into our product development projects</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

**WASTE ELIMINATION**

<table>
<thead>
<tr>
<th>WE1</th>
<th>Waste reduction is focused on the functional areas within the company</th>
<th>1 2 3 4 5 6 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>WE2</td>
<td>This company analyses internal processes to minimise waste</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>WE3</td>
<td>Our supply chain partners are working together to eliminate waste</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>WE4</td>
<td>We understand end-to-end processes and work together to eliminate waste throughout the supply chain</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>WE5</td>
<td>We eliminate waste by avoiding over production</td>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

**HUMAN RESOURCE**

| HR1   | Our employees receive training to perform multiple tasks              | 1 2 3 4 5 6 7|
### HR2
Employees at this plant learn how to perform a variety of tasks

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

### HR3
The longer an employee has been at this plant, the more tasks they learn to perform

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

### HR4
Employees are cross trained at this plant, so that they can fill in for others, if necessary

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

### HR5
At this plant, each employee only learns how to do one job

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

### HR6
Resources are available for employee development

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |

### INFORMATION ANALYSIS

| IS1 | Our information analysis team is reliable. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| IS2 | Our information analysis team adds value to the manufacturing process | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| IS3 | Our information analysis team is a vital input into our active management strategy | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| IS4 | Our information analysis team provides oral and written information regularly | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| IS5 | We act upon the recommendations of the information analysis team | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

### SECTION C: LEAN CULTURE

We would like to find out a little more about your views regarding lean culture in the public sector. Please indicate the extent to which you agree or disagree by ticking the corresponding number between 1 (Strongly disagree) and 7 (Strongly agree). A rating of (4) point represents a neutral view of the statement.

### LEAN CULTURE

<table>
<thead>
<tr>
<th>LEAN CULTURE</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neutral</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC1</td>
<td>Our organisation reduces process set-up time (time required to prepare or refit equipment/workstation for production).</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>LC2</td>
<td>A problem is viewed as an opportunity to improve</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
Our organisation produces only what is demanded by customers when needed (e.g., JIT).

We are able to respond quickly to customers’ changing demands.

We consider the impact of decisions on the rest of the organisation.

We believe that reducing waste makes us more competitive.

SECTION D: SUPPLY CHAIN COMPETITIVENESS

We would like to find out a little more about your views regarding supply chain competitiveness. Please indicate the extent to which you agree or disagree by ticking the corresponding number between 1 (Strongly disagree) and 7 (Strongly agree). A rating of (4) point represents a neutral view of the statement.

<table>
<thead>
<tr>
<th>SUPPLY CHAIN COMPETITIVENESS</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neutral</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCC1 Manufacturing lead times are shorter</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCC2 Our deliveries are on time</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCC3 We have fewer or no shipping errors</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCC4 There is minimal customer complaint</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCC5 There is an improvement in order item fill rate</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCC6 We have a customer response time</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCC7 Sale forecast matches the demand</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCC8 We have improvement in inventory turns</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you for taking time to complete this questionnaire. Your views are much appreciated.
APPENDIX C

NRF SEARCH LETTER

To whom it may concern

This letter serves to inform that a thorough literature search has been performed for: Sizwe Khosa, Student no: 215264231. On the topic:

LEAN PRACTICES AND SUPPLY CHAIN COMPETITIVENESS IN THE STEEL INDUSTRY IN GAUTENG, SOUTH AFRICA.

The search has been carried out on 07 August 2019 by Ms. Rebecca Pani (Employed in the Gold Fields Library)

Per my knowledge, there is currently no indication of this research being carried out before.

Regards

Telephone: 016 950-6627
e-mail: rebeccaf@vut.ac.za
Fax to email: 086 614 1300
APPENDIX D

ETHICS CLEARANCE LETTER

Vaal University of Technology
Your world to a better future

30 April 2020

RESEARCHER: Mr S Khoza

PROJECT TITLE: Lean Practices and Supply Chain Competitiveness in the steel industry in Gauteng, South Africa

Ethics Reference Number: FRECMS-18032020-028
25264231

Decision: Approved

Dear Mr S Khoza

Thank you for submitting the above-mentioned project for ethical consideration. The application was detailed and provided useful information. You may commence with your data collection. This clearance is valid for three years from the date of this letter.

Please also note the following:

The Ethics Reference number, as stated above, should be used in all correspondence regarding this research project.

As the primary researcher you undertake to:

➢ Only follow the procedures for which approval has been given.
➢ Inform the Faculty Research Ethics Committee (FREC) of any significant deviations that may occur in the research project which directly influences what has been approved.
➢ Report any adverse events that might occur, within 14 days of the event, to the FREC. (Refer to the Ethical Guidelines as to what procedure you will need to follow in such an event).
➢ Submit annual progress reports to the FREC.
➢ Inform the FREC once the research project has reached completion and the findings have entered the public domain.

The FREC would like to take this opportunity to wish you well with your research project.

Kind Regards

Dr FE Mahomed

Faculty Research Ethics Committee Chair

Faculty of Management Sciences
APPENDIX E
DECLARATION BY LANGUAGE EDITOR

8 Belle Ombre Road
Tamboerskloof
Cape Town
8001.

18 February 2022

LANGUAGE EDITING

This is to certify that I language-edited the dissertation, “Lean practices and supply chain competitiveness in the steel industry in Gauteng, South Africa.” By Sizwe Khoza for the MTech Business degree in the Faculty of Management Sciences, Vaal University of Technology.

Elizabeth Trew
Trew.eliz@gmail.com
021 424 6135
073 235 1147
# APPENDIX F
## TURNITIN REPORT

<table>
<thead>
<tr>
<th>SLZWE KHOZA MTECH TURNITIN</th>
<th>ORIGINALLITY REPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>12%</td>
<td>14%</td>
</tr>
<tr>
<td>SIMILARITY INDEX</td>
<td>INTERNET SOURCES</td>
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</table>

### PRIMARY SOURCES

<table>
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<th>Source</th>
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<th>Percentage</th>
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</thead>
<tbody>
<tr>
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<td>repository.nwu.ac.za</td>
<td>Internet Source</td>
<td>8%</td>
</tr>
<tr>
<td>2</td>
<td>Submitted to Mancosa</td>
<td>Student Paper</td>
<td>4%</td>
</tr>
</tbody>
</table>

Exclude quotes: Off
Exclude bibliography: Off
Exclude matches: 0.3%