SCHOOL OF MECHANICAL, INDUSTRIAL & AERONAUTICAL ENGINEERING

THE CURRENT UNDERSTANDING OF LEAN WAREHOUSING PRINCIPLES IN A THIRD PARTY LOGISTICS PROVIDER IN SOUTH AFRICA

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Abstract

A single case study of a major third party logistics provider (3PL) in South Africa was completed for this research. A total of four warehouses, including 43 workers partook in the study.

The primary objective of this research was to determine how well employees within the warehousing industry understand Lean principles, and to illustrate the gap in Lean knowledge between the employment levels, i.e. Managers, Supervisors and Material Handlers. Group-administered questionnaires were used as the principle means of gathering data.

All participants for each respective warehouse were present in a “classroom” format during completion of the questionnaires. The author was also present during all sessions to ensure consistency and to clarify any questions that participants had.

The questionnaire tested each participant’s understanding with regards to seven key Lean principles in warehousing. These seven principles were identified from previous research on Lean within warehousing. The results gathered from the questionnaires were then validated using semi-structured follow-up interviews.

It was found that a real gap in Lean knowledge exists between Managers and Material Handlers (shop-floor workers). Managers understand the key Lean principles within warehousing, as well as the importance thereof. While the employees actually working on the floor do not. The main reasons for this are due to a lack of suitable training and knowledge sharing.

Based on the seven key Lean warehousing principles, the following were identified in the study as the most important ones to focus on: Continuous Improvement and Visual Management. These are believed to be basics in warehousing. However, employees still seem to struggle with the true understanding and significance thereof.

It is imperative that the understanding of Lean principles and the involvement of management exist when striving to be successful with Lean. The gaps in Lean knowledge have been identified and laid out in this report. The reasons for each gap have also been investigated and discussed in detail.

Finally, pertinent areas have been highlighted to assist with the development of Lean training material. This will ensure that the current gap of Lean understanding among warehousing employees is closed.

Acknowledgements

I would firstly like to thank my wife Reine, for her endless support and motivation during my persistent journey. I would also like to thank Teresa Hattingh, my supervisor for her dedication and guidance throughout this research. Lastly, I'd like to thank all participants who committed their time to this research, without you this would not have been possible.

"*Ek is tot alles in staat deur Christus wat my krag gee"* (Fil. 4:13).

Declaration

I declare that this research is my own unassisted work. It is being submitted as due requirement to the University of the Witwatersrand, Johannesburg, in partial fulfilment for the degree of Master of Science in Engineering (Industrial) (50/50).

Alexander D. Swart

This the 12th day of October 2015

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1. INTRODUCTION

1.1 Purpose of the study

The use of Lean in warehousing has been lagging compared to the supply chain and manufacturing industries. This has evidently created a gap of knowledge for Lean warehousing (Bozer, 2012).

As stated by Garcia (2003), “The successful application of Lean techniques (in warehousing) would lead to reduced lead-time (the unnecessary time part of the order-to-delivery processes), order picking time, and the time for material handling. This can be achieved through reduction of the non-value adding activities, and improvement of velocity and flow in the warehouse.” To reaffirm, Phogat (2013) agrees that Lean in warehousing further leads to waste elimination and creating more value to the customer.

Therefore, the purpose of this research report is to determine what warehousing personnel in the third party logistics industry’s’ understanding is with regards to key Lean principles. This will evidently illustrate the gap between the various employment levels within warehousing.

One third party logistics providers’ employees will be used as a case study. All positions, from shop-floor employees (Material Handlers) to Warehouse / Branch Managers, will partake in the investigation.

Various other areas of the operation are also improved, including customer relations, maintenance, quality and ultimately cost reduction by focusing on continuous improvement (Lean Techniques for Warehousing, 2014). Evidence of Lean implementation indicates that significant qualitative and quantitative influence connected to quality, cost, time and customer satisfaction is realised (Radnor, 2012).

The use of Lean tools and techniques in warehousing can be highly beneficial (Bozer, 2012). Consequently, by classifying the understanding of Lean of the aforementioned employees, the author wishes to provide recommendations on Lean principles within warehousing. The research can then be used to identify the gaps in current Lean understanding.

These gaps can then be filled by identifying and developing Lean training material for all warehouse employees.

1.2 Background

1.2.1 Warehousing Overview

Warehousing is seen as the point in a logistics system where a business holds and stores its goods. This includes a very broad range of facilities and locations that offer warehousing for various functions, including but not limited to, the storage of raw material, finished goods as well as industrial goods while in transit. It further includes more specialised warehousing facilities such as refrigeration facilities, pharmaceutical facilities, potato cellars and tobacco warehouses to name a few.

Langley et al (2008) state that firms have had a very negative view on warehouses, and believed it obstructed the flow of goods through the system (supply chain). It was also believed that it only added cost to a product, without adding any form of value (Langley et al, 2008). According to Bowersox et al (2013), the value of tactical storage facilities was not well understood. Warehouses were seen as necessary evils, which only added costs to the distribution process. Needless to say, supply chain managers sought to avoid warehousing as far as possible.

Bowersox et al (2013) explains that during the inception of warehouses in the supply chain, inventory turnover, handling efficiency, and labour productivity were not major concerns. Since labour was quite inexpensive, resources were used as and when needed. This also meant that inadequate attention was given to resources efficiency, work methods or handling, and space optimisation and utilisation.

Bowersox et al (2013) argue that the view on warehousing in today's business is changing. This is due to the awareness that warehousing can provide more value to a product than costs. Warehousing functionality is now seen as mixing and modifying a product in order to meet customer requirements (Bowersox et al, 2013).

Warehouses were used as long-term storage facilities with up to ninety days' worth of supply (Langley et al, 2008). Although this is still true today, the emphasis on warehousing has moved from simple passive storage of goods, to strategic inventory assortment. Strategic warehousing enables you to reduce stock holding and lead

times. Many warehouses adopted the just-in-time principle to reduce work-in-process inventory (Bowersox et al, 2013). This further aided companies to store inventory at a centrally located facility, thus decreasing the need for inventory at every other warehouse or assembly plant. At this strategic and centrally located warehouse, products can be sorted, sequenced, batched and consolidated and shipped out when required (Bowersox et al, 2013).

Another key function that warehousing performs is the fact that it creates timely service for raw material and finished goods. The proximity of a strategically located warehouse allows companies to meet customer demand with shorter lead times. More importantly, the proper use of warehousing makes products available when and where a customer demands it. The function of warehousing continues to be of great importance, as customer service is seen as a dynamic, value-adding competitive advantage (Langley et al, 2008).

Bowersox et al (2013), state that the benefits of strategic warehousing are classified into mainly two areas; economic and service. The use of a warehouse in any logistical system should be justified by a combination of cost and customer service. The ideal condition is one where the warehouse provides both an economic and customer service benefit.

1.2.2 Warehousing and Lean

According to Womack and Jones (2003), Lean enables a company to do more with less and less – less equipment, less time, less human effort and less space – while coming ever closer to giving the customer exactly what they want. The above is achieved by simultaneously eliminating waste in the system.

As stated by Bowersox et al (2013) in the section above, the benefits of warehousing are mainly classified into economic and service benefits. Womack and Jones (2003) confirm above that this is achievable with Lean. There are also several areas within a warehouse where Lean concepts can be of great value. Lean can help a company identify the value-adding activities within a warehouse, as well as eliminate non-value adding processes. Lean provides the warehousing operation with a competitive edge by ensuring the following (Art of Lean, Inc.):

- On-time delivery and low cost service to its customers through improved efficiency and productivity, together with high quality and accuracy in preparing orders.
- Improved stock integrity and better control over services by preventing picking disruptions, lack of material availability and loss of sales opportunities.
- Accurate levels of information flow and traceability between the warehouse and other legs of the supply chain.
- Management of the ever changing customer requirements and market complexities by adapting to demand changes and remaining flexible to meet seasonal and new customer demands.

Numerous Lean principles and methodologies can be used in the warehousing industry. These include, but are not limited to continuous improvement (or Kaizen), A3's, value stream mapping, visual management systems, balanced workloads (or Heijunka), standardised work, seven wastes, just-in-time (JIT) strategies, kanban systems and 5S methodology. The above will be discussed in greater detail in the subsequent sections.

1.3 Research Motivation

Lean has been very successful in many industries, mainly in manufacturing and health care (Bicheno & Holweg, 2009; Bozer, 2012). The success of Lean implementation and Lean assessment tools in warehousing have also been largely researched and documented (Sobanski, 2009; Bozer, 2012).

However, there seems to be a lack of widely available research regarding the understanding of Lean principles and methods within the warehousing industry. Research shows that increasing emphasis is placed on efficient warehousing operations, and that warehousing plays an integral part in the supply chain (Bozer, 2012).

Bozer (2012) states that: “There is no doubt that Lean warehousing is gaining momentum both in terms of academic research and industrial applications. And that available resources and information on Lean warehousing is limited compared to well-established areas such as Lean manufacturing and emerging areas such as Lean healthcare.”

Sobanski (2009) agrees that there has been limited academic research on Lean warehousing. At the time of this research in 2014, no additional published research was found on the topic of Lean warehousing. There was also no research on the understanding of Lean principles, thus illustrating the significance of this research.

Companies have recognised that in order to remain competitive, initiatives such as Lean can be extremely useful. Numerous articles published by prominent companies stating that a 3PL (Menlo Worldwide), made significant improvement in their warehouses using Lean tools and techniques (Bozer, 2012). Lean in warehousing leads to substantial improvement, better lead-times and enhanced customer value (Phogat, 2013).

It is thus evident from the research that Lean has a positive impact on warehousing operations (Garcia, 2003; Bozer, 2012; Phogat, 2013). The current understanding of Lean principles by employees however, needs to be investigated further.

Bicheno and Holweg (2009) state that “real” Lean is behaviour-driven and it’s what employees do daily without being told, that is considered Lean. In order to achieve Lean warehousing, one requires a certain mind set, where a can-do attitude is the starting point (Lean Thinking in the Warehouse, 2014). It is therefore imperative to determine what employees understand under Lean warehousing principles, in order to change their behaviour.

Due to the success of Lean in the manufacturing and health care industries, and the lack of Lean knowledge in the warehousing industry, it has been decided to focus this research on the subject of Lean. This research will look at employees’ understanding of Lean principles within warehousing, as well as the gap in Lean knowledge between the various employment levels.

By defining the understanding of these specified principles, training and development material for Lean can be established and used for improving warehousing operations.

1.4 Research Objectives

The main objective of this research is to determine how well employees within the warehousing industry understand Lean principles and methods, and to illustrate the gap in Lean knowledge and understanding between the employment levels. The identified employees' understanding will be tested (using group-administered questionnaires) with regards to certain key Lean principles within warehousing (as acknowledged in the literature review). A case study on one of South Africa's top third party logistics providers (3PL) has been used.

The results will be used to help identify 1) the understanding of Lean principles for the various levels of the workforce, 2) which specific Lean principle(s) employees need development on and 3) why there is a lack of understanding of these specific Lean principle(s). These outcomes can then be used to develop training material on Lean (the development of the training material is out of scope for this research).This will enable warehouse operations to cultivate their employees' understanding of Lean principles, ultimately leading to an optimised warehousing facility (Garcia, 2003).

The following list captures the main objectives that this research aims to achieve:

- determine the key Lean principles and methods within warehousing, based on previous research.
- determine how well the identified Lean warehousing principles and methods are understood by shop-floor workers (Material Handlers, Admin Clerks, Pickers and General Workers).
- determine how well the identified Lean warehousing principles and methods are understood by warehouse management (Managers, Supervisors and Team Leaders).
- identify which specific Lean principles and methods are well understood, understood, partially understood and unknown or misunderstood to illustrate the gap of knowledge between the employment levels.
- investigate if and why there is a gap of understanding between the employment levels.

1.5 Research Question and Problem Statement

Although many Lean tools and techniques exist in the warehousing industry, the subject of Lean warehousing remains mostly unknown. Research on Lean implementation and assessment in warehousing has been investigated and documented (in Sobanski, 2009), but the understanding of Lean principles and the gap in Lean knowledge remain unexplored.

To this end, the fundamental research problem of this report can be summarised in the question below:

What is the current gap of understanding of a 3PL's warehouse employees on key Lean principles in warehousing?

1.6 Research Limitations

This research report was limited to the study of one third party logistics provider (3PL), with data gathered from four of its warehouses. The main reasons are financial and time constraints, a lack of access to other 3PLs and the author's employment by the 3PL on which this research is based. The scope of this research is limited to testing Lean knowledge of employees, and not actual Leanness of a warehouse or relationship between the two.

2. Literature Review

2.1 A Brief History of Lean

2.1.1 The Inception of Lean

According to Drucker (1989), one of the first people to work with concepts of scientific management was industrial engineer Frederic Taylor. At the heart of Taylor's concepts was the organised study of work. This is where the work is broken down into its simplest form, and analysed to improve a workers performance. Taylor argued against the waste of human effort.

From these concepts, two related fields of study were developed, namely work measurement and method study. Work measurement determines the amount of time it takes to complete a certain task, while method study is concerned with the methods and activities that constitute a specific task (Slack and Johnston, 2001).

Henry Ford used these concepts to construct the first complete manufacturing strategy. Ford moved away from traditional manufacturing strategies like batch and queue systems. Instead of combining specific tasks and grouping them together, Ford focussed on the flow of activities. The first assembly line was introduced by Ford in 1913 (Lean Enterprise Institute, 2009). According to Wickens (1995), the introduction of the assembly line enabled Ford to decrease the unit price of a vehicle from around $850 to $350. This aided Ford to capture two thirds market share and dominate the automobile industry.

According to Womack *et al.* (1990), the Toyota Production System was the beginning of Lean manufacturing principles and methods. The essence of Lean manufacturing principles is identifying and eliminating non-value adding activities in the system. This is true for both manufacturing and service industries. Lean is about creating value for the customer at the right place, the right time and at the right price.

2.1.2 Evolution of Lean - The Toyota Production System

In the early 1930's, Kiichiro Toyoda and Taiichi Ohno from Toyota revisited Henry Ford's original concepts and thinking. They furthered his thinking with a series of innovations to provide a continuous process flow while simultaneously offering a wide variety of products. The main focus was to shift from a single person and machine, to the flow of a specific product through the entire process. This was the start of the Toyota Production System (TPS) (Lean Enterprise Institute, 2009).
With the help of the TPS, Toyota was able to introduce error proofing machines to ensure enhanced quality, align the machines in sequence of the process, configure each machine to have quick setup times for producing small volumes, and introducing Kanban systems in between each step to notify its need for more material. All of these innovative changes make it possible to produce high variety, high quality and low cost service to respond to the ever changing customer needs. Information management is also simplified by this thought of thinking (Lean Enterprise Institute, 2009).

According to the Art of Lean, Inc., the oldest part of the Toyota Production System is the Jidoka concept, as created by Sakichi Toyoda in 1902. The concept of Jidoka can be described as built in quality at every step of the process, along with the separation of man and machine. This can enable a single person to work on multiple machines at once. It also stops the process when a defect is detected, thus eliminating the production of defective products.

The Art of Lean, Inc. states that the most famous element of the TPS is the just-in-time concept. Toyota started this concept in order to drastically reduce the waste of money on excess materials and equipment. In the 1950's, other elements such as standardised work, takt time, kanban and supermarkets were added to the concept of JIT.

The Japanese word *muda,* or waste is also a focus point in Lean. Lean is a set of management principles that strives to reduce the waste in a system. Womack *et al.* (1990) further states that Lean involves diverse techniques to develop a process using less tools, material and human resource.

The Art of Lean, Inc. states that the goal of the TPS is to meet customer expectations by providing world class quality products or services. Historically, the TPS has had four basic goals, they are:

1. Provide world class quality and service to the customer.
2. Develop employees' potential based on trust, respect and teamwork.
3. Reduce cost by eliminating waste.
4. Develop flexible production standards based on market demand.

A graphic representation of the Toyota Production System house is seen below:

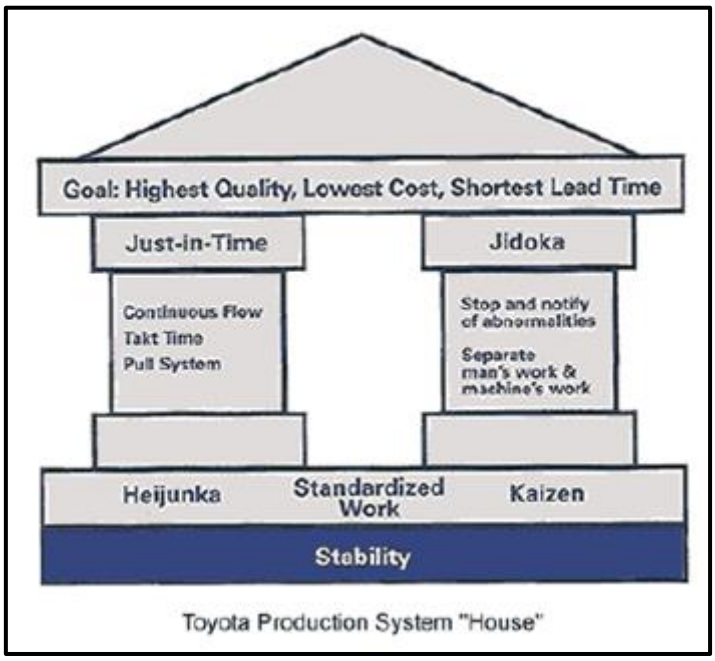

Figure 1: Toyota Production System "House" (Art of Lean, Inc., 2014)

The roof signifies the goal that the "House of Lean" strives to achieve; that is eliminating waste while providing high quality products and/or services to customers. Customer satisfaction is at the heart of the Lean. According to Bicheno and Holweg (2009), Taiichi Ohno stated that all they are trying to do is reduce the time from order placement to cash.

In the middle of the "house" is the culture of continuous improvement, involving all the employees of an organisation. There are also two primary pillars of the "house" –

namely Just-In-Time (JIT) and Jidoka (build in quality). The concept of JIT strives to deliver the right part, in the correct quantity and at the right time using minimal resources. JIT reduces inventory and aims to prevent under and over production (Art of Lean, Inc.).

The second pillar, Jidoka can be seen in two parts; 1) Build in quality in the process and 2) Separation of man and machine in the work environment. In essence, Jidoka is a built in intelligence that enables the system to stop automatically when it detects an abnormality or error (also known as poka-yoke). This helps limit the amount of defects that ends up downstream, it minimises machine damage, prevents injuries and enables you to identify a problem quicker. With the ability of machines to stop automatically when an abnormality is detected, it allows man and machine to be separated. This frees up resources to add further value elsewhere (Art of Lean, Inc.).

According to Art of Lean, Inc., standardisation is the foundation of the “House of Lean”. Standardisation is critical for the correct functioning of JIT and Jidoka. Through standardisation, the variation in a process is limited and efficient production or service can be achieved. There are several procedures and documents that are critical to the success of standardisation. They include, but are not limited to; 5S for work areas, team training, standardised work charts, standard operating procedures (SOP’s), work instructions and visual control sheets.

2.2 Lean Philosophy

In their book The Lean Toolbox, Bicheno and Holweg (2009) states that Lean is not just about waste reduction or prevention, it is about always putting the customer first. And by doing so, waste is automatically removed. They further state that “real” Lean is behaviour-driven. It is what employees do daily without being told, that is considered Lean.

The most important behaviour according to Bicheno and Holweg (2009) is the constant reinforcing of the correct tools and principles, by all levels of an organisation. Self-demonstration and daily coaching is the best (only) way for staff to learn these tools and principles.

Bicheno and Holweg (2009) further state that Lean is about doing more with less. This definition is similar to that of productivity, i.e. (outputs / inputs), but is seen as a broader interpretation where you do good with less resources, materials and energy to ultimately achieve a sustainable business.

In contradiction with Lean philosophy of always putting the customer first, is the non-Lean systems such as economic order quantities (EOQ), mass production, push systems, reduced variety and long lead times which are designed with the producer in mind, not the customer (Bicheno and Holweg, 2009).

Taiichi Ohno has the following four points to help understand Lean (Bicheno and Holweg, 2009):

1. Mentally force yourself into tight spots.
2. Systematically observe the current reality.
3. Create simple and low cost solutions.
4. Embrace the pleasure of Kaizen accomplishment.

The complete Lean philosophy can be summarised in Womack and Jones’ five Lean principles, as discussed in the following section.

2.2.1 The Five Lean Principles

Womack and Jones (2003) explain the five Lean principles as set out in their book, Lean Thinking. Womack and Jones (2003) pinned their focus on Lean enterprise, rather than Lean manufacturing.

In essence, the five principles place emphasis on the system, making it relevant to both the manufacturing and service industries. However, several managers believe that Lean is only applicable in the manufacturing industry, missing the point that the main focus is on vision.

The five Lean principles as discussed by Womack and Jones (2003) are listed below:

1. **Principle 1:** Specify value from the point of view of the customer – Identify what is important to the customer and their perspective on value, and not that of the supplier or manufacturer. Know your customer.

2. **Principle 2:** The value stream – Identify the sequence of processes all the way from raw material to the final customer. Map the entire value stream (the whole supply chain) to identify non - value adding waste.

3. **Principle 3:** Flow – Create processes that make value flow. Minimise the delays of value added activities and eliminate non - value adding activities.

4. **Principle 4:** Pull – Only respond to the customer's rate of demand.

5. **Principle 5**: Perfection – Delivering exactly what the customer wants, at a reasonable price, in the correct quantity and at the right time, with minimum waste.

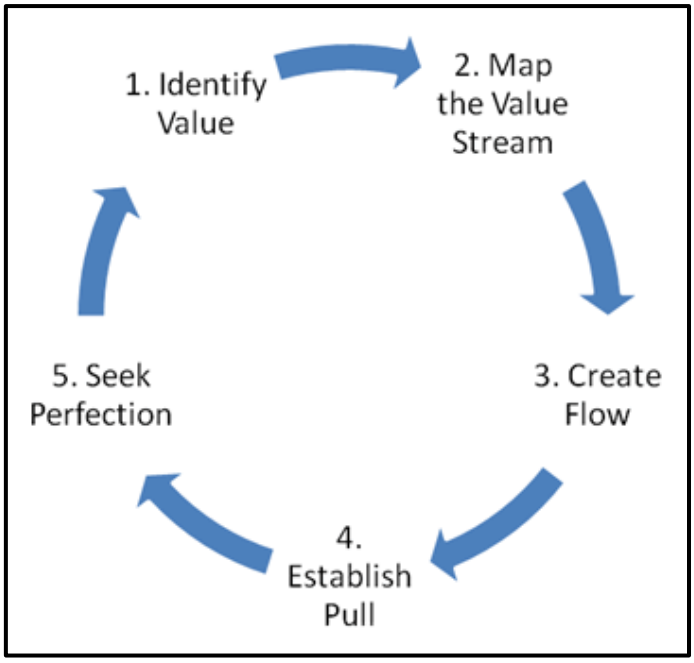

Figure 2: Five Principles of Lean (Lean Enterprise Institute, 2014)

The five principles are not a once off exercise, but rather a journey of continual improvement to get the desired perfect state.

These five principles will be discussed in greater detail below. The aptness of each principle with regards to evaluating the understanding of Lean principles and concepts in the warehousing industry will also be discussed.

Principle 1: Value

The first principle as specified by Womack and Jones (2003) is value. Consistent with Bicheno and Holweg (2009), Porter says that, “In competitive terms, value is the amount buyers are willing to pay for what a firm provides them. Value is measured by revenue, a reflection of the price a firms’ product commands and the units it can sell.”

Value can only be defined by the ultimate customer. Thus the starting point of Lean is to thoroughly understand what the customer perceives as value. This can be accomplished through identifying the value adding activities in an operation. A company has mainly three different types of value adding activities. They are:

- Value adding activity (VA) – An activity that makes the product or service more valuable to the ultimate customer.

- Non-value adding activity (NVA) – An activity that creates no value to the customer. One of the main focusing points of Lean is to eliminate these non-value adding activities.

- Necessary non-value adding activity (NNVA) – An activity that does not create any value to the customer, but is seen as necessary or mandatory in order to achieve the product or service.

Womack and Jones (2003) make use of the following concepts to accurately identify value:

- Target cost
- Ultimate customer
- Muda

Target cost - Womack and Jones (2003) state that the target cost is achieved when all visible waste in a process has been removed while producing a product with the minimum amount of effort and resources. This process transforms inventory from the initial raw material to the intended product for the customer.

Ultimate customer – The external customer is the starting and ending point. Optimisation should always take place around the customer, and not around internal processes. The customer's true demand in terms of price, delivery and quality should be understood (Bicheno and Holweg, 2009). There may however be multiple end customers, and it is critical to identify their combined value perceptions.

In the South African warehousing industry, the end customer can range from an automotive OEM (Original Equipment Manufacturer), car dealer, pharmacy, wholesaler, restaurant, shop or the consumer. By truly understanding Lean thinking, companies can ensure that they align themselves with their customers. This enables them to understand what the customers perceive as value, rather than the company. Continuous improvement of current processes, and sufficient communication with the customer, will guarantee that their needs are completely fulfilled.

Value should always be measured and managed from the customer's perspective.

The seven types of Muda – "Muda" is the Japanese word for waste. Waste elimination is a key point in Lean and is critical in understanding value. According to Bicheno and Holweg (2009), one organisation has a simple definition of waste. They classify waste as anything other than the minimum activities and materials necessary to get the job done immediately, right the first time and to the satisfaction of the customer.

The seven wastes were first introduced by Taiichi Ohno, the father of the Toyota Production System. Consistent with Bicheno and Holweg (2009), Ohno's seven wastes were initially designed for the manufacturing industry. It is however also applicable in many service industries. The seven wastes are:

1. The waste of overproduction
2. The waste of waiting
3. The waste of motion
4. The waste of transporting
5. The waste of over processing
6. The waste of inventory
7. The waste of defects

The seven wastes are very relevant in the warehousing industry. They are clearly visible when you visit the Gemba (the place where it's happening). The following list includes, but is not limited to the specific wastes involved in a warehousing operation:

- The waste of motion – A key factor in warehousing is the number of times that a product is handled. Handling a product unnecessarily is seen as "double handling", or as a non-value adding activity. These should be eliminated to create value to the customer.
- The waste of inventory – Storing extra or buffer stock in the warehouse is another sign of waste. It takes up additional space that can be utilised better in order to create value, and optimise the flow of processes.
- The waste of overproduction – Energy and time is spent on producing a product that is not needed by the customer. An example includes pre-packing.

Principle 2: Value Stream

The value stream can be described as a set of processes or activities that a product or service undergoes to meet customers' requirements. It involves the core activities that provide value to the customer.

Mapping out the entire value stream of an organisation is an effective way to expose waste. According to Jacobs et al (2009), the idea is to develop a detailed diagram of a process that clearly shows activities that add value, that do not add value, and steps that involve just waiting. By drawing a diagram that identifies the non - value adding activities, we can understand the impact of changing certain processes.

It is important for employees to see the value that they are contributing to the product or service. In order to achieve this, Value Stream Mapping (VSM) is introduced.

Bicheno and Holweg (2009), state that the real purpose of mapping is to design the future state. It is a visualisation exercise – showing the vision of the current state, as well as the desired future state. VSM is also an outstanding way to get employees involved and to participate. Mapping can also be a great tool to generate new ideas. It provides a better understanding of how material and information flow are connected. It builds the basis for an effective Lean implementation plan, by optimising how information and material flow co-operate to minimise waste.

Bicheno and Holweg (2009) further state that good mapping practice involves four maps; Current State, Future State, Ideal State and an Action Plan. Maps should be developed by those employees working in a specific area, and should be signed-off by those working in that area.

The ultimate goal of a value stream map is to remove non-value adding activities. By doing so, waste is removed from the process/system and more value is created for the customer. It also enables you to meet customer demand more efficiently and effectively, by providing a product or service at the right time, place and condition that the customer expects.

In warehousing, a VSM would typically show the time that a customer has to wait from the time he places an order, until he receives that order. By creating a value

stream map with minimal waste, warehouses would be able to service their customers quicker and more efficiently.

Another important factor essential to making value streams work is the use of, and adherence to standard work. According to Womack and Jones (2003), standard work is the best way to get a job done in the allocated time, and getting it right the first time, every time. A process can only be improved once it's been standardised and when it is stable. Standardisation is the basis for any future enhancements. Only once there is a standard operating procedure in place, and it is followed consistently, can quality be guaranteed.

In Jeffrey Likers book, The Toyota Way (Liker, 2004), he says that Lean philosophy is enabling those who do the work, to build in quality by allowing them to write the standard procedures themselves. The quality procedures must be practical and simple enough to be used daily by the workers.

In warehousing, standard operating procedures, or SOP's, are critical in order to understand a certain process. SOP's, along with work instructions form the foundation of a workers training and development. These standard procedures are often developed without involving the workers who actually do the work.

With the purpose of improving a current process, it is imperative to involve the workers from the outset, and make them responsible for continually advancing the standards. Only then should the quality department become involved to conduct audits to verify that the procedure is being followed.

Principle 3: Flow

Womack and Jones (2003) classify flow as the progressive success of activities along the value stream so that products continue from design to launch, order to delivery, and raw materials to delivery and into the hands of the customer without any form of delay or stoppages. Flow is thus the continuous movement of inventory from step to step in an even, steady form and equal amount.

In warehousing, the flow of inventory can typically follow these steps:

- Receiving – Offloading of inventory and inspection of products to ensure correct quality.
- Put-away – Storing of the product in the suitable location, and making it available for picking to a customer.
- Picking – Once an order has been placed by a customer, the relevant product(s) are picked and prepared for dispatch.
- Dispatch – As orders are fulfilled, they are packed and made ready for delivery to the customer.

According to Womack and Jones (2003), takt time, visual control and standard work give a clear indication of how work is flowing. For relevance of this research proposal, only visual control and standard work will be considered.

Visual management - Visual management and controls are clear and simple ways of communicating key information by using visual signals such as coloured cones, specific charts and kanbans. These visual controls allow for a quick method of communication in order to be more efficient. By making something clearly visible, it ensures that it is always in plain sight and is easily remembered.

It is especially helpful to indicate when there is a problem or variation in the process. When it is made visible, it becomes apparent to all employees and the corrective action can be taken right away to resolve the problem.

There are various types of visual controls, these include floor demarcation, shadow boards for tools, indicator lights, workgroup display boards, inventory control, SOP's display boards, continuous improvement boards and Andon boards to name a few.

5S's - Another visual control is 5S programmes. Bicheno and Holweg (2009) believes that 5S is probably the most popular tool in Lean. But they further state that a 5S programme should not be misunderstood as a clean-up exercise, which will risk the sustainability of the programme and even the concept of Lean.

To this end, Bicheno and Holweg (2009) state the real objectives of Lean:

- to reduce waste
- to reduce variation, and
- to improve productivity.

Throughout their book The Lean Toolbox, Bicheno and Holweg (2009) warns the reader against using Lean as a set of tools to go about and make changes to the current operation. Rather approach each situation individually and then determine which Lean tool will be best suited to solve the problem at hand. This is also true in implementing a 5S programme.

The classic 5S's are: Seiri, Seiton, Seiso, Seiketsu, Shitsuke. These are translated into Sort, Simplify, Scan, Standardise and Sustain (Bicheno and Holweg, 2009). The 5S's are relevant to almost any industry or situation, including warehousing. An important aspect of warehousing is its housekeeping, where 5S is a central theme in maintaining a clean and orderly warehouse.

Principle 4: Pull

Bicheno and Holweg (2009) explain pull as the short-terms response to the customer's rate of demand. It is important to note that this is the final customer's demand, and not distorted by the intermediate bullwhip effect. This is to reduce and try and eliminate overproduction. Pull needs to take place along the entire demand flow network, and not isolated within a single company. This will involve sharing final customer demands along the whole supply chain, which will reduce uncertainty in forecasting numbers.

Pull systems are typically classified as those systems where production is based on consumption of an upstream process. Consequently, demand needs to pull products through the process to initiate production (Bicheno and Holweg, 2009).

Bicheno and Holweg (2009) state that according to Hopp and Spearman, the main benefits of a pull system are reduction in work-in-progress (WIP) and cycle time, because with pull, overproduction is not possible. In addition, higher quality (due to a process with shorter queues) and a smoother flow of production is a further benefit. Ultimately all of these lead to a reduction in cost (Bicheno and Holweg, 2009).

Kanban - Pull is the scheduling principle, and kanban is a form of pull mechanism (Bicheno and Holweg, 2009). Other pull mechanisms include Eli Goldratt's Drum-Buffer-Rope, CONWIP (or constant work-in-progress), faxban and an audio-based call.

Bicheno and Holweg (2009) state that Womack and Jones' fourth principle (pull) has been given this order deliberately. A lot must happen first before introducing a kanban system, including stable work through standard work, reduced demand amplification, reduced changeover, reduced breakdowns and defects (Bicheno and Holweg, 2009). Only once these concerns have been addressed, should kanban be implemented.

Kanban is a signalling device (usually in the form of a card) to control the release and flow of materials in an operation. It is an effective way to decrease muda (Bicheno and Holweg, 2009). The picture below graphically depicts a kanban system:

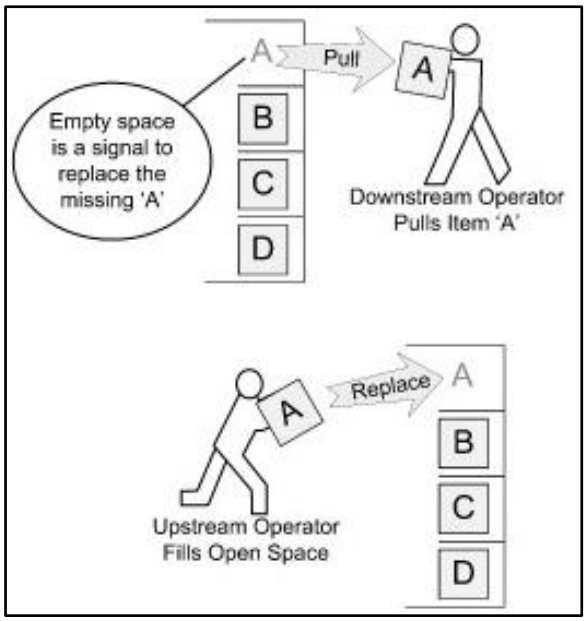

Figure 3: Kanban Definition (Velaction, 2014)

Several variations of kanban are used in the warehousing industry. This tool can be used by warehouse management to carry lesser inventory. It can also be used to notify the completion of one process, and signal the start of the next. The advantages of a kanban system in warehousing is the fact that you can get equipment and the necessary tools to complete a process in less time when it's visible, and product is pulled through the process.

Principle 5: Perfection

The final principle of Womack and Jones (2003) is perfection. According to Bicheno and Holweg (2009), perfection is not merely defect free, but rather delivering exactly what the customer requires, when the customer wants it, at a reasonable price and with the least muda.

In warehousing, perfection can be classified as “the perfect order”. This is seen as delivering an order exactly on time, free of any damages or defects and containing the correct materials. Second to perfect orders, are perfect inventories and the two are reliant on one another. With current information technology, it is not uncommon to achieve a shipping accuracy rate exceeding 99.9% (Lean Thinking in the Warehouse).

Womack and Jones (2003) argue that a company should compete with perfection, and not simply with competitors. Bicheno and Holweg (2009) verifies this statement, by saying that a company should beware of benchmarking and best practices of the industry or competitors, because the real benchmark is zero waste.

Of great importance to become “perfect” is the setting of goals, and the necessary communication to the relevant people. Too often goals are not met, due to insufficient communication, or the impression that it has indeed occurred.

The best way to grow into perfection is probably through Lean improvement. Bicheno and Holweg (2009) have a hierarchy of improvement, containing five levels. They are:

1. The individual
2. The work team or mini point kaizen
3. Kaizen blitz group or point kaizen
4. Value stream improvements: flow kaizen groups
5. Supply chain kaizen

The Philosophy of Kaizen

Kaizen (or continuous improvement) is central to Lean operations. Quality starts at the customer, but the customers' views are ever changing and standards are increasing, creating the need for a continual improvement environment. Kaizen is continuous improvement in small increments, and at all levels (Bicheno and Holweg, 2009).

According to Imai (1986), there are several guiding principles to Kaizen. They include:

- Question the rules – Rules are made to be broken, and must be broken as time passes. Standards however are necessary.

- Develop ingenuity – Management has a priority to develop the participation and resourcefulness of all employees.

- Root cause analysis – Identify the root cause by using the five whys. Do not solve problems hastily.

- Eliminate the whole task – Continually ask if a certain task is necessary.

- Reduce or change activities – Identify opportunities to combine various tasks.

Kaizen Events

Bicheno and Holweg (2009) reason that a Kaizen event fills the gap between local improvement initiatives, the individual and a greater initiative like value stream improvements. Kaizen events are the principal means to get multi skilled and cross - functional teams involved in Lean. Such an event makes both improvements and is a form of teaching and communicating. It is done over a short period of time, which enables managers to get involved as well, and not only warehouse floor workers.

Continuous improvement is critical in a warehouse environment to remain competitive, optimise the processes, improve material flow and to ultimately cut costs (Bicheno and Holweg, 2009).

2.3 Warehousing and Lean

2.3.1 The Various Types of Warehouses

Many people view warehouses as being the same and consider it a big black box that stores inventory and raw materials (Bozer, 2012). They view it as a “necessary evil” or as a necessary non-value adding activity. But in reality, all warehouses are not the same, and there are several different types of warehouses fulfilling different roles in the supply chain.

According to Bozer (2012), a key to understanding Lean and Lean implementation starts with the understanding of the various types of warehouses. Although the principles of Lean do not change for the different warehouses, the type of warehouse can impact the implementation and understanding of these principles.

Bozer (2012) has identified six different warehouse types. The different types of warehouses are classified according to the customer it serves, based on Womack and Jones’ first Lean principle; value from the perspective of the customer. They are:

1. Raw material and component warehouses
2. Finished goods warehouses
3. Distribution warehouses
4. Retail warehouses
5. Service/spare parts warehouse
6. Consolidation warehouse

For the purpose of this study, only one of the above mentioned warehouses will be considered in the case study and questionnaire. The 3PL on which the case study is based primarily operates this type of facility as a contract warehouse. This facility can either be a stand-alone or multi-client facility. It is discussed in further detail below:

Service/spare parts warehouse: The primary function of a service/spare parts warehouse (after-market warehouse) is the storing and picking of goods for customer orders. This warehouse typically has a wide range of SKUs filling small to

large orders. It stores, picks, packs and ships orders to customers. The customers range from individual customers, retail stores, distribution hubs, commercial customers, businesses and dealers. Although not all inventory kept in these warehouses are service or spare parts, it follows similar processes within the warehouse.

The warehouses used in this case study are service/spare parts warehouses leased by the third party logistics provider (3PL). The 3PL is responsible for management of all physical warehousing activities, as well as providing information and reporting. The workers that will partake in this questionnaire are all employed by the 3PL.

2.3.2 Applicability of Lean for Warehousing Issues

2.3.2.1 Lean, Six Sigma and TOC

Various improvement methodologies exist that can be used in the warehousing industry. These include Lean, Six Sigma and Theory of Constraints (TOC) to name a few. Viswanathan and Littlefield (2009) state that companies are striving to meet unpredictable customer demand while simultaneously decreasing inventory. Lean needs to be looked at together with best practices in the supply chain industry, including demand management and inventory management to become an ideal Lean company.

The selection of which improvement programme to choose is dependent on the culture of the company. According to Murphy (2011), the general consensus points towards Six Sigma if an organisation values analytical studies, to TOC when separation between worker and management is sought after and towards Lean if visual change and immediate action is required.

As stated by Martyn (2010), Six Sigma is seen as a reactive approach, focusing on a step-by-step methodology for solving a specific problem. Whereas Lean looks at active, long term continual improvements for maximising the effectiveness of a company.

Table 1 below shows the comparisons between the abovementioned methodologies:

Table 1: Comparison of Improvement Programs (Nave, 2002)

Program	Six Sigma	Lean thinking	Theory of constraints
Theory	Reduce variation	Remove waste	Manage constraints
Application guidelines	1. Define. 2. Measure. 3. Analyze. 4. Improve. 5. Control.	1. Identify value. 2. Identify value stream. 3. Flow. 4. Pull. 5. Perfection.	1. Identify constraint. 2. Exploit constraint. 3. Subordinate processes. 4. Elevate constraint. 5. Repeat cycle.
Focus	Problem focused	Flow focused	System constraints
Assumptions	A problem exists. Figures and numbers are valued. System output improves if variation in all processes is reduced.	Waste removal will improve business performance. Many small improvements are better than systems analysis.	Emphasis on speed and volume. Uses existing systems. Process interdependence.
Primary effect	Uniform process output	Reduced flow time	Fast throughput
Secondary effects	Less waste. Fast throughput. Less inventory. Fluctuation—performance measures for managers. Improved quality.	Less variation. Uniform output. Less inventory. New accounting system. Flow—performance measure for managers. Improved quality.	Less inventory/waste. Throughput cost accounting. Throughput—performance measurement system. Improved quality.
Criticisms	System interaction not considered. Processes improved independently.	Statistical or system analysis not valued.	Minimal worker input. Data analysis not valued.

2.3.3 Why Lean as an Improvement Methodology for Warehousing?

As mentioned in previous sections of this report, firms have had a very negative view on warehouses, and believed it obstructed the flow of goods through the system. It was also believed that it only added cost to a product, without adding any form of value (Langley et al, 2008).

However, the view on warehousing in today's business is changing. This is due to the awareness that warehousing can provide more value to a product than costs. Warehousing functionality is now seen as mixing and modifying a product in order to meet customer requirements (Bowersox et al, 2013).

This being said, there still remain challenges within warehousing prohibiting companies from successfully delivering value - added services to their clients. The following section describes the most pertinent issues experienced by warehouses in general, also known as the seven wastes (Bozer, 2012). It further explains why Lean is an appropriate methodology for solving each specific challenge:

1. The storage of excess inventory – This not only minimises your effective storage space in the warehouse, but also has an impact on productivity, as employees may struggle to pick the appropriate order due to excess inventories being stored. This is seen as ***overproduction***. In the warehousing environment, this occurs when an activity is completed before it is needed by the customer. Examples include pre-packing of goods before its required, picking orders too far in advance, thus creating unnecessary congestion and work-in-progress in the dispatch area. Lean strives to eliminate overproduction through the **Pull** principle, where the warehouse only reacts to the customer's rate of demand (Womack and Jones, 2003).

2. Unnecessary travel – Warehouse employees spending excessive time traveling within the warehouse to store and pick products. This may introduce avoidable additional employees to cater for the workload. This can be classified as ***transportation*** waste. In warehousing, this can be the movement of products or employees. This is seen as a "necessary non-value adding" process that the customer is not paying for. Although it can never be fully eliminated, the

warehousing operation should strive to minimise this as far as possible. When products aren't stored in a logical sequence, it forces a picker to travel unnecessary distances when picking an order (Bozer, 2012). Lean attempts to minimise transportation waste through their third principle, **Flow** by eliminating non-value adding activities.

2. Waiting time – When employees are ready to pick a certain order, but the inventory is not available to pick. Further waiting may occur when material handling equipment is required for certain warehousing activities, but is unavailable. This is categorised as ***waiting*** waste. This occurs when employees are ready to continue their work, but the process doesn't allow them to, due to unavailability of products, machines or the system (Bozer, 2012). Waiting waste is minimised through the implementation of Lean's third principle, **Flow**, where delays in the process flow is diminished.

3. Motion – In cases where inventory is not stored at the correct location level, employees need to reach or bend over to pick the items. The reverse is also true, when employees have to store items at ergonomically uncomfortable heights when it can be avoided. This is classified as ***motion*** waste. In cases where employees need to reach or bend over to pick or stores items, it is seen as a waste of motion. Applying better **Flow,** the third Lean principle, would strive to eliminate this waste as far as possible, by storing the correct items in their appropriate locations to suit picking and storing needs.

4. Wrong or no Inventory – Warehouses rarely carry the exact inventory required, due to various different reasons. However, storing an excess or shortage of products remains a big challenge for warehouses. A shortage means that customer orders are not filled, while excess inventories restrict the flow of product through the facility. In Lean, this is seen as ***inventory*** waste. Along with various other "tools" like economic order quantity (EOQ) models, minimum-maximum inventory level and inventory optimisation, Lean attempts to carry the precise amount of inventory that is needed through the implementation of the **Pull** principle, by only reacting to the customer's demand. This however remains a big challenge in warehousing, as they need to cater for varying demands.

5. Insufficient processing – This issue occurs when warehouse employees need to re-enter certain information in order to do their daily job. It includes multiple scanning of barcodes (which can be eliminated) or using equipment with additional capacity. Classified as ***over-processing*** waste. Any duplication of information entry is seen as waste (Bozer, 2012). One very important aspect of Lean, **Value Streams**, can be greatly beneficial to streamline the process and eliminate such wastes (Womack and Jones, 2003).

6. Defects and Damages – A major challenge in warehousing is picking the wrong item or wrong quantity. This can lead to under or over supplying the customer, or worse, supplying them with the wrong order. It further leads to more returns that need to be processed (due to incorrect shipment of orders), which means more staff is required. Damages are another challenge within warehousing, where inventory needs to be scrapped if can't be repaired. This directly affects a company's bottom line. As discussed in the previous section, picking the wrong item or wrong quantity can be major challenge in warehousing. It leads to under or over supplying the customer, or worse, supplying them with the wrong order. This is classified as the ***defect*** waste, which includes damages within the warehouse. Through the correct use of Womack and Jones' fifth and final Lean principle, **Perfection**, a company can supply its customer with exactly what is required, at a reasonable price, in the correct quantity and at the right time.

Another specific challenge that warehouses are facing, is the replenishment process. Replenishment is when items (stock) are taken from the main storage area and moved to an area called the forward pick face. The pick face is then used to pick and fill orders.

The challenges that warehouses have is when replenishment happens too soon or in quantities that are too great (Bozer, 2012). Bozer (2012) further elaborates that this would lead to increasing the inventory in the forward pick face unnecessarily, which in turn increases the pick time and/or walking time in the forward pick face.

Naude (2009) investigated and ranked internal warehouse movement and transportation problems in her doctorate dissertation. From the study, the following problems/challenges where identified (in South African warehouses):

- Design of material flow
- Warehouse capacity
- Outdated warehouse equipment
- Outdated transport equipment
- Warehouse maintenance
- Warehouse safety

It is clear from the challenges listed above and from the literature in this section, that Lean can have a positive impact on the processes and operations within warehousing. By applying Lean principles, the challenges experienced in warehousing can be addressed and solved (Womack and Jones, 2003).

Garcia (2003) states that order picking times, as well as non-value adding activities can be significantly reduced with the successful application of Lean methods.

However, Phogat (2013) also declares that: “Lean philosophy alone is not enough to resolve all warehousing problems. But when combined with traditional project management skills, it is amazingly effective at transforming a warehouse into a clean and organized system that performs like a production line, delivering predictable and reproducible results with significantly less labour.”

The succeeding section discusses the application of Lean within warehousing.

2.3.4 Application of Lean in Warehousing

In a report done by Professor Y.A. Bozer he states that warehousing plays a significant role in the supply chain. Bozer (2012) claims that “compared to the collective body of information and knowledge available on Lean manufacturing, Lean supply chain, and Lean logistics (in decreasing order of prevalence), there is very little information on Lean warehousing.”

Bozer (2012) further explains that there is largely no explored and documented research on the subject of Lean warehousing in the academic community, creating a gap of knowledge in this area.

In the industrial community however, third party logistics providers that have embarked on the concept of Lean warehousing have experienced great success.

Bozer (2012) found numerous articles published by prominent companies stating that Menlo Worldwide (a 3PL) made significant improvement in their warehouses using Lean tools and techniques. Some of these improvements include a picking productivity improvement of 32 percent, error and defect rates decreasing by 44 percent and an on-time delivery percentage of above 99% (Bozer, 2012). It is evident that Lean thinking, tools and techniques are valuable in the warehousing industry.

The following list summarises the principles of Lean warehousing as identified by Bozer (2012). These principles will be used to determine the key Lean principles in warehousing. It will further serve as guidance for certain questions when developing the questionnaire. They are:

1. Visual management, 5S, Kaizen and problem solving.
2. Status boards showing progress and/or order statuses.
3. Standardised work and equipment in the warehouse.
4. One-piece flow in receiving, put-away, picking and dispatch.
5. Level flow throughout the facility.
6. Pull systems based on order due dates.
7. Minimised staging locations in receiving and dispatch.
8. Eliminate double-handling between processes.

9. Inbound and outbound shipments scheduled by time window.
10. Elimination of all excess inventories.
11. Commodity characteristic and velocity slotting (Lean storage).
12. Measure and improve storage density and travel times.
13. Pick directly to shipping container (eliminating handovers).
14. Promotion of continuous improvement.

According to Jones et al. (1997) bin size reduction, product storage, velocity stocking, standardised routing, standardised work, facility harmonisation, manpower scheduling, staggered routing and root cause analysis problem solving techniques are all Lean concepts specific to warehousing.

In agreement with the above, Bradley (2006) states that the main concepts within Lean warehousing are organisation/company buy-in, Kaizen events, order accuracy and on-time shipment.

Sobanski (2009) developed a comprehensive Lean implementation assessment tool to measure Lean principles being applied in warehousing. In his doctoral dissertation, Sobanski (2009) identified certain key Lean principles and methods to help with the development of his Lean implementation and assessment tool.

Although the assessment and implementation of Lean principles and concepts within warehousing do not form part of this research, the use of the identified principles should be beneficial in determining the understanding of warehousing employees with regards to Lean.

Based on the research concluded by Sobanski (2009), the following were identified as key Lean principles that particularly relate to warehousing:

1. Standardised processes
2. People
3. Quality assurance
4. Visual management
5. Workplace organisation
6. Lot sizing
7. Material flow
8. Continuous improvement

The above principles were based on the theoretical framework developed by Ohno, Shingo, Womack et al., Womack and Jones and Liker. According to Sobanski (2009), the Lean principles identified from the above literature can be utilised as a comprehensive list to measure lean activities of warehouse employees.

The above will assist the author in determining the key Lean principles in warehousing and to evaluate the current understanding of employees on these principles.

2.3.5 Why a Knowledge of Lean is Important?

In order to apply Lean principles successfully, an understanding of those principles is essential. Piatowski (n.d.) states that a reason relating to failure of Lean implementation is due to lack of proper knowledge. According to Piatowski (n.d.), creating an understanding of Lean principles and theories requires all employees to participate. The success of Lean implementation is dependent on how well this knowledge is applied, as well as obtaining new Lean knowledge (Piatowski).

The first step that Piatowski (n.d.) recommends with Lean implementation is to gain a knowledge and understanding of Lean tools and methodologies. Watson (2011) reiterates that theoretical Lean knowledge is the first step, but that applying the newly gained knowledge is just as important, if not more.

Partnership and team work among employees should build on the theoretical Lean knowledge. Piatowski (n.d.) further states that in order to be successful with any Lean initiative, the strength and abilities of the leaders (managers) are imperative. Staats & Upton (2011) are in agreement and believe that managers are critical in launching the process.

When implementing Lean initiatives, teams who have the engagement and drive from management are more successful (Staats & Upton, 2011). It is therefore vital that Lean principles are understood, and equally important that managers are involved with Lean initiatives. Watson (2011) also states that all employees can benefit from this, and will enable each one to become a better professional.

This research report will thus aim to illustrate the gap of Lean knowledge and understanding between the employment levels, with the purpose of qualifying the necessity of this study and the ultimate development of relevant training material. It is therefore critical to close this gap with the appropriate Lean training, as well as instil the importance of the commitment and participation of managerial staff (Piatowski; Staats & Upton, 2011).

The following section summarises the key Lean warehousing principles as outlined by previous research.

2.4 Consolidation of Lean Warehousing Literature

2.4.1 Key Lean Principles Identified in Warehousing

Based on the extensive literature survey completed earlier in this chapter, the author has consolidated the main Lean principles evident in warehousing from the key authors listed below.

The essential Lean principles, concepts and methods were gathered by examining the literature and the theoretical framework that Bicheno & Holweg (2009), Womack & Jones (2003) and Bozer (2012) developed in their respective work.

Only these authors work were focused on, as it encompasses all the relevant Lean knowledge that was sought after, and is a detailed summary of Lean research available. Their work further overlaps with each other, indicating the significance of the research presented in this report. The identified Lean principles are:

1. Value
2. Continuous Improvement (Kaizen)
3. Standardised Processes
4. Visual Management
5. Flow & Pull
6. Quality Assurance
7. Workplace Organisation

This is validated by the research completed by Sobanski (2009). In accordance with Sobanski's (2009) compilation of Lean research in warehousing, the following Lean methods occurred most often (in the various assessment tools analysed) with regards to each Lean principle stipulated above:

Table 2: Lean Principle and Associated Lean Methods (adapted from Sobanski, 2009)

Lean Principle	Lean Method	
Value	Customer Value	Seven Wastes
Continuous Improvement	Continuous Improvement Events	Employee Suggestions
Standardised Work / Processes	Standard Operating Procedures (SOP's)	Standardised Work / Planning
Visual Management	Metrics & KPI Boards	Value Stream Mapping
Flow & Pull	Levelled Flow & Work	Layout & Zones
Quality Assurance	Quality Metrics	Problem Solving & Error Proof Methodology
Workplace Organisation	Cleanliness	5S & Signage Boards

These Lean principles and methods listed above forms the foundation of the Lean framework that has been developed. The framework will comprise of a list of questions to test the understanding of warehouse employees with regards to these specific Lean principles and methods.

Detailed Description of the Lean Methods

The seven Lean principles and corresponding methods determined above are detailed in the section below. A brief description and definition of each particular Lean principle along with their methods relating to Lean warehousing are given as well:

1. Value

The Lean methods relating to these principles as identified by the author are Customer Value and the Seven Wastes.

- In line with Bicheno & Holweg (2009), value can only be defined by the ultimate customer. It is imperative to thoroughly understand what the customer perceives as value. By recognising what is important to the customer and their perspective on value, is the starting point of Lean. This can be accomplished through identifying the value adding activities in an operation.
- Arguably the most famous of all Lean literature is the concept of seven wastes. Bicheno & Holweg (2009) classify waste as anything other than the minimum activities and materials necessary to get the job done immediately, right the first time and to the satisfaction of the customer.

2. Continuous Improvement (Kaizen)

The Lean methods relating to these principles as identified by the author are Kaizen Events and Employee Suggestions.

- According to Sobanski (2009), “Kaizen Events are the physical continuous improvement activities and documentation of those activities where employees directly impacted by changes, are involved in developing solutions for improvement.”

  Bicheno & Holweg (2009) further state that Kaizen Events are the principal means to get multi skilled and cross-functional teams involved in Lean. Such an event makes both improvements and is a form of teaching and

communicating. It is done over a short period of time, which enables managers to get involved as well, and not only warehouse floor workers.

- Employee Suggestions are designed to capture employee thoughts and ideas on possible improvements, developments and recognition.

3. Standardised Work / Process

The Lean methods relating to these principles as identified by the author are Standard Operating Procedures (SOP's) and Standardised Work / Planning.

- A Standard Operating Procedures (SOP) is specific written method or steps that are necessary to complete a particular function, task or job, also known as a work instruction.

- Standardised Work / Planning relates to the amount of work given to employees based on what needs to be completed and the time required to complete the specific task. This ensures level loading of employees' work as far as possible.

4. Visual Management

The Lean methods relating to these principles as identified by the author are Metrics & KPI Boards and Value Stream Mapping.

- Metrics & Key Performance Indicator (KPI) Boards serve as a form of visual communication, to measure and track the targeted performance versus the actual.

- Value Stream Mapping is used to clearly show activities that add value, that do not add value, and steps that involves just waiting (Jacobs et al, 2009). It is further used to identify continuous improvement opportunities within these activities (Sobanski, 2009).

5. Flow and Pull

The Lean methods relating to these principles as identified by the author are Levelled Flow & Work and Layout & Zones.

- Levelled Flow and Work relate to balancing the flow of material with that of the manpower, in order to successfully manage the completion of work within the warehouse.

- Layout and Zones denote the physical layout of products within the warehouse, in order to optimise the manpower and material movement throughout the process (Sobanski, 2009).

6. Quality Assurance

The Lean methods relating to these principles as identified by the author are Quality Metrics and Problem Solving & Error Proofing Methodologies.

- Quality Metrics refer to specific measurements with regards to quality and the relevant corrective actions in place for each (Sobanski, 2009).

- Problem Solving consists of various techniques followed to solve a certain problem, including Five Why's and Root Cause Analysis, while Error Proofing

Methodologies refer to building quality into a process to eliminate waste and defects.

7. Workplace Organisation

The Lean methods relating to these principles as identified by the author are Cleanliness and 5S & Signage Boards.

- Cleanliness relates to the overall orderliness and neatness of areas within a warehouse. It may also be referred to as housekeeping.

- 5S (as discussed earlier in this research report) is translated into Sort, Simplify, Scan, Standardise and Sustain (Bicheno and Holweg, 2009). This is used to ensure that there is a place for everything, and everything is in its place. While Signage Boards act as a tool to reduce wastes associated with looking for equipment, tools and places.

The above mentioned Lean principles along with each Lean method will form the basis of the data gathering.

3. Research Methodology

3.1 Introduction

This research report will attempt to determine the understanding of warehouse employees in a South African third party logistic provider (3PL), with regards to the key Lean principles and concepts outlined in chapter two. This chapter will cover the research methodology that was followed to conduct the research.

The author of this research report has compiled a framework based on the Five Lean Principles of Womack and Jones (2003), the principles acknowledged by Bozer (2012), the Lean principles identified by Sobanski (2009) and Lean research completed by Bicheno & Holweg (2009). A summary of the key Lean principles can be found in the previous chapter.

This framework consists of a series of suitable questions to help identify the understanding of key Lean principles by warehousing employees.

A single company delivering end-to-end supply chain solutions, and operating as a third party logistics provider (3PL) in South Africa has been used for this case study. The selected 3PL is a global company (among the top 20 global 3PLs) and one of the leading logistics providers in South Africa. They have incorporated Lean as an improvement methodology through their quality management system and advanced quality processes. This system includes multiple Lean methods, processes and tools that are deployed and audited in all of their warehouses.

Numerous warehouse workers and managers from this company have taken part in answering the questions within this framework, and also forms the base of the data collected.

It has further been decided that the focus would be on the 3PL's warehouses, seeing that it falls within their core business, and they are known as the subject matter experts in the logistics industry. Four warehouses operated by the 3PL have been included in this study, which will comprise of all the data attained.

As detailed above, the constructed framework will test the understanding of the identified individuals with regards to the following Lean principles within warehousing (as acknowledged in the literature review):

1. Value
2. Continuous Improvement (Kaizen)
3. Standardised Processes
4. Visual Management
5. Flow & Pull
6. Quality Assurance
7. Workplace Organisation

The literature review from the previous chapter has formed the foundation of the research and supported the formation of the Lean framework.

3.2 Research Strategy

In line with Saunders et al (2009) research strategy is “the general plan of how the researcher will go about answering the research questions”.

Saunders et al (2009) further states that the suitable research strategy has to be selected based on the following:

- Research questions and objectives
- The extent of existing knowledge on the subject area to be researched
- The amount of time and resources available
- The philosophical underpinnings of the researcher

The proposed research methodology is a qualitative approach that will test the Lean knowledge of the participants, as discussed below.

3.2.1 Quantitative and Qualitative Research Methodologies

According to Saunders et al. (2009) there are two different research methodologies; quantitative and qualitative research. It is important that researchers first understand the theoretical background, which will lead to selecting the appropriate research method. These two strategies are discussed in further detail below:

- **Quantitative research:** Rubin and Babbie (2010) classify this research method as finding accurate answers for the hypothesis by utilising statistical tools. They further state that the most important criteria for quantitative research are using defined steps throughout the research process with a specific objective to collect data. The nature of the data emphasised is through numbers.
- **Qualitative research:** This research strategy focusses on the interpretation and analysis of words, rather than numerical data. It is finding answers and meanings from analysing human behaviour (Rubin and Babbie, 2010). Qualitative research is thus seen as flexible when collecting data, due to the enabling of the researcher to adapt based on the findings of observations or circumstances (Rubin and Babbie, 2010).

3.2.2 Case Study Research – A Qualitative Research Methodology

As stated by Welman et al. (2005), “the term case study pertains to the fact that a limited number of units of analysis are studied intensively. The units of analysis include individuals, groups and institutions. In case studies we are directed towards understanding the uniqueness and the idiosyncrasy of a particular case.”

According to Yin (2003), qualitative analysis means the author is subjectively part of the subject matter, as is the case in this study, with the author being employed by the 3PL on which this case study is based.

As a result, a qualitative research approach is taken by the author to analyse the open ended questions, since the data attained is in the form of words, using the

workers' interpretation, knowledge and understanding of the questions in the Lean framework that has been developed (Yin, 2003).

It is acknowledged by both Saunders et al (2009) and Yin (2003) that there exists various research strategies, and there are vast similarities among them. The important consideration would be to select the most advantageous strategy for a particular research study. This research report is based on a case study, since the data gathered is on a single 3PL company and is most advantageous to determine the research question.

3.2.3 Data Collection Method

Various forms of data collection techniques exist and were considered. They are:

- Electronic questionnaires (e-mails)
- Telephonic interviews
- Questionnaire hand-outs
- Face to face interviews
- Group-administered questionnaires

The population to be surveyed works close together and in similar settings. With all things considered, it was decided that group-administered questionnaires will be the most applicable research instrument to answer the relevant questions in the Lean framework.

According to Bornman (2009), the most appropriate method of surveying this type of sample is through group-administered questionnaires. This method is a form of self-administered survey. Respondents are grouped together; the questionnaires are handed out and completed within a group situation.

The Lean framework discussed in chapter 2 (and further in this chapter) has been used as a blueprint to develop the questionnaire. By utilising the group-administered questionnaire as the primary data collection method, the author will also be able to best answer the research question along with the objectives of this study. Further benefits of using this research method are discussed in the course of this chapter.

Table 3 below depicts the advantages and disadvantages of the proposed method (Bornman, 2009):

Table 3: Group-Administered Questionnaire Advantages and Disadvantages (adapted from Bornman, 2009)

Data Collection Technique	Advantages	Disadvantages
Group Administered Questionnaire	Multiple questionnaires can be completed within a short period of time and with minimal effort	The presence of the researcher could seem intimidating and may impact the answers of the questionnaire
	The researcher can control the conditions under which the questionnaire is completed	It is not appropriate for sensitive issue
	The researcher is present to clarify any questions and to offer assistance where needed	

This method differs from a group interview or focus group where each questionnaire is filled in individually, instead of a group format.

Jankowicz (1996) advocates that there is no single best method to gather data. The group-administered questionnaire was chosen for the following reasons:

- Geographical location of the employees that form part of the population, seeing that all employees will be present at the same site.
- Most of the employees do not have computers and/or internet, making it difficult to respond to electronic questionnaires.
- Healthy response rate of completed questionnaires.
- The researcher's ability to offer assistance where needed.
- The researcher's ability to clarify any uncertainties.
- The researcher's ability to control the circumstances.
- Effective method of data gathering.
- Ideal for the required sample size.

Since the population used to gather the data work closely together, in the same conditions and environments, group-administered questionnaires were considered to be most suitable and beneficial for the purpose of this research report.

3.2.4 Possible Limitations of the Study

A possible limitation was identified by the author prior to the inception of the study; that is, the literacy level of the participants. The majority of the participants formed part of the Material Handler employment level (which accounted for approximately 70% of the total sample size). Although this employment level is the lowest in the warehousing industry, a matric qualification is the minimum requirement to be employed by the 3PL. Furthermore, each prospective employee writes an ABET English literacy test, for which the minimum pass rate is 90% (or level 4).

Thus for the purpose of this study, it has been assumed that the language proficiency is at an adequate level to answer the questionnaire.

This potential limitation was further mitigated through the use of group-administered questionnaires. As stated above, group-administered questionnaires enabled the author to be present during each data gathering session to clarify and assist with any uncertainties. The author verbally rephrased questions that were not fully understood, or any questions asked by participants during each session, in order to ensure that language competence is not a limitation of the study.

3.3 Sampling Methods

A variety of sampling methods are found in literature for qualitative research. The subsequent section discusses and justifies the sampling method on which the data collection is based.

3.3.1 Non-Probability Sampling

According to Welman et al. (2005), “the probability that any element (unit of analysis) will be included in a non-probability sample cannot be specified.” Non-probability sampling is less complicated and more economical than its probability sampling counterpart.

There are various forms of non-probability sampling, including (Welman et al., 2005):

- Accidental sampling
- Quota sampling
- Purposive sampling
- Snowball sampling
- Self-selection sampling
- Convenience sampling

For the purpose of this research report, the author has chosen the purposive sampling technique. The reason for using the purposive sampling technique is discussed below.

3.3.1.1 Purposive Sampling

Purposive sampling is one of the most common research strategies. It groups participants together consistent with a predetermined criteria based on the research question. The units (people) that are investigated are based on the researcher’s judgement (Laerd, 2012).

Participants for this research have been purposively chosen from a population of warehouse workers. Because this research focuses on determining the understanding of these workers, only those involved in this type of work were suitable for the sample.

The purposive sampling technique to be used is homogeneous sampling. This technique aims to achieve a sample whose units share very similar traits and/or characteristics (such as gender, background, occupation). Thus, a homogeneous sample is chosen when the research question to be answered is particular to the characteristics of a certain group (Laerd, 2012). In the case of this research, it is a group of warehouse employees.

The selection of this sampling approach is validated by Welman et al. (2005), stating that purposive sampling is an effective method when the researcher is working with small samples. For the purpose of this research, a sample of 40 - 45 warehouse workers will partake in the questionnaire, making purposive sampling ideal.

The advantages and disadvantage of purposive sampling are listed in table 4 below:

Table 4: Purposive Sampling Advantages and Disadvantages (adapted from Laerd, 2012)

Sampling Method	Advantages	Disadvantages
Purposive Sampling	Wide range of sampling techniques (including homogeneous sampling)	Highly prone to researcher bias
	Generalisations can be made from the sample that has been studied	Judgement used to select the units of study
	Only suitable candidates remain in the sample to be studied	
	Accurate results	

In line with the section above, non-probability, purposive sampling will be used as the data collection method.

Furthermore, purposive sampling also enables other researchers to determine the generalisation possibility of the qualitative research to other situations or phenomena, better known as transferability (Petty et al., 2012)

3.4 Ethics Consideration

The ethical considerations for conducting research on human subjects, as laid out by The University of the Witwatersrand, were adhered to in the process of gathering the necessary data (The University of the Witwatersrand, 2014).

These ethical codes comprised of the following (based on the Code of Ethics of the American Anthropological Association):

- A researcher's paramount responsibility is to those studied. Where there is conflict of interest, they must come first. Researchers must do everything within their power to protect their informants' physical, social and psychological welfare and to honour their dignity and privacy.
- The aims of the investigation should be communicated as well as possible to informants.
- Informants should have the right to remain anonymous.
- Questions asked should not be insulting or embarrassing.
- The use of monitoring devices such as tape recorders and cameras should be open, and fully understood by the people concerned. They should be free to reject them if they wish. Results should be consonant with the informant's right to welfare, dignity and privacy.
- There should be no exploitation of informants for personal gain. Fair returns should be given them for all services. There is an obligation to reflect on the foreseeable repercussions of research and publication on those studied.
- The privacy and wishes of informants should at all times be respected.
- No reports should be provided to sponsors that are not also available to the general public and, where possible, to the group studied itself, subject to the policy laid down in the document, Policy on Matters Relating to Sensitive and Confidential Research.

The author ensured that the data gathering was consistent with the ethical guidelines set out above. Ethics clearance was received from the School of Ethics at the University of the Witwatersrand before commencing the data gathering. The following ethics documentation was further completed for this study, which can be found in Appendix C and D:

- Letter of consent from the company on which this case study was based
- Letter of consent for participants (Group-administered questionnaire)
- Letter of consent for interviewees (Semi-structured follow-up interview)

The letter of consent was explained to all participants prior to answering the questionnaire. They were also made aware that participation is voluntary, and that all data gather are for research purposes only. The same procedure was followed prior to commencement of the follow-up interviews.

3.5 Lean Framework - Construction of the Questionnaire

Welman et al. (2005) argues that the starting point of a questionnaire should be the investigation of management, planning or theoretical question to be answered. Only questions related to the research question should be addressed. It is important to include as much previous research as possible when designing a questionnaire.

Welman et al. (2005) mentions several considerations to keep in mind when formulating questions for a questionnaire. They are detailed below:

1. Choose between open-ended and closed-ended (multiple-choice variety) questions.
2. Take the respondents' literacy level into account.
3. Be careful not to offend.
4. Be brief and focused.
5. Remain neutral.
6. Use a logical and justified sequence.
7. Ensure that all questions are appreciable to all respondents.
8. Basic layout of questionnaire.

The above mentioned considerations and framework by Welman et al. (2005) has served as a guideline in construction of the questionnaire.

3.5.1 Pilot Study

Once completion of the questionnaire is done, a pilot study is a logical next step. In accordance with Remenyi and Money (2006), a pilot study is required as it helps to determine whether the proposed approach being followed is effective. It further helps in identifying different lines of questioning.

A pilot study was conducted at one of the automotive parts and accessories warehouses that the 3PL is currently managing. A total of five employees participated in the study, with the following employment level breakdown:

1 x Manager

1 x Supervisor

3 x Material Handlers

The results from this study can be seen in chapter 4. The following changes were made to the questionnaire after the pilot study:

- The author found that some of the questions could be worded differently, specifically those relating to Kaizen Events and Levelled Flow and Work. These were changed for better understanding, while ensuring that the purpose of each question remained. Kaizen was substituted with continuous improvement to avoid any confusion.

- One of the two questions relating to the Lean principle Standardised Processes (and the Lean method Standardised Work / Planning) was removed, as it tested the same understanding with regards to standardised work.

3.5.2 Lean Framework - Questionnaire Format

The particular questions and format of the Lean framework are based on the seven Lean principles, together with their specific Lean methods as adapted from the literature in the preceding section. The seven principles along with their methods are detailed below:

1. Value

- Customer Value
- Seven Wastes

2. Continuous Improvement

- Continuous Improvement Events
- Employee Suggestions

3. Standardised Processes

- Standard Operating Procedures (SOP's)
- Standardised Work / Planning

4. Visual Management

- Metrics and Key Performance Indicator (KPI) Boards
- Value Stream Mapping

5. Flow & Pull

- Levelled Flow and Work
- Layout and Zones

6. Quality Assurance

- Quality Metrics
- Problem Solving and Error Proofing Methodology

7. Workplace Organisation

- Cleanliness
- 5S and Signage Boards

The questionnaire aims to determine each employees understanding with regards to the above principles. The questionnaire will consist of a series of questions for each Lean principle. There are a total of 24 questions in the questionnaire.

The answers to the 24 questions from all respondents will then be assessed and the results will be analysed in order to determine the understanding of the various employment levels in the warehousing industry.

The results from the questionnaire will enable the author to determine the following research objectives, as outlined previously in this research report:

- determine how well the identified Lean warehousing principles and methods are understood by shop floor workers (Material Handlers, Admin Clerks, Pickers and General Workers).
- determine how well the identified Lean warehousing principles and methods are understood by warehouse management (Managers, Supervisors and Team Leaders).
- identify which specific Lean principles and methods are well understood, understood, partially understood and unknown or misunderstood to illustrate the gap of knowledge between the employment levels.
- investigate if and why there is a gap of understanding between the employment levels.

Based on the data analysed, a conclusion on the current knowledge and understanding of Lean principles within warehousing should be reached. These results are discussed in detail in the next chapter.

In order to achieve the research question and objectives listed above, the questions as well as a model answers on which the questionnaire is based is illustrated in section 3.6.1.1.1.

3.6 Data Analysis and Validation

The author analysed and examined all the answers given by the employees to the 24 questions from the questionnaire. The author inspected each answer given by an employee with regards to the model answer, and graded each against the following categories:

1. Not understood or misunderstood
2. Partially understood
3. Understood
4. Well understood

All scores for each employment level (Manager, Supervisor and Material Handler) have been graded and displayed according to each Lean principle and method outlined in the previous section. Table 5 further elaborates the criteria by which each of the categories has been graded:

Table 5: Grading Criteria and Description of Categories

Grading Category	Description	Average Grading Level
1. Not Understood	The Lean principle / method is not known, misunderstood or explanation / answer to the question is below a grading level of 25%.	$1 < \text{grading} \leq 1.5$
2. Partially Understood	The Lean principle / method is only partly understood, where the participant is aware of it, but explanation / answer is at a grading level below 50%.	$1.5 < \text{grading} \leq 2.5$
3. Understood	The Lean principle / method is known and the participant is able to explain / answer the question correctly. However, some shortcomings exist and the answer is below a grading level of 75%.	$2.5 < \text{grading} \leq 3.5$
4. Well Understood	The Lean principle / method is well known and fully understood. The participant is able to explain / answer the question without any shortcomings. The answer is above a grading level of 75%.	$3.5 < \text{grading} \leq 4$

3.6.1.1 Validation

Validating the data gathered is an essential part of research to ensure legitimacy of results. Guion et al. (2011) reason that, “Validity, in qualitative research, refers to whether the findings of a study are true and certain - “true” in the sense that research findings accurately reflect the situation, and “certain” in the sense that research findings are supported by the evidence.”

The validity and credibility of the data is critical in qualitative research. Credibility (or truth value) is the degree to which the findings can be trusted or believed by the participants of the study (Petty et al., 2012).

To ensure credibility and validity of data, the author will make use of the following two validation strategies; Peer debriefing and Triangulation. These two methods are discussed in greater detail below.

3.6.1.1.1 Peer Debriefing

Peer debriefing is a research approach used to enhance the trustworthiness in qualitative research. Denzin and Lincoln (1994) believe that peer debriefing increases the credibility of a research project. Hendricks (2006) further suggests that peer debriefing minimises researcher-bias, focusses on the correctness and accuracy of research interpretations and enables sharing of the findings.

The peer debriefing method the author used is twofold. First, the author sat with an independent peer to evaluate the questions and model answers in the questionnaire. This was to ensure high face validity of the questionnaires. Second, the author sat with another peer to grade a random sample of fifteen questionnaires. This was to guarantee that no bias was committed when questionnaires were graded. The credentials of the two peers are displayed below:

- The first peer was Mr Stanley Macmillan, an Industrial Engineer (MSc Eng.) and an industry Lean expert with over 20 years’ worth of experience. Previous roles in industry included roll-out of Lean programmes in operations, while he currently develops and provides internal Lean training in the 3PL used in this

case study. Mr Macmillan also has formal training, coaching and mentoring from BMGi. Mr Macmillan was used to scrutinise and to validate the model answers of each question. The model answers were then updated and are displayed later in this section. These model answers were subsequently used to grade each questionnaire.

- A second peer (Mrs Reine Swart, a BEng (Industrial Engineer) and a current MSc Engineering student at the University of Witwatersrand, whose research is also completed on the topic of Lean) graded a random sample of fifteen questionnaires. The scores of these questionnaires were then compared to those of the author. An additional sample was also graded together to further guarantee objective results. The relevant questionnaires were then reviewed and discussed, and the necessary changes were made. Minimal to no differences were evident in the grading of this sample.

The findings from each peer have been compared to that of the author, to develop a broader and deeper understanding of the research instrument, ultimately ensuring a higher confidence (Guion et al., 2009). The outcome of the peer debriefing is detailed below.

Peer Debriefing Outcome

After completion of the peer debriefing with Mr Macmillan, the following modifications were made to the model answers where applicable (updated answers in red, b.). Furthermore, key words / phrases have been added to aid during grading of each question.

Value

Customer Value

1. Why is it important to know what the customer sees as value?
    a. *Model Answer - It enables the worker / company to create a product and / or service that is valuable to the customer, and that the customer is willing to pay for.*
    b. *Model Answer - It enables the worker / company to create a product and / or service that is valuable to the customer, and that the customer*

is willing to pay for. To provide the customer with a product or service that they expect and want.

Key words / phrases: Creates value to the customer, meeting their expectations, happy to pay for the service, in line with their requirements.

2. Why is it important to know who your customer is?
    a. *Model Answer – In order to give the customer / next process / next company a product and / or service that is acceptable in terms of quality, value and price (as deemed by the customer).*
    b. *Model Answer – In order to give the customer / next process / next company a product and / or service that is acceptable in terms of quality, value and price (as deemed by the customer). Meeting the requirements of the customer.*

    Key words / phrases: Meeting / exceeding customer requirements, better understand what they want, provide quality outputs, adding value.

Seven Wastes

1. What is the definition of a waste?
    a. *Model Answer - Anything other than the minimum activities and materials necessary to get the job done immediately, right the first time and to the satisfaction of the customer.*
    b. *Model Answer - Anything other than the minimum activities and materials necessary to get the job done immediately, right the first time and to the satisfaction of the customer. Any non-value adding activity in the process.*

    Key words / phrases: Non-value adding, minimum effort, extra / unnecessary work.

2. Why is it important to identify and eliminate all wastes in the warehouse?
    a. *Model Answer – To create a process / product / service that is value-adding, waste free and satisfactory for the customer. Most important it saves time and money.*

b. *Model Answer – To create a process / product / service that is value-adding, waste free and satisfactory for the customer. It increases efficiency and productivity in the warehouse. Most important it saves time and money.*

Key words / phrases: Improved processes, better productivity, saves money, work faster.

Continuous Improvement (Kaizen)

Continuous Improvement Events

1. Explain what you understand under a continuous improvement event?
    a. *Model Answer - This is improvement activities and documentation of those activities where employees directly impacted by changes, are involved in developing solutions for improvement.*
    b. *Model Answer - This is improvement activities and documentation of those activities where employees directly impacted by changes, are involved in developing solutions for improvement. Definition of CI also accepted: Continually improving and eliminating waste from a process by finder better, faster, cheaper ways of doing something that is still at acceptable quality.*

    Key words / phrases: Making work easier and faster, doing things smarter, cutting cost, saving time.

It is important to note at this stage that the question above relates to continuous improvement events, but that the author also accepted the definition/answer of continuous improvement.

2. Why do you think continuous improvement activities are important?
    a. *Model Answer – It empowers employees to get involved and provide ideas and thoughts for sustained improvements.*
    b. *Model Answer – It empowers employees to get involved and provide ideas and thoughts for sustained improvements. It strives to always improve the service provided to a customer, in terms of quality and cost.*

    Key words / phrases: Keep on making things better, customer satisfaction, reducing cost, improving productivity.

Employee Suggestions

1. What do you think is the purpose of an employee suggestion programme?
    a. *Model Answer - To formally capture, document, track, recognise and reward employee ideas. As well as encourage employee participation and improve employee motivation.*

    Key words / phrases: Employee ideas, suggested changes / improvements, employee engagement.

2. How would an employee suggestion programme benefit you as an employee?
    a. *Model Answer - It provides an open platform for all employees to list improvement ideas and suggestions, ultimately leading to increasing job satisfaction, improving morale and increasing employee engagement.*

    Key words / phrases: Engagement, providing changes / solutions, solving problems.

Standardised Work / Processes

Standard Operating Procedures (SOP's)

1. What is the main purpose of a Standard Operating Procedure (SOP)?
    a. *Model Answer - To have a standard process for all operators to perform each task with the best method.*

    Key words / phrases: Standard method, shows how a task is to be completed.

2. Why is it important to have a Standard Operating Procedure (SOP) visible in the warehouse?
    a. *Model Answer – It creates visual direction and reminders to employees on how to properly perform a certain task or process.*
    b. *Model Answer – It creates visual direction and reminders to employees on how to properly perform a certain task or process. It further creates awareness and enhances safety in the warehouse.*

    Key words / phrases: Constant reminder of the process, explains how tasks should be performed, uniform process.

Standardised Work / Planning

1. What is the purpose of balancing activities and work within the warehouse?
    a. *Model Answer - To ensure all work, workers and equipment within the warehouse are equally loaded in order to perform at their optimum.*

    Key words / phrases: Balancing load, spreading out work / activities, perform tasks better and faster, equally loaded workers.

Visual Management

Metrics and Key Performance Indicator (KPI) Boards

1. Why is it important to track and display key metrics (such as on-time shipment, customer satisfaction, inventory accuracy, picking productivity and accuracy etc.) and KPI's in the warehouse?
    a. *Model Answer – It graphically depicts and communicates the actual performance and outcomes versus what is expected. It further helps to identify continuous improvement opportunities.*

    Key words / phrases: Planned vs. actual performance, shows improvement opportunities.

2. What is the main purpose of Value Stream Mapping?
    a. *Model Answer – To visually map a process (or part of a process) to show activities that are value adding and non–value adding. It is further used to create continuous improvement activities within these activities / processes.*

    Key words / phrases: Displaying the total process, eliminating waste, visual map, highlight value-adding activities.

Value Stream Mapping

1. How would Value Stream Mapping benefit you as an employee?
    a. *Model Answer – It will enable them to clearly see the process / activities and create a platform for discussions and improvement suggestions, ultimately increasing employee involvement and job satisfaction.*
    b. *Model Answer – It will enable them to clearly see the process / activities and create a platform for discussions and improvement suggestions, ultimately increasing employee involvement and job satisfaction. It will also assist in identifying and eliminating non-value adding activities.*

Key words / phrases: Shows the entire process, visual reminder of the process, impact of activities on each other, continuous improvement tool.

Flow & Pull

Levelled Flow and Work

1. What is the main purpose of a pull system within a warehouse?
    a. *Model Answer – It manages the effective flow of inventory by reducing waste related to work in progress and keeps material moving in concurrence with customer / daily demand.*
    b. *Model Answer – It manages the effective flow of inventory by reducing waste related to work in progress and keeps material moving in concurrence with customer / daily demand. It further balances the activities for different processes and assists with activity and resource planning.*

    Key words / phrases: Balancing activities and work, creates flow.

2. Why is it important to level the flow of material and work within a warehouse?
    a. *Model Answer – To ensure that the movement of material and work is stable in all functions in the warehouse, in order to reduce bottlenecks and waste.*
    b. *Model Answer – To ensure that the movement of material and work is stable in all functions in the warehouse, in order to reduce bottlenecks and waste. It also ensures work is completed on time.*

    Key words / phrases: Eliminate waste, completing task in required timeframe, faster processes.

Layout and Zones

1. What are the benefits of grouping similar items in the same zone within a warehouse?
    a. *Model Answer – It allows for optimal planning of work required per process, equipment needed, racking configuration and worker and equipment movement.*
    b. *Model Answer – It allows for optimal planning of work required per process, equipment needed, racking configuration and worker and equipment movement. It makes picking and binning activities easier and optimises storage.*

    Key words / phrases: Enables faster picking, work faster, improving productivity.

2. What are the benefits of placing the fastest moving items in locations closest to the receiving and dispatch areas?
    a. *Model Answer – It minimises the travelling distance, movement and motion associated with picking an order or performing a put-away task. Ultimately ensuring a faster picking and put-away process.*

    Key words / phrases: Enables faster picking, improving productivity.

Quality Assurance

Quality Metrics

1. Why is it important to have corrective action procedures (CAPA) in place for processes within a warehouse?
    a. *Model Answer – It ensures that the correct steps are followed when an employee is presented with a problem and that the same mistakes are not made repeatedly.*
    b. *Model Answer – It ensures that the correct steps are followed when an employee is presented with a problem and that the same mistakes are not made repeatedly. It minimises incidents from re-occurring.*

    Key words / phrases: Assists the problem solving process, eliminates errors from re-occurring.

Problem Solving and Error Proofing Methodology

1. What is the importance of having a structured problem solving procedure (5Why's, root cause analysis, etc.) in place to determine the root cause?
    a. *Model Answer – It provides an official process to detect and resolve problems as they occur.*

    Key words / phrases: Alignment of problem solving techniques, quicker problem solving.

2. Why is it important to have built-in quality checks in all processes within a warehouse?
    a. *Model Answer – It enables workers to quickly detect problems or defects to ensure customers aren't serviced with incorrect items. It also eliminates the number of rework to be performed by early detection of a problem / defect.*
    b. *Model Answer – It enables workers to quickly detect problems or defects to ensure customers aren't serviced with incorrect items. It also eliminates the number of rework to be performed by early detection of a problem / defect. Ultimately increasing the quality of a product/service.*

Key words / phrases: Delivering better quality, service the correct parts / product..

Workplace Organisation

Cleanliness

1. What is the importance of proper housekeeping (keeping all areas in the warehouse clean)?
    a. *Model Answer – It enhances the work environment, reduces the risk of making errors, reduces waste, makes the job easier, increases safety and ensures the warehouse looking neat and professional.*

    Key words / phrases: Free from waste, efficient work environment, preventing errors.

5S and Signage Boards

1. What are the main benefits of an active 5S programme in the warehouse?
    a. *Model Answer – To ensure there is a place for everything and everything is in its place. By sorting material, machines and equipment, setting them in order to minimise travel, movement, and motion, ensuring its clean and standardised and all the above is sustained.*
    b. *Model Answer – To ensure there is a place for everything and everything is in its place. By sorting material, machines and equipment, setting them in order to minimise travel, movement, and motion, ensuring its clean and standardised and all the above is sustained. Employees feel a sense of responsibility and accountability within their workplace.*

    Key words / phrases: Increased productivity, place for everything and everything in its place.

2. What is the main purpose of appropriate signage (sign boards) in all areas within a warehouse?
    a. *Model Answer – Signage minimises the guesswork of employees and serves as a tool to indicate where material and equipment needs to be staged or when and where products need to be moved.*

b. *Model Answer – Signage minimises the guesswork of employees and serves as a tool to indicate where material and equipment needs to be staged or when and where products need to be moved. It also enhances safety by mapping out areas and processes for easy identification and awareness.*

Key words / phrases: Indicates escape routes / exits, easy and quick communication tool.

From the updated model answers above it is clear that the core of each answer remained unchanged, with some additional points added to each. This further aided the author in grading the questionnaires to determine each employees understanding.

3.6.1.1.2 Triangulation

Triangulation is a technique used by qualitative researchers to check and establish validity in their studies by analysing a research question from several perspectives (Guion et al., 2011). Creswell & Miller (2000) further state that data may be collected in different ways such as interviews, questionnaires, observations or archival data.

Carlson (2010) believes that if the researcher can verify the various data sets with each other, the understandings and conclusions drawn from them are likely to be truthful. Guion et al. (2009) agrees that if the conclusions from each of the methods are similar, validity is established.

From the various triangulation methods that exist, the author has selected methodological triangulation for the purpose of this research. This is to ensure quality and validity of the data, and will be most suitable for this research.

Methodological triangulation involves the use of multiple qualitative methods to study the same phenomenon (Guion et al., 2009). In the case of this research, a literature review, group-administered questionnaires along with semi-structured follow-up interviews have been completed. This is to ensure credibility of the research findings.

After completion of the literature review and the group-administered questionnaires, semi-structured follow-up interviews were held with selected managers and supervisors who partook in the questionnaire. At the time of these interviews, only three of the four managers were available (with their three accompanying supervisors).

The purpose of the follow-up interviews was to validate the findings generated from the questionnaires and to gain an even deeper understanding thereof. It also ensured that accurate and credible conclusions could be drawn. The follow-up interview procedure is discussed in Chapter 4.

3.6.2 Grading of Questionnaires

All questionnaires were graded against the criteria set out in 3.6 and the model answers from the preceding section. Each question was examined alongside the relevant model answer, and a grading of 1, 2, 3 or 4 was given depending on the correctness of the answer provided. For the purpose of this study, it has been assumed that each question, lean method and principle in the questionnaire is equally weighted when graded.

An average score for each of the Lean principles and methods were calculated for Managers, Supervisors and Material Handlers. These were then categorised according to table 6. For example, an average score of 1.5 will fall under the “Not Understood” category, while an average score of greater than 3.5 will be deemed as “Well Understood”. This categorisation will further assist the author to illustrate the gap in Lean knowledge between the employment levels.

A table has been included in appendix E indicating each question, along with a typical answer received during the group-administered questionnaire sessions and the marks / grading given for that answer. This is to show how the grading process was conducted for each answer received.

Furthermore, two graded Lean questionnaires are included in appendix F as examples of how a questionnaire was “marked” (graded). The relevant information and results are displayed in the subsequent chapters.

3.7 Demographics of Warehouses Used in this Study

3.7.1 Warehouse A

The first warehouse used in obtaining the necessary data (pilot study) was an after-market parts & accessories warehouse in the automotive industry, located in Rosslyn, Gauteng. The 3PL is responsible for the receiving, storing, picking, packing and servicing the dealer network throughout South Africa. A total of 18 workers are employed at this warehouse. Only the manager at this warehouse has received prior Lean training.

3.7.2 Warehouse B

The second warehouse used in this study operates in the high-tech industry, relating to printers, scanners and copiers. As with warehouse A, the 3PL is responsible for the receiving, storing, picking and packing of all products. This warehouse is located in Midrand, Gauteng. A total of 25 workers are employed at this facility. No participants at this warehouse have received Lean training.

3.7.3 Warehouse C

The third warehouse used in this study, and operated by the 3PL is in the government education industry, responsible for storing, picking, packing and the delivery of workbooks and textbooks to schools around the country. This warehouse is located in Alberton, Gauteng and has a total of approximately 40 workers. Only the manager at this warehouse has received prior Lean training.

3.7.4 Warehouse D

The final warehouse used in this study operates in the financial industry. The 3PL is responsible for storing, picking, packing and the delivery of high-value items, including bank cards and other banking accessories. This warehouse employs around 45 workers and is located in Roodepoort, Gauteng. No participants at this warehouse have received Lean training.

3.7.5 Summary

Table 6 below shows a summary of the warehouses (and employees) that participated in this study:

Table 6: Warehouse Demographics

Warehouse Demographics				
Warehouse	**Industry**	**Responsibilities**	**Location**	**Number of Workers**
A	**Automotive**	**Receiving, Storing, Picking, Packing, Distribution**	**Rosslyn, Gauteng**	5
B	**High-tech**	**Receiving, Storing, Picking, Packing**	**Midrand, Gauteng**	11
C	**Government Education**	**Receiving, Storing, Picking, Packing, Distribution**	**Alberton, Gauteng**	10
D	**Financial**	**Receiving, Storing, Picking, Packing, Distribution**	**Roodepoort, Gauteng**	17

4. Results

4.1 Introduction

The purpose of this section is to summarise the results of the group-administered questionnaires conducted on warehouse workers employed by the third party logistics provider. It further incorporates the results from the semi-structured follow-up interviews that were held.

The aim of the questionnaire was to 1) determine how well the identified Lean warehousing principles and methods are understood by Managers, Supervisors and Material Handlers respectively, and 2) illustrate the gap in understanding of these principles among the three employment levels. These results were then validated with triangulation using the extensive literature survey covered in chapter 2 of this report, and the data gathered from the follow-up interviews.

The questionnaire was structured around the seven key Lean principles in warehousing, with each associated Lean method, as detailed below:

1. Value

- Customer Value
- Seven Wastes

2. Continuous Improvement

- Continuous Improvement Events
- Employee Suggestions

3. Standardised Processes

- Standard Operating Procedures (SOP's)
- Standardised Work / Planning

4. Visual Management

- Metrics and Key Performance Indicator (KPI) Boards
- Value Stream Mapping

5. Flow & Pull

- Levelled Flow and Work
- Layout and Zones

6. Quality Assurance

- Quality Metrics
- Problem Solving and Error Proofing Methodology

7. Workplace Organisation

- Cleanliness
- 5S and Signage Boards

Each question was graded according to the criteria discussed in the previous section, and the results are displayed later in this chapter.

4.2 Participants

The results from the questionnaires were categorised according to the employment level of each worker. All Managers, Supervisors and Material Handlers results were grouped together respectively and an average grading was obtained for each Lean principle and method.

A total of four warehouses, comprising of 43 participants were used in the study; the first in the automotive industry (the pilot study), the second in the high-tech industry, the third in government education industry and the final warehouse in the financial industry. The four warehouses had the following employment levels:

Table 7: Three Employment Levels Participant Split

Warehouse	Employment Level	Number of Participants	Average Split
A	Manager	1	2%
	Supervisor	1	2%
	Material Handler	3	7%
B	Manager	2	5%
	Supervisor	2	5%
	Material Handler	7	16%
C	Manager	2	5%
	Supervisor	2	5%
	Material Handler	6	14%
D	Manager	2	5%
	Supervisor	1	2%
	Material Handler	14	33%
	Total	43	100%

The following section details the results for the employment levels seen above for each Lean principle and method, along with the outcomes of the follow-up interviews for each principle.

It is important to note that the pilot study was used as part of the final data analysis, as the results gathered were very similar to the other three warehouses. The changes made to the questionnaire after the pilot study was also minimal, and the author believes that it would only enrich the final results.

4.3 Current Understanding of Lean Principles

As stated in previous sections of this research report, a total of 24 questions were asked to participants, relating to the seven Lean principles and associated Lean methods as identified in preceding research. The actual results of the seven Lean principles with regards to the three employment levels are depicted in this section. The presentation of results is split into the seven Lean principles as discussed below.

4.3.1 Layout of the Results Section

The first figure under each of the seven principles shows the average grading of each warehouse with regards to each Lean principle. The average grading of Managers, Supervisors and Material Handlers for each warehouse is shown. Presenting the data in this way enables the reader to quickly compare grading between the warehouses. Example, one can easily evaluate the grading received by Material Handlers between warehouse A, B, C and D.

The second and third figures show the average results of each employment level for all four warehouses. The second figure displays the average grading received by all Managers, Supervisors and Material Handlers respectively with regards to the Lean principle.

The third figure specifies the average grading received by all Managers, Supervisors and Material Handlers respectively for the associated Lean method. Example, the second figure shows the average grading received by all Supervisors for the Value principle (3.0), while the third figure indicates the average score received for each Lean method, Customer Value (2.9) and the Seven Wastes (3.2).

Two tables are also presented in the results section for each Lean principle. The first indicating the average grading and grading category for the Lean principle, while the second table shows the same information for each Lean method. The grading received for each Lean principle and related methods are also explained in detail.

The last section in this chapter summarises the questions and answers obtained from the follow-up interviews. The results from the group-administered questionnaires and the follow-up interviews are discussed in chapter 5.

4.3.2 Value

The first Lean principle identified from literature was Value, with its associated Lean methods Customer Value and Seven Wastes.

The results from the questions above are depicted per employment level (Manager, Supervisor and Material Handler) in the following figures.

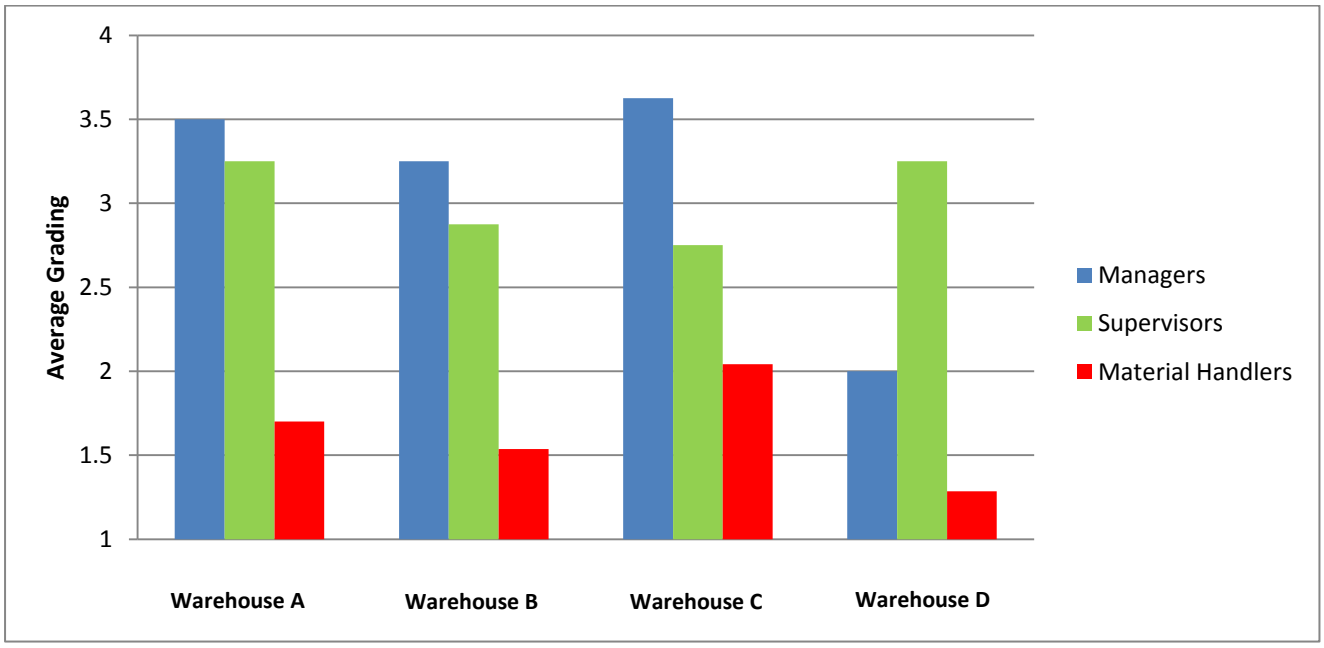

Figure 4: Value – Average Grading per Warehouse

Based on the data gathered and analysed regarding Value, the following conclusions around this principle and its methods can be drawn, as depicted below:

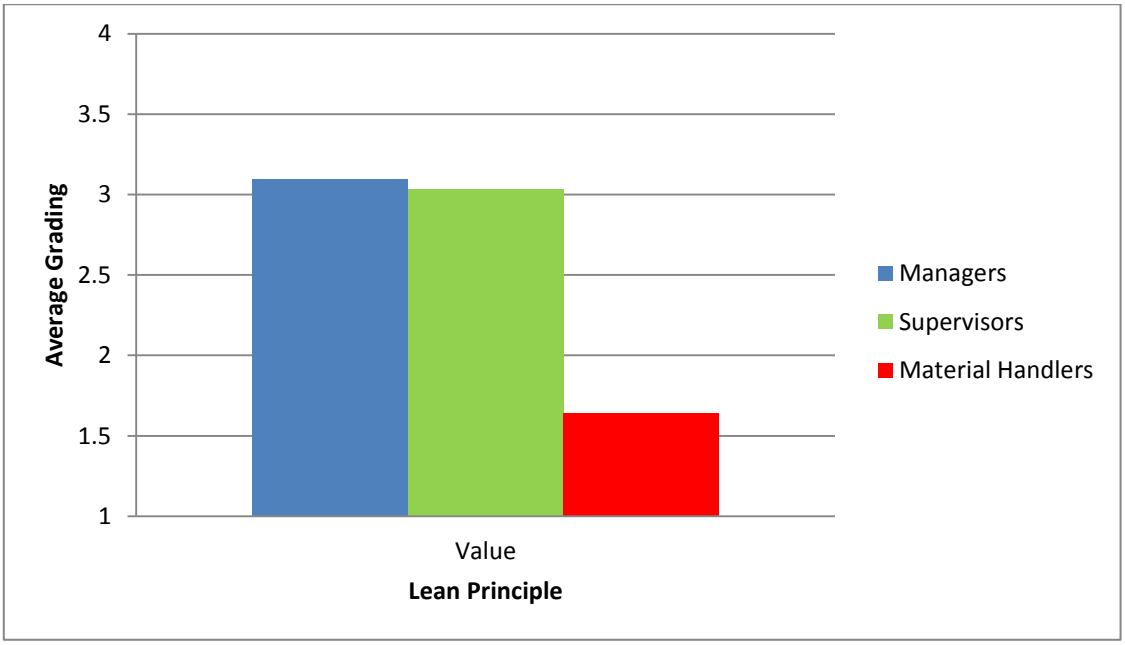

Figure 5: Value Principle

Table 8: Value Principle – Results

Value	Employment Level		
Grading	**Managers**	**Supervisors**	**Material Handlers**
Average Grading	3.1	3.0	1.6
Grading Category	Understood	Understood	Partially Understood

The following questions were asked regarding the Value principle:

- **Customer Value**

1. Why is it important to know what the customer sees as value?
2. Why is it important to know who your customer is?

- **Seven Wastes**

1. What is the definition of a waste?
2. Why is it important to identify and eliminate all wastes in the warehouse?

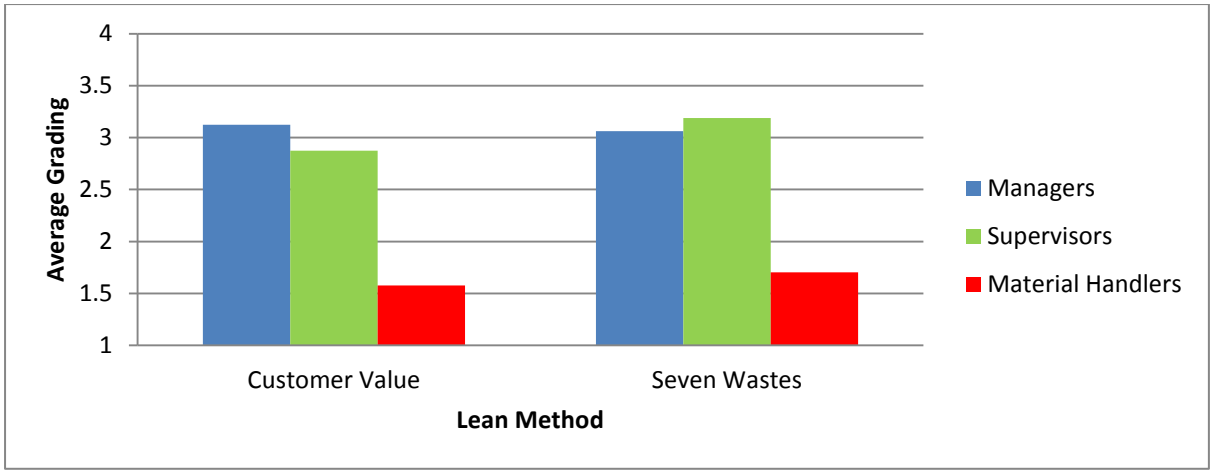

Figure 6: Lean Methods of Value

Table 9: Value Methods – Results

Value		Employment Level		
Lean Method	**Grading**	**Managers**	**Supervisors**	**Material Handlers**
Customer Value	**Average Grading**	3.1	2.9	1.6
	Grading Category	Understood	Understood	Partially Understood
Seven Wastes	**Average Grading**	3.1	3.2	1.7
	Grading Category	Understood	Understood	Partially Understood

The Value principle has two associated Lean methods, namely Customer Value and Seven Wastes.

Both Managers and Supervisors fall into the “Understood” category, with a grading of 3.1 and 3 respectively, while Material Handlers only “Partially Understood” the Value principle with a grading of 1.6.

The Seven Wastes method is only “Partially Understood” by Material Handlers with a grading of 1.7. This is unwanted, seeing that they are the workers operating on the floor, where the most visible and significant waste occurs. According to Bozer (2012), the source of waste is important to understand; as one of the key objectives of Lean is to identify and eliminate waste.

In order to add value to a customer’s product or service, the concept of waste needs to be clearly understood. A definite starting point for Lean training would thus be on the Seven Waste method. Another critical Lean tool used to distinguish waste in any

process is value stream mapping. This is discussed in greater detail under the Visual Management principle.

Furthermore, Customer Value is only just categorised as “Partially Understood” by Material Handlers, with a grading of 1.6, while Managers and Supervisors “Understood” this principle. Participants (especially Material Handlers) found it difficult to answer the questions relating to Customer Value correctly. The importance of knowing your customer and what they consider as valuable is one of the most significant Lean principles.

In line with Bicheno & Holweg (2009) is recognising what is important to the customer and their perspective on value. It is thus very important for all employment levels to recognise what the customer sees as value, in order to create a product / service that they are willing to pay for and that they deem as valuable.

The “Partially Understood” grading category received by Material Handlers for the Value principle may be regarded as a potential risk for an operation. It all starts with the customer and understanding their needs and what’s important to them sets the tone for all downstream processes.

The knowledge of the Value principle among shop-floor workers (and that of all employment levels) is a certain focus point, as it is the starting point of Lean (Bicheno & Holweg, 2009).

4.3.3 Continuous Improvement

The second Lean principle identified from literature was Continuous Improvement, with its related Lean methods Continuous Improvement Events and Employee Suggestions.

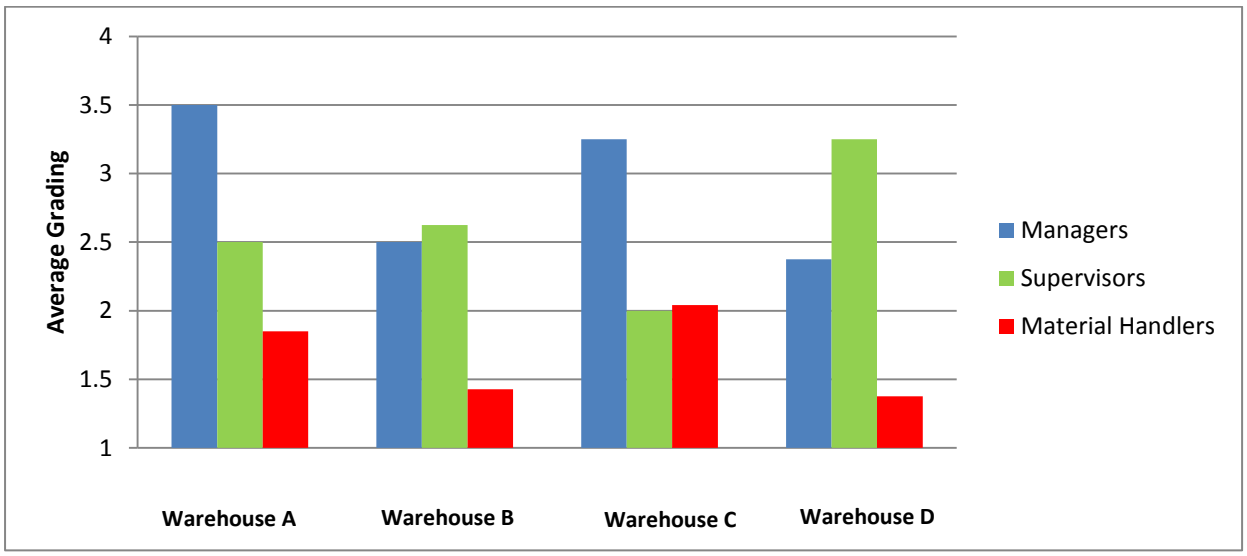

Figure 7: Continuous Improvement – Average Grading per Warehouse

The figures and tables below depict the average grading and grading category received by the three employment levels with regards to the Continuous Improvement principle and methods.

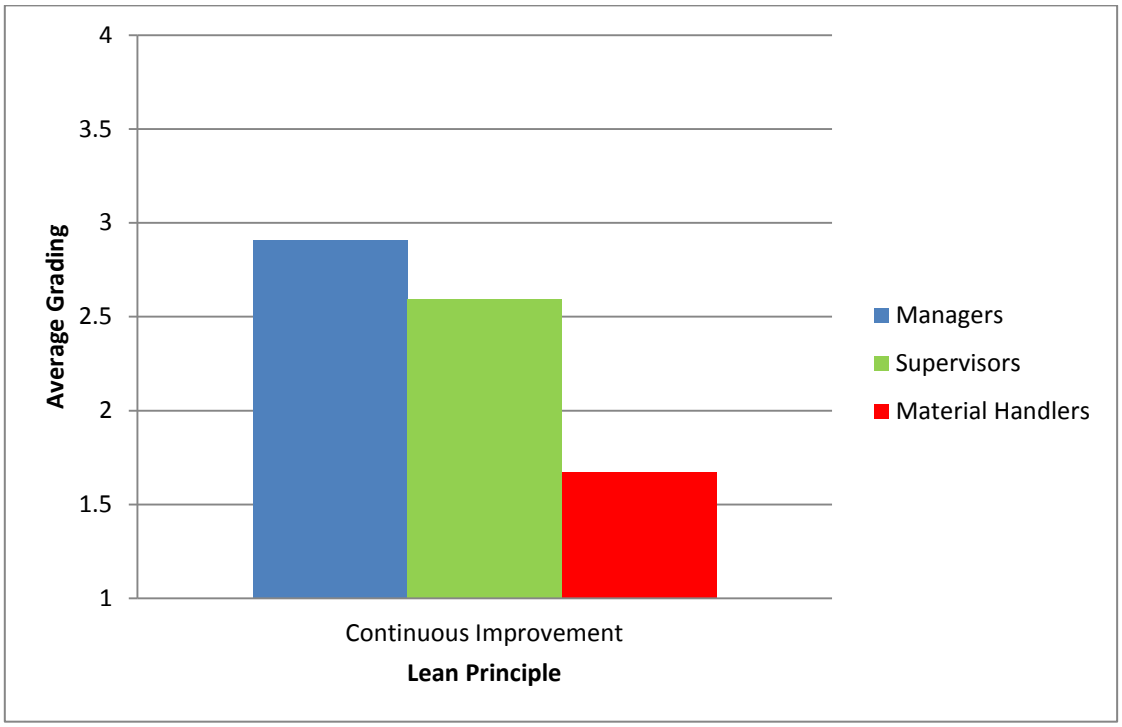

Figure 8: Continuous Improvement Principle

Table 10: Continuous Improvement Principle – Results

Continuous Improvement	Employment Level		
Grading	**Managers**	**Supervisors**	**Material Handlers**
Average Grading	2.9	2.6	1.7
Grading Category	Understood	Understood	Partially Understood

The following questions were asked regarding the Continuous Improvement principle:

- **Continuous Improvement Events**

1. Explain what you understand under a continuous improvement event?
2. Why do you think continuous improvement activities are important?

- **Employee Suggestions**

1. What do you think is the purpose of an employee suggestion programme?
2. How would an employee suggestion programme benefit you as an employee?

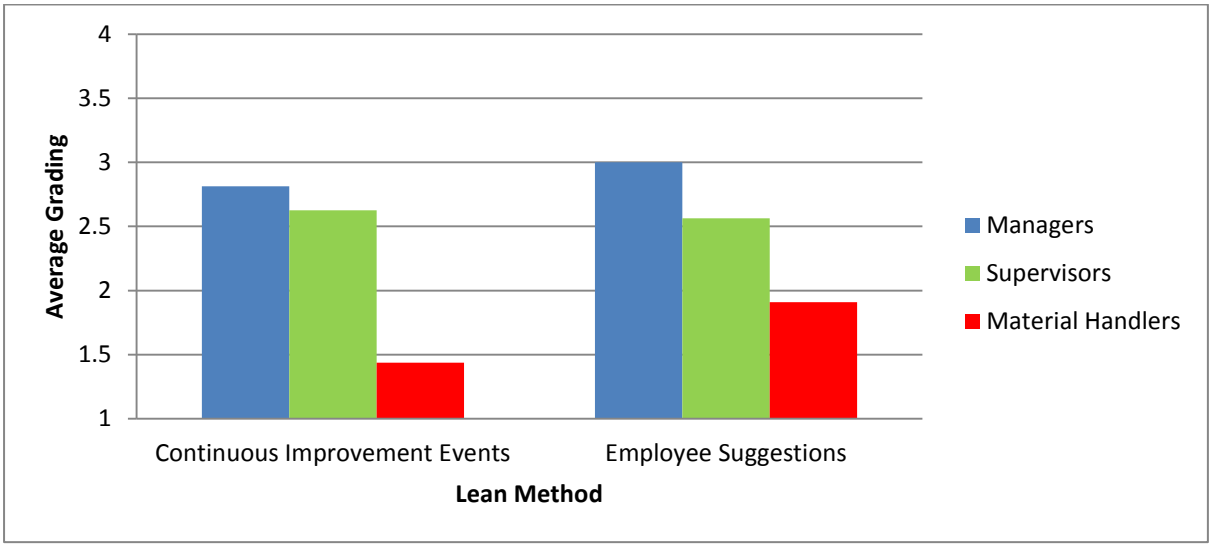

Figure 9: Lean Methods of Continuous Improvement

Table 11: Continuous Improvement Methods – Results

Continuous Improvement		Employment Level		
Lean Method	**Grading**	**Managers**	**Supervisors**	**Material Handlers**
Continuous Improvement Events	**Average Grading**	2.8	2.6	1.4
	Grading Category	Understood	Understood	Not Understood
Employee Suggestions	**Average Grading**	3.0	2.6	1.9
	Grading Category	Understood	Understood	Partially Understood

The Continuous Improvement principle has two related Lean methods, Continuous Improvement Events and Employee Suggestions.

Material Handlers fall into the “Partially Understood” category, while Managers and Supervisors “Understood” the Continuous Improvement principle.

Important to note is that the questions regarding the Continuous Improvement Events method was aimed at obtaining the understanding of such an event (a Kaizen event), although most answers provided by participants tried to give the definition of continuous improvement. This was however, also accepted by the author as the correct answer.

This being said, the lack of understanding by Material Handlers (with a score of 1.4), of continuous improvement is far from ideal in any warehouse. Managers and Supervisors “Understood” this method, but room for improvement remains.

In relation to Womack and Jones (2003), continuous improvement will always be necessary regardless of how many times an activity has been improved. There will continually be more ways of eliminating waste.

To reaffirm the above, Sobanski (2009) believes that the most significant Lean principle within warehousing relates to continuous improvement. Sobanski (2009) further states that the continuous improvement principle is more important than any other principle, as it engages employees through problem solving.

It is therefore imperative to ensure that a continuous improvement culture is instilled in all employees and that they are properly trained to approach their daily tasks with continuous improvement (and problem solving) in mind. This will enable them to take ownership of their work as well as improve on a daily basis.

Employee Suggestions is a better understood method among employees. Material Handlers “Partially Understood” this method with a grading of 1.9. Seeing that this is the platform that allows employees to communicate their ideas and suggestions to management (especially those working on the floor), it is equally important to address this. It may further lead to improving employee morale and motivation.

The gap in knowledge between management and shop-floor workers will limit a truly effective culture of Lean. Closing this gap will enable a warehouse to increase the

possibility of successfully embracing a culture of continuous improvement. A continuous improvement culture will ensure on-going improvements, employee satisfaction and engagement.

4.3.4 Standardised Work / Processes

The third Lean principle identified from literature was Standardised Work / Processes, with its associated Lean methods Standard Operating Procedures (SOP's) and Standardised Work / Planning.

The results from the questions above are depicted per employment level (Manager, Supervisor and Material Handler) in the following figures.

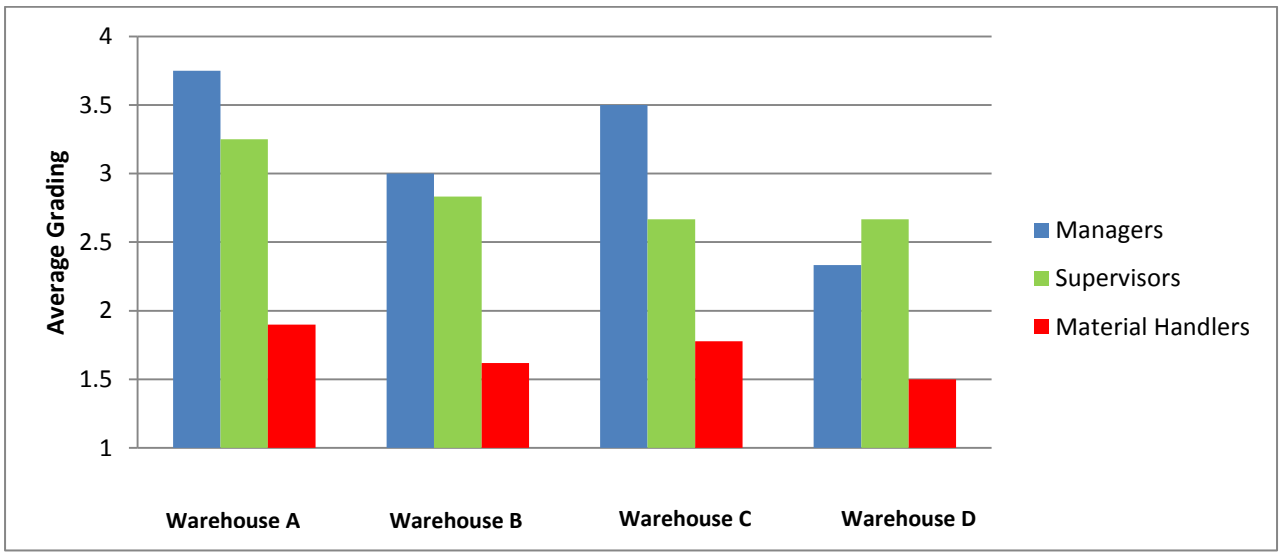

Figure 10: Standardised Work / Processes – Average Grading per Warehouse

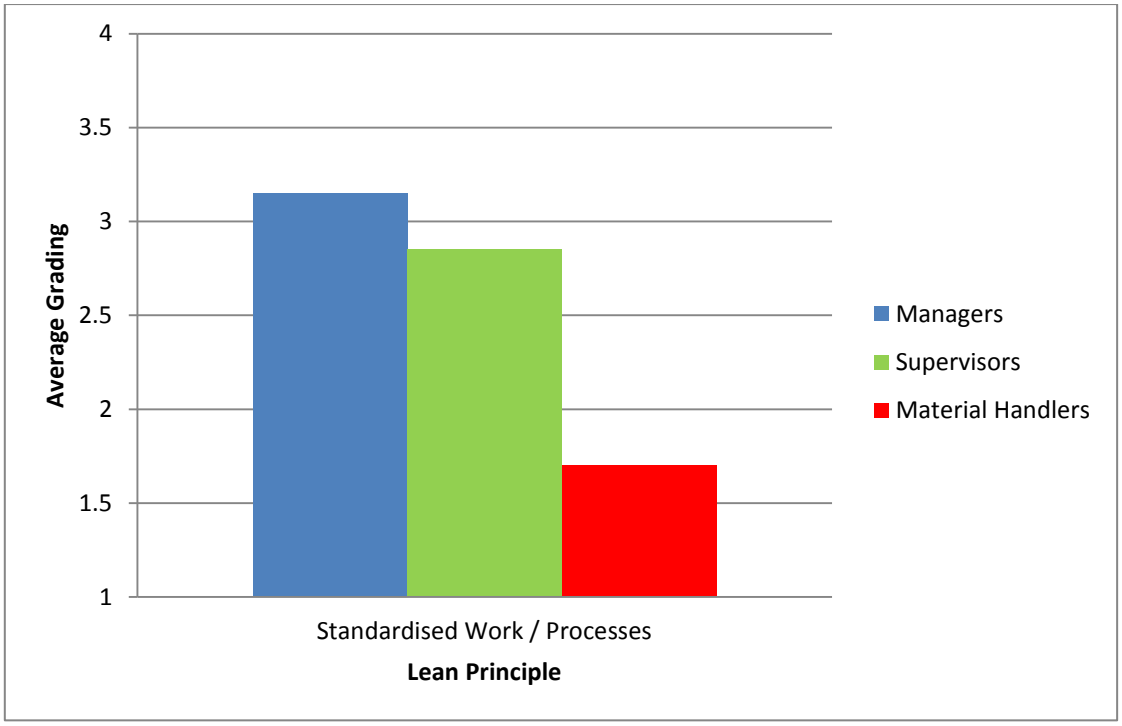

Figure 11: Standardised Work / Processes Principle

Table 12: Standardised Work / Processes Principle – Results

Standardised Work / Processes	Employment Level		
Grading	**Managers**	**Supervisors**	**Material Handlers**
Average Grading	3.1	2.9	1.7
Grading Category	Understood	Understood	Partially Understood

The following questions were asked regarding the Standardised Work / Processes principle:

- **Standard Operating Procedures (SOP's)**

1. What is the main purpose of a Standard Operating Procedure (SOP)?
2. Why is it important to have a Standard Operating Procedure (SOP) visible in the warehouse?

- **Standardised Work / Planning**

1. Why is it important to plan daily work activities based on standardised work units?
2. What is the purpose of balancing work flow for activities within the warehouse?

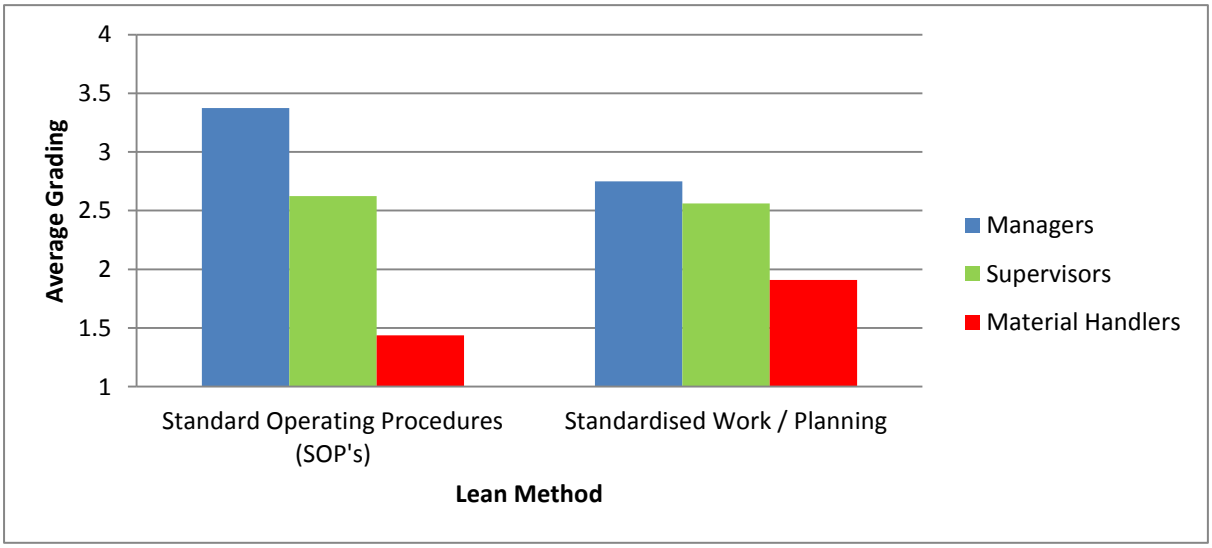

Figure 12: Lean Methods of Standardised Work / Processes

Table 13: Standardised Work / Processes Methods – Results

Standardised Work / Processes		Employment Level		
Lean Method	**Grading**	**Managers**	**Supervisors**	**Material Handlers**
Standard Operating Procedures (SOP's)	**Average Grading**	3.4	3.2	1.7
	Grading Category	Understood	Understood	Partially Understood
Standardised Work / Planning	**Average Grading**	2.8	2.4	1.6
	Grading Category	Understood	Partially Understood	Partially Understood

The Standardised Work / Processes principle has two Lean methods, namely Standard Operating Procedures (SOP's) and Standardised Work / Planning.

The Standardised Work / Processes principle was "Understood" by Managers and Supervisors with a grading of 3.1 and 2.9 respectively, and "Partially Understood" by Material Handlers with 1.7.

One thing to highlight is the "Partially Understood" category for the SOP method by Material Handlers. In order to perform a certain task or process effectively and efficiently, the best method of doing it needs to be understood. Furthermore, displaying an SOP in the workers' area is equally important, as it serves as a constant reminder of the best method to perform a certain task.

Womack and Jones (2003) state that standard work is the best way to get a job done in the allocated time, and getting it right the first time, every time.

By ensuring that the employees understand the purpose of an SOP is very important as it creates a standard process of doing a task. Only once there is a standard operating procedure in place and followed consistently, can quality be guaranteed and can the process be continuously improved.

It is thus essential for Material Handlers to improve on this principle (with the necessary guidance and involvement from Managers), as they are the ones most affected in their daily activities.

4.3.5 Visual Management

The fourth Lean principle was Visual Management, with its related Lean methods Metrics & KPI Boards and Value Stream Mapping.

The results for each employment level (Manager, Supervisor and Material Handler) are shown in the figures below.

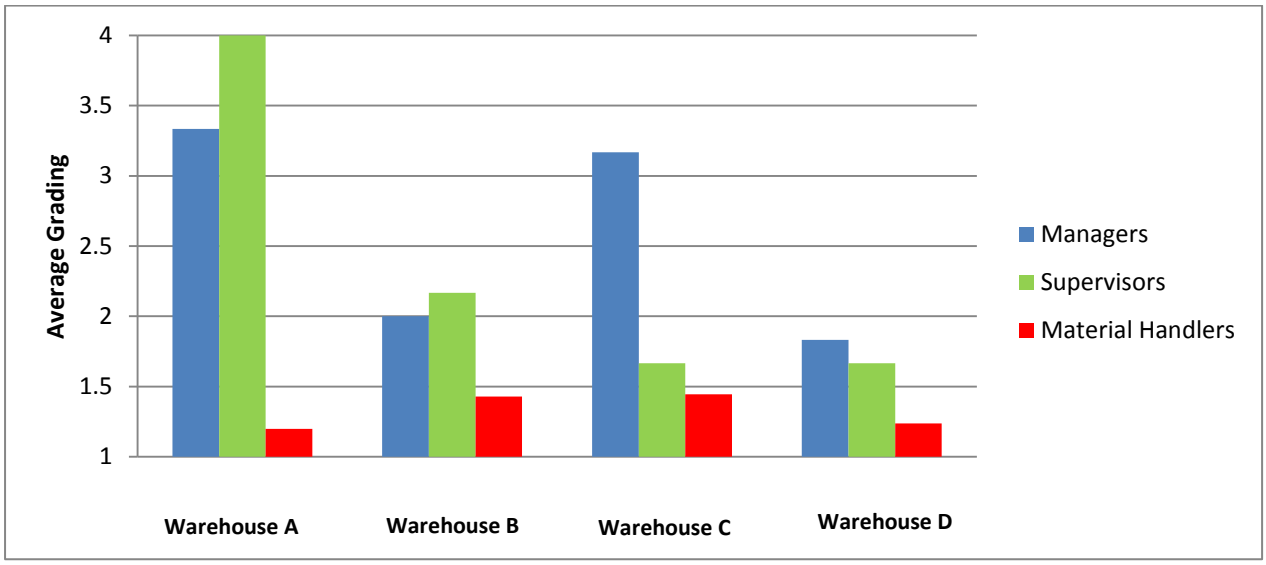

Figure 13: Visual Management – Average Grading per Warehouse

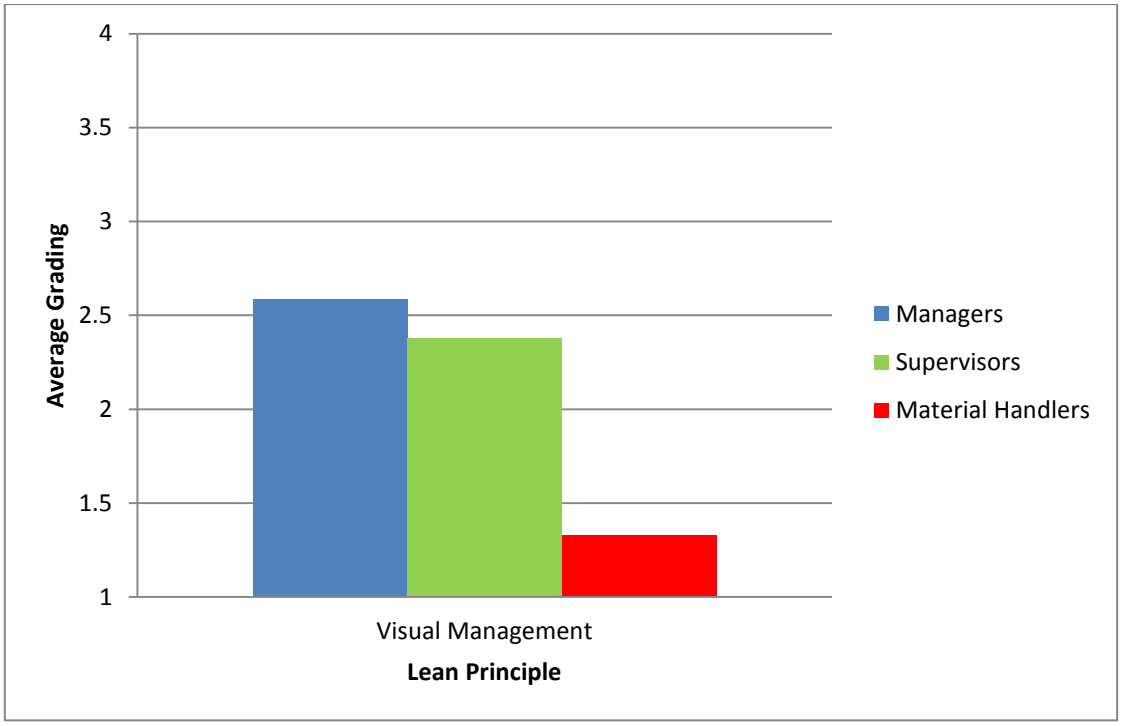

Figure 14: Visual Management Principle

Table 14: Visual Management Principle – Results

Visual Management	Employment Level		
Grading	**Managers**	**Supervisors**	**Material Handlers**
Average Grading	2.6	2.4	1.3
Grading Category	Understood	Partially Understood	Not Understood

The following questions were asked regarding the Visual Management principle:

- **Metrics and Key Performance Indicator (KPI) Boards**

1. Why is it important to track and display key metrics (such as on-time shipment, customer satisfaction, inventory accuracy, picking productivity and accuracy etc.) and KPI's in the warehouse?

- **Value Stream Mapping**

1. What is the main purpose of Value Stream Mapping?
2. How would Value Stream Mapping benefit you as an employee?

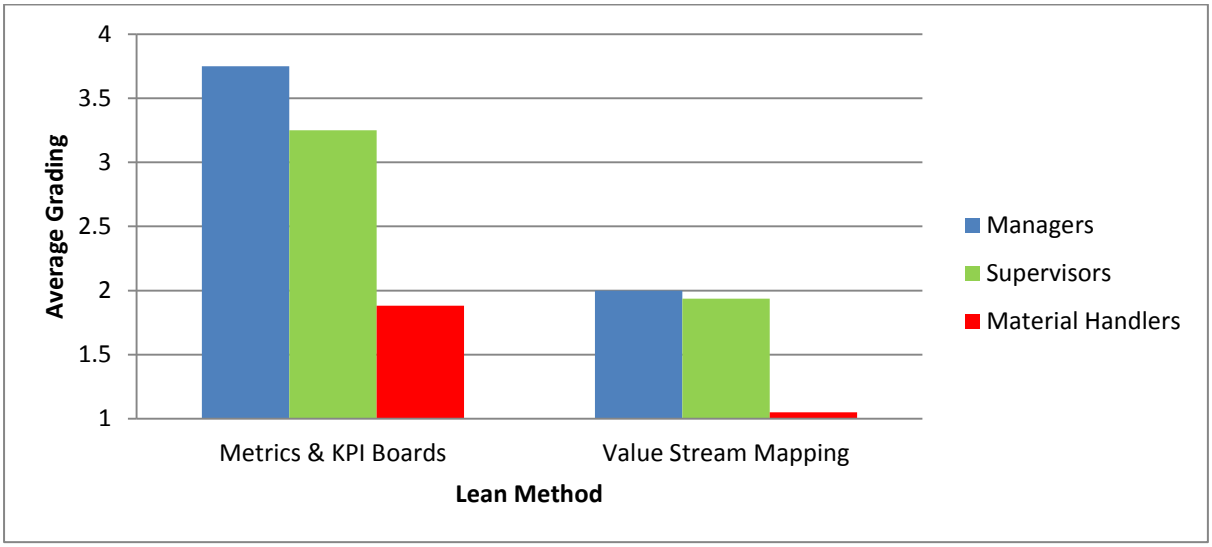

Figure 15: Lean Methods of Visual Management

Table 15: Visual Management Methods – Results

Visual Management		Employment Level		
Lean Method	**Grading**	**Managers**	**Supervisors**	**Material Handlers**
Metrics & KPI Boards	**Average Grading**	3.8	3.3	1.9
	Grading Category	Well Understood	Understood	Partially Understood
Value Stream Mapping	**Average Grading**	2.0	1.9	1.1
	Grading Category	Partially Understood	Partially Understood	Not Understood

The Visual Management principle has two accompanying Lean methods, namely Metrics & KPI Boards and Value Stream Mapping.

According to Jacobs et al (2009), the idea is to develop a detailed diagram of a process that clearly shows activities that add value, that do not add value, and steps that involves just waiting. By drawing a diagram that identifies the non-value adding activities, we can understand the impact of changing certain processes. This diagram is called value stream mapping.

Based on the data acquired on Visual Management, Managers barely “Understood” this principle with a grading of 2.6, while Supervisors “Partially Understood” with 2.4 and Material Handlers did not understand this principle, scoring 1.3. The Visual Management principle received the worst grading of all principles among all employment levels. This is primarily due to all participants struggling to answer the questions relating to value stream mapping. Both Managers and Supervisors only “Partially Understood” this method, while Material Handlers are believed to not understand this method. Most participants were not aware of what a value stream map is, or what it is used for.

Jacobs et al. (2009), states that it is important for all employees to see the value that they are contributing to the product or service. In order to achieve this, value stream mapping (VSM) is introduced. It is thus vital for all employees to spend time together and map out the value stream, indicating the value adding and non–value adding activities, and illustrating the importance of certain steps in the process. This will enhance employee engagement as well as help them identify continuous improvement activities within the warehouse. It will further expose the waste within the process / warehouse.

There is a wide lack of understanding the value stream mapping method, which can be greatly beneficial if used correctly. This is thus a certain starting point when compiling Lean training material for all employment levels. Equally, all employees, especially those working in the specific areas in the warehouse should be involved with and responsible for developing and updating the value stream map. This will assist in building a Lean culture where continuous improvement is at the heart of all activities. It will further enhance employee engagement to create value adding activities free of any waste.

The questions relating to Metrics & KPI Boards were well answered, as they were among the best graded methods. This method was “Well Understood” by Managers, with a grading of 3.8, while Supervisors “Understood” this method with a grading of 3.3. Material Handlers “Partially Understood” this method with a score of 1.9. Most participants are familiar with the objective of displaying key metrics within the warehouse, but frequent discussions around these measures should continue to take place.

4.3.6 Flow & Pull

The fifth Lean principle identified from literature was Flow & Pull, with its associated Lean methods Levelled Flow & Work and Layout & Zones.

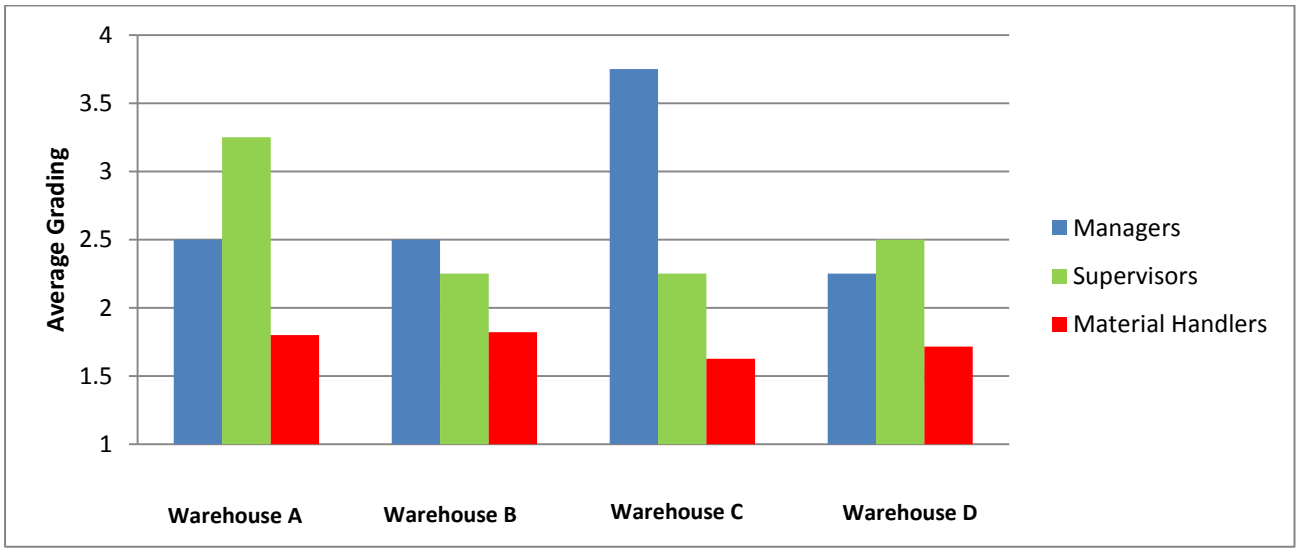

Figure 16: Flow & Pull – Average Grading per Warehouse

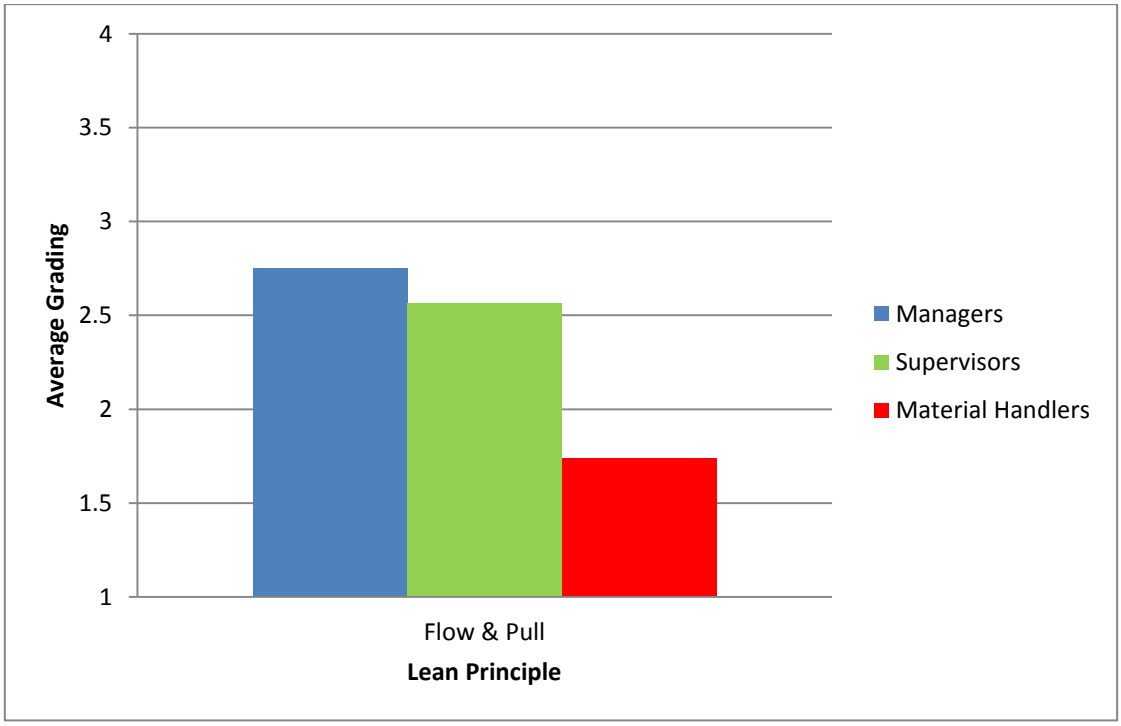

Figure 17: Flow & Pull Principle

Table 16: Flow & Pull Principle – Results

Flow & Pull	Employment Level		
Grading	Managers	Supervisors	Material Handlers
Average Grading	2.8	2.6	1.7
Grading Category	Understood	Understood	Partially Understood

The following questions were asked regarding the Flow & Pull principle:

- **Levelled Flow and Work**

1. What is the main purpose of a pull system within a warehouse?
2. Why is it important to level the flow of material and work within a warehouse?

- **Layout and Zones**

1. What are the benefits of grouping similar items in the same zone within a warehouse?
2. What are the benefits of placing the fastest moving items in locations closest to the receiving and dispatch areas?

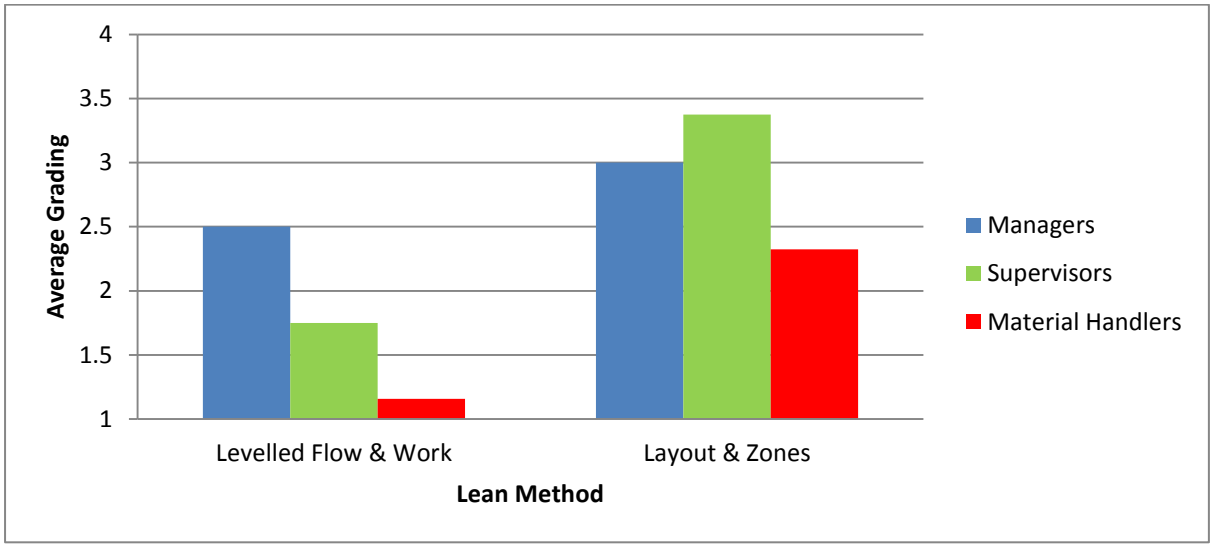

Figure 18: Lean Methods of Flow & Pull

Table 17: Flow & Pull Methods – Results

Flow & Pull		Employment Level		
Lean Method	**Grading**	**Managers**	**Supervisors**	**Material Handlers**
Levelled Flow & Work	**Average Grading**	2.5	1.8	1.2
	Grading Category	Partially Understood	Partially Understood	Not Understood
Layout & Zones	**Average Grading**	3.0	3.4	2.3
	Grading Category	Understood	Understood	Partially Understood

The Flow & Pull principle has two related Lean methods, namely Levelled Flow & Work and Layout & Zones.

Managers and Supervisors “Understood” the Flow & Pull principle, while Material Handlers only “Partially Understood” this principle. This is largely due to a lack of understanding of the Levelled Flow & Work method. Managers and Supervisors “Partially Understood” this method with a grading of 2.5 and 1.8 respectively, while Material Handlers do not understand this method with a grading of only 1.2. This is also among the poorest scores for any Lean method.

If the daily work to be completed is not planned properly in advance, it can lead to bottlenecks in the system, meaning customer orders may not be dispatched within the required timelines.

Womack and Jones (2003) classify Flow as the progressive success of activities along the value stream so that products continue from raw materials to delivery and into the hands of the customer without any form of delay or stoppages, while Pull can be classified as supplying a product or service at the customer’s rate of demand.

Appropriate planning and optimising flow of material is important for all employees to ensure daily work gets completed within the necessary timelines.

4.3.7 Quality Assurance

The sixth Lean principle was Quality Assurance, with its Lean methods Quality Metrics and Problem Solving & Error Proof Methodology.

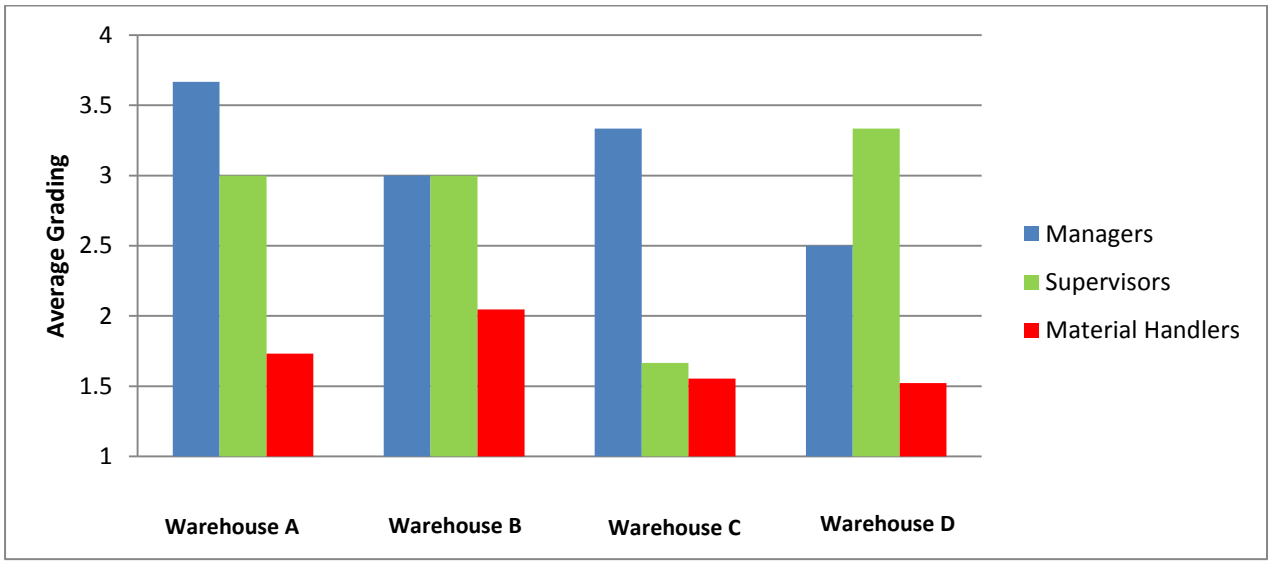

Figure 19: Quality Assurance – Average Grading per Warehouse

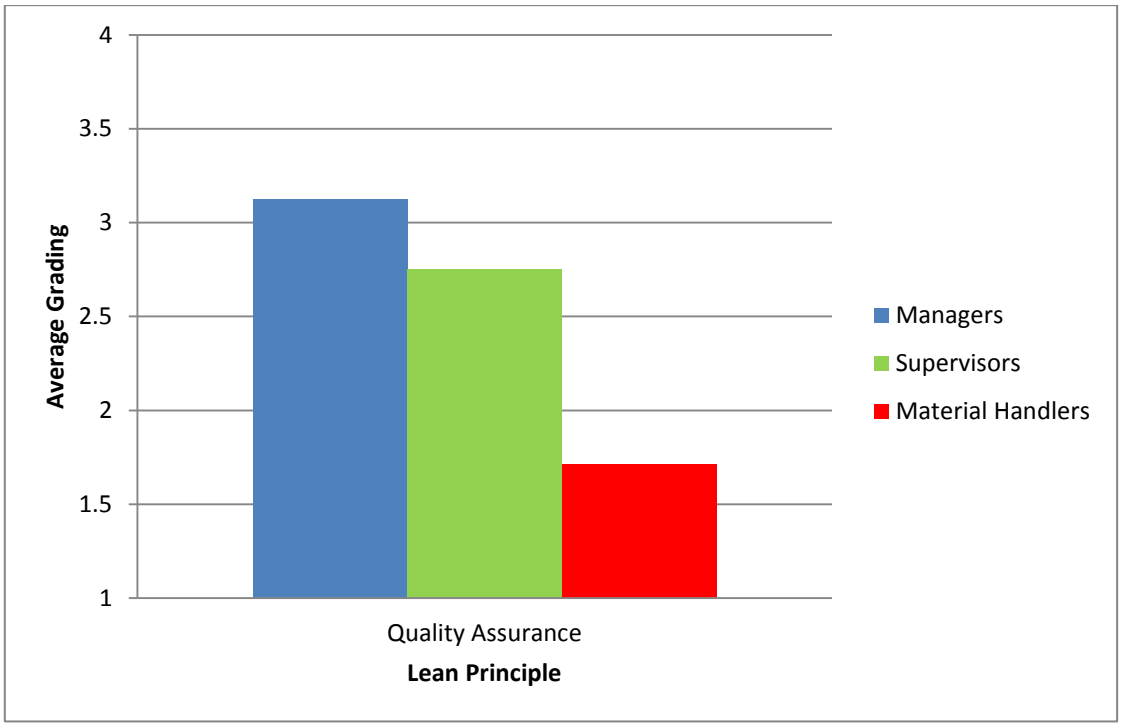

Figure 20: Quality Assurance Principle

Table 18: Quality Assurance Principle – Results

Quality Assurance	Employment Level		
Grading	**Managers**	**Supervisors**	**Material Handlers**
Average Grading	3.1	2.8	1.7
Grading Category	Understood	Understood	Partially Understood

The following questions were asked regarding the Quality Assurance principle:

- **Quality Metrics**

1. Why is it important to have corrective action procedures (CAPA) in place for processes within a warehouse?

- **Problem Solving and Error Proofing Methodology**

1. What is the importance of having a structured problem solving procedure (5Why's, root cause analysis, etc.) in place to determine the root cause?
2. Why is it important to have built-in quality checks in all processes within a warehouse?

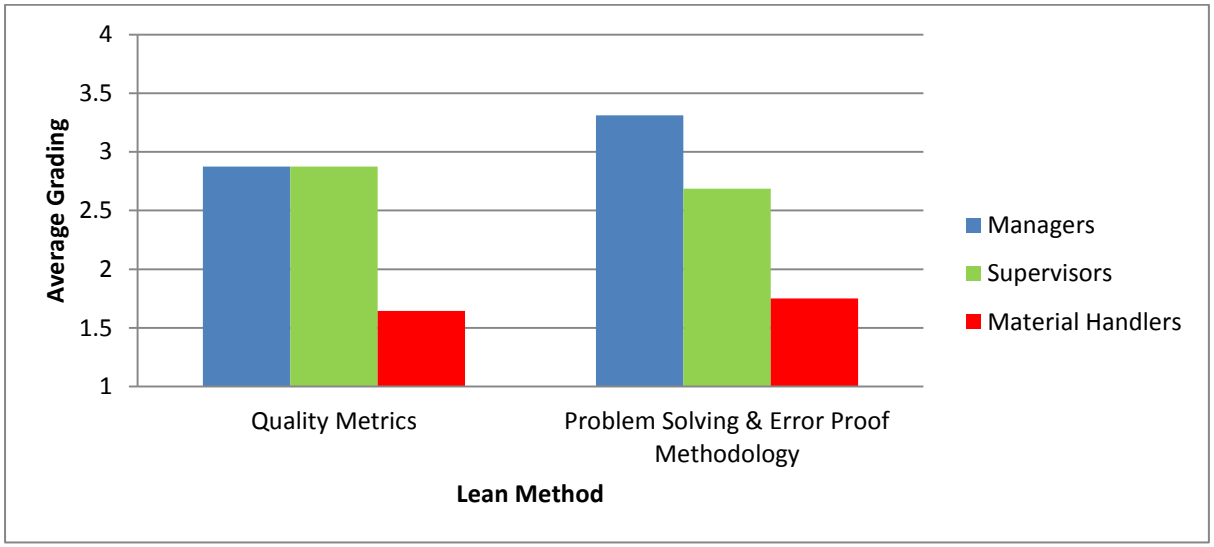

Figure 21: Lean Methods of Quality Assurance

Table 19: Quality Assurance Methods – Results

Quality Assurance		Employment Level		
Lean Method	**Grading**	**Managers**	**Supervisors**	**Material Handlers**
Quality Metrics	**Average Grading**	2.9	2.9	1.6
	Grading Category	Understood	Understood	Partially Understood
Problem Solving & Error Proof Methodology	**Average Grading**	3.3	2.7	1.8
	Grading Category	Understood	Understood	Partially Understood

The Quality Assurance principle has two Lean methods, namely Quality Metrics and Problem Solving & Error Proofing Methodology.

It is apparent that Quality is “Understood” by Managers and Supervisors (3.1 and 2.8 respectively), but only “Partially Understood” by Material Handlers (1.7). Although quality metrics can be put in place to prevent repeated errors or mistakes, it is imperative that it is also understood by the employees working with it hands-on, i.e. the Material Handlers. Problem solving and error proofing techniques should be taught to these workers to enable them to effectively address and solve issues as they occur (this again, has a close connection with continuous improvement).

By assuring that there is a structured problem solving procedure in place to determine the root cause of a problem, as well as properly understanding this process, employees will be able to address problems as they occur and ensure that customers aren’t serviced with incorrect items. It will further reduce the number of rework required in the warehouse and other parts of the supply chain.

Emphasis should be placed on error proofing processes and proper training of the necessary tools to be used when presented with a problem. This will lead to higher quality output to customers.

4.3.8 Workplace Organisation

The final Lean principle identified was Workplace Organisation, with its Lean methods Cleanliness and 5S & Signage Boards.

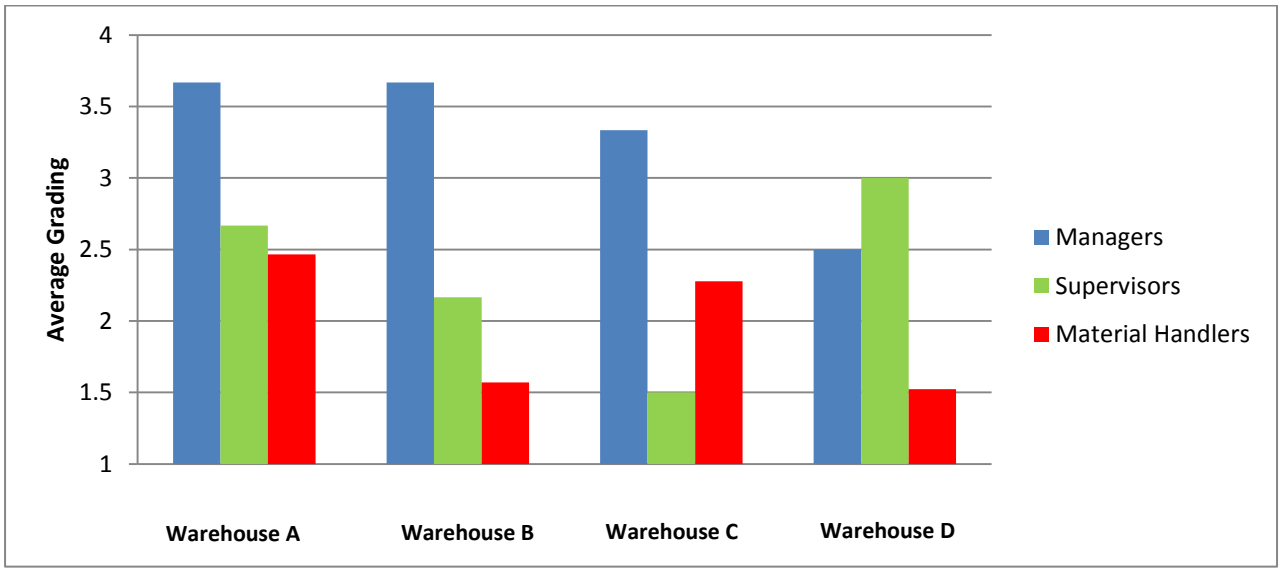

Figure 22: Workplace Organisation – Average Grading per Warehouse

The following questions were asked regarding the Workplace Organisation principle:

- **Cleanliness**

1. What is the importance of proper housekeeping (keeping all areas in the warehouse clean)?

- **5S and Signage Boards**

1. What are the main benefits of an active 5S programme in the warehouse?
2. What is the main purpose of appropriate signage (sign boards) in all areas within a warehouse?

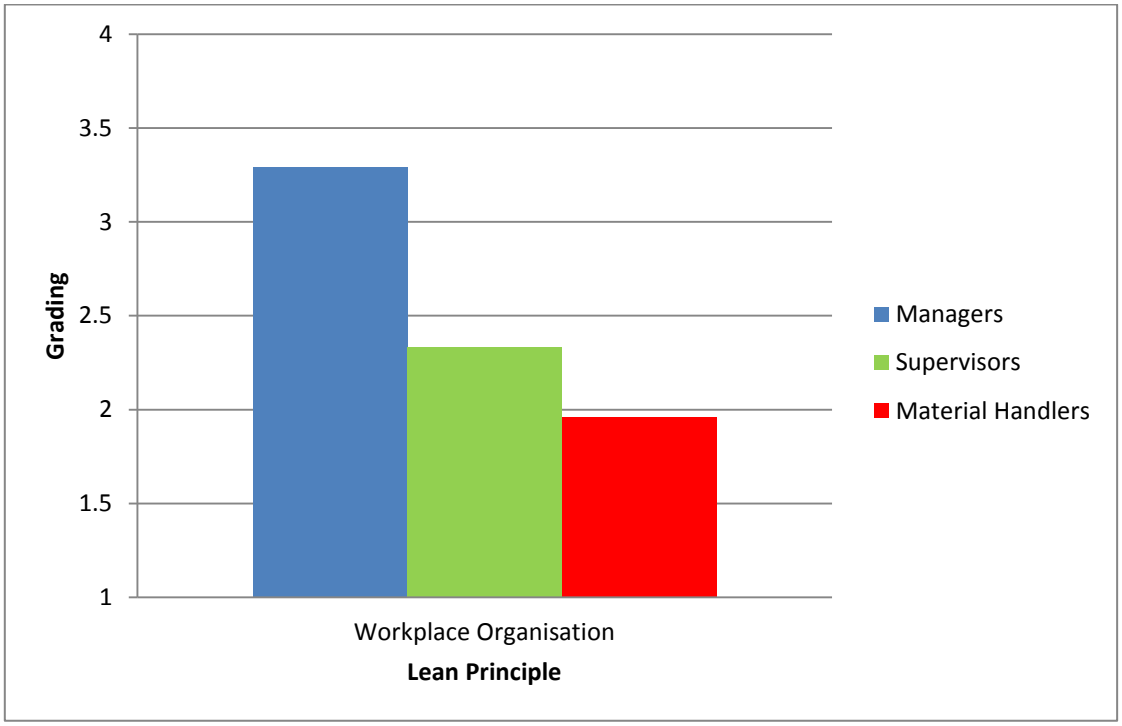

Figure 23: Workplace Organisation Principle

Table 20: Workplace Organisation Principle – Results

Workplace Organisation	Employment Level		
Grading	**Managers**	**Supervisors**	**Material Handlers**
Average Grading	3.3	2.3	2.0
Grading Category	Understood	Partially Understood	Partially Understood

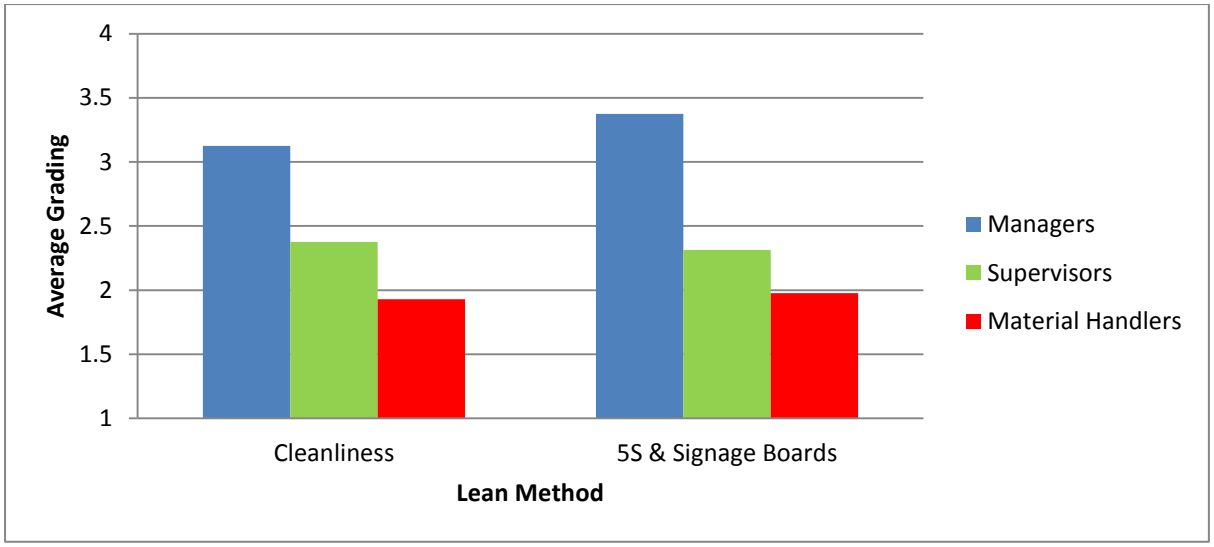

Figure 24: Lean Methods of Workplace Organisation

Table 21: Workplace Organisation Methods – Results

Workplace Organisation		Employment Level		
Lean Method	**Grading**	**Managers**	**Supervisors**	**Material Handlers**
Cleanliness	**Average Grading**	3.1	2.4	1.9
	Grading Category	Understood	Partially Understood	Partially Understood
5S & Signage Boards	**Average Grading**	3.4	2.3	2.0
	Grading Category	Understood	Partially Understood	Partially Understood

The final Lean principle, the Workplace Organisation principle, has two Lean methods, Cleanliness and 5S & Signage Boards.

Workplace Organisation is “Understood” by Managers with a grading of 3.3, while it is only “Partially Understood” by Supervisors and Material Handlers with a grading of 2.3 and 2.0 respectively. It’s noticeable that Managers appreciate the importance of this principle, and the benefits that can be realised when it is enforced.

The importance of a clean, clearly demarcated warehouse cannot be overstated. It enhances the workplace, increases safety and reduces the risk of making errors. It further minimises the waste within the warehouse.

A clean, neat facility (also referred to as housekeeping) and appropriate signage is seen as one of the basics of warehousing. It is therefore unwanted that the

employees working on the floor, Supervisors and Material Handlers only “Partially Understood” this principle. In order to excel in the warehouse, a neat and professional looking facility is vital.

A Lean tool that will help solve this issue is an active 5S programme. Bicheno and Holweg (2009) believe it is used to ensure that there is a place for everything, and everything is in its place. While applicable Signage Boards act as a tool to reduce waste associated with looking for equipment, tools and places.

Although the Workplace Organisation principle is one that has graded well against the others, it still requires more focus (particularly among Supervisors and Material Handlers), where Managers need to get involved to ensure that all employees understand the importance thereof. A well organised facility creates visual changes that can encourage employees.

4.3.9 Summary

The average grading of all employment levels for all four warehouses, i.e. Managers, Supervisors and Material Handlers with regards to the seven Lean principles and associated Lean methods are shown in figures 25 and 26 below. The line graph clearly indicates the gap in understanding (grading) of Lean principles between the three employment levels, and specifically the gap between Managers and Supervisors and that of Material Handlers.

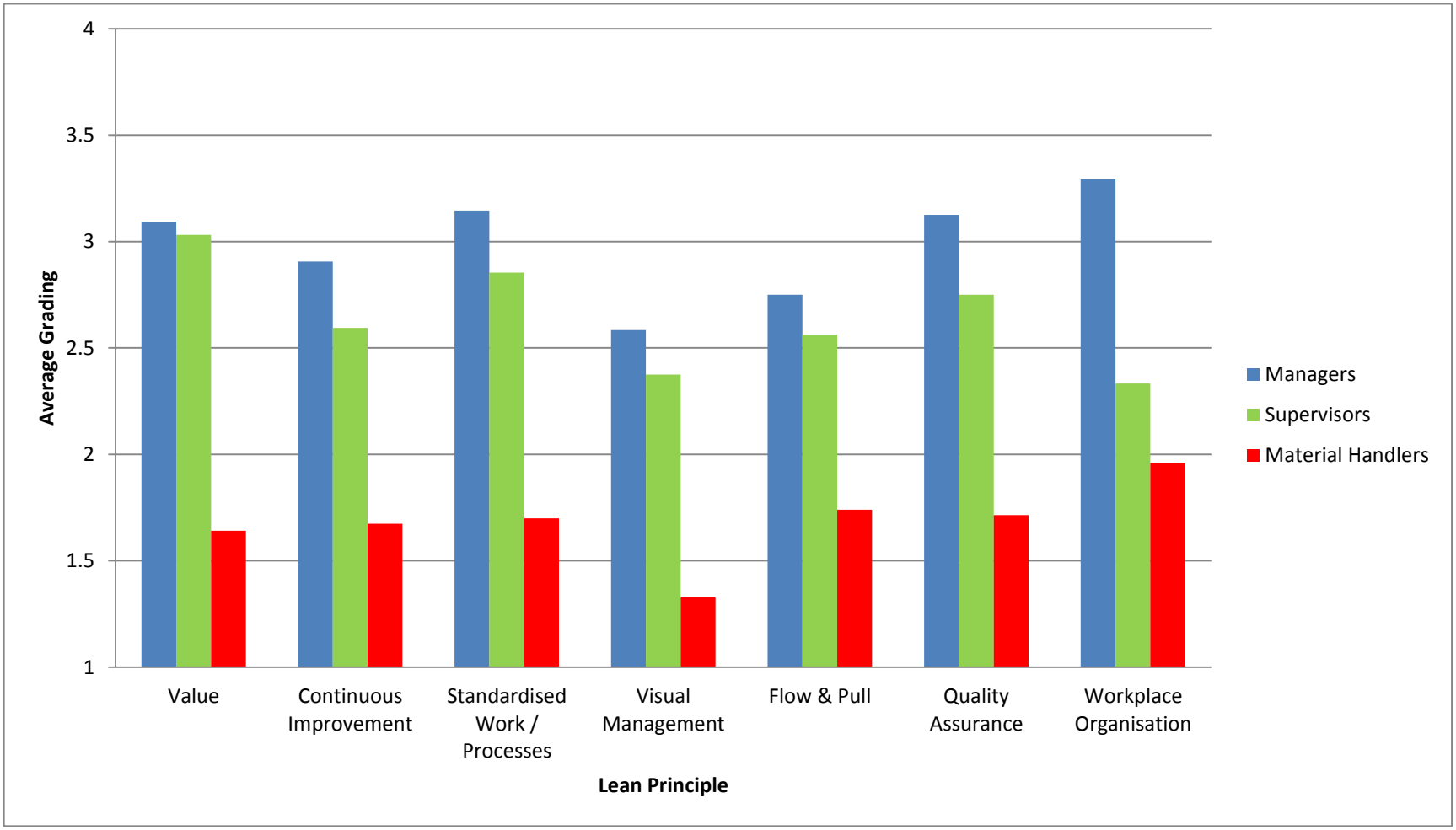

Figure 25: Combined – Average Grading for all Lean Principles

A line graph is also shown to indicate the gap in understanding (grading) of each Lean method for the three employment levels. There exists a clear gap among Managers, Supervisors and Material Handlers. The main outliers are discussed below:

- **Metrics & KPI Boards**
  1. This Lean method received the highest grading among Managers. This is because they understand the value in displaying and keeping track of the daily progress, and how it relates to a successful operation.
- **Value Stream Mapping**
  1. Material Handlers scored the worst grading for this Lean method. This is not surprising, as the concept of VSM was misunderstood by all employment levels. This is due to very limited exposure to this concept at the third party logistics provider being studied.
- **Layout & Zones**
  1. This Lean method received the highest grading among Supervisors, higher than that of Managers. Material Handlers also scored their highest grading for this Lean method. This is a positive indication for an operation, and most likely due to them spending most of their time on the warehouse floor.

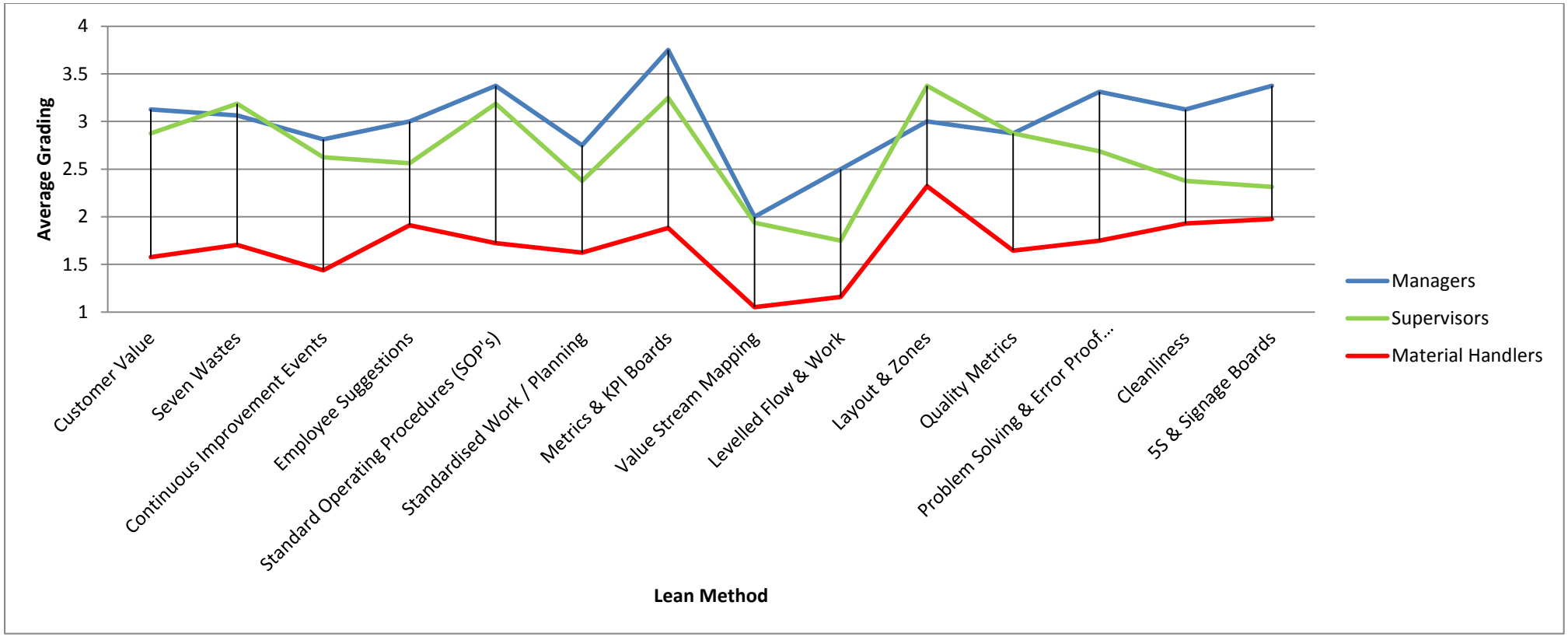

Figure 26: Combined – Average Grading for all Lean Methods

Table 22 below summarises all the results gathered during the group-administered Lean questionnaire. It illustrates the average grading, mode, median, range and grading category for each of the seven Lean principles. The significance of these statistical terms is discussed in the next chapter.

Table 22: Summary of Results

Lean Principle	Managers					Supervisors					Material Handlers				
	Avg. Grading	Mode	Median	Range	Grading Category	Avg. Grading	Mode	Median	Range	Grading Category	Avg. Grading	Mode	Median	Range	Grading Category
Value	3.1	4	3	3	Understood	3.0	3	3	3	Understood	1.6	1	1	3	Partially Understood
Continuous Improvement	2.9	4	3	3	Understood	2.6	3	3	3	Understood	1.7	1	1	3	Partially Understood
Standardised Work / Processes	3.1	4	3	2	Understood	2.9	3	3	3	Understood	1.7	1	1	3	Partially Understood
Visual Management	2.6	4	3	3	Understood	2.4	1	2	3	Partially Understood	1.3	1	1	3	Not Understood
Flow & Pull	2.8	4	3	3	Understood	2.6	1 & 4	2	3	Understood	1.7	1	1	3	Partially Understood
Quality Assurance	3.1	4	3	2	Understood	2.8	3	3	3	Understood	1.7	1	1	3	Partially Understood
Workplace Organisation	3.3	4	3	3	Understood	2.3	2	2	3	Partially Understood	2.0	1	2	3	Partially Understood
AVERAGE	**3.0**				**Understood**	**2.6**				**Understood**	**1.7**				**Partially Understood**

All results obtained in this section will be discussed according to the aforementioned research objectives and research question:

What is the current gap of understanding of a 3PL's warehouse employees on key Lean principles in warehousing?

The results are discussed in great detail in Chapter 5.

4.4 Follow-up Interview Results

As mentioned in the previous section, the purpose of the semi-structured interviews was to guarantee validity of the research findings. This was achieved by conducting separate follow-up interview sessions with both the manager and a supervisor from three of the warehouses that partook in the study. The manager and supervisor for each respective warehouse were interviewed simultaneously.

According to DiCicco-Bloom & Crabtree (2006), semi-structured interviews are the most common interviewing format for qualitative research and can transpire either with an individual or in groups. In this case, two participants were interviewed together. This was done due to two main reasons: 1) the results received by managers and supervisors were very similar (as depicted in figure 26) and the author felt that by interviewing them together, the validity would be more comprehensive, and 2) due to the time and availability of the participants.

Based on the data collected from the group-administered questionnaires, the author constructed a particular list of key questions regarding the seven Lean principles in warehousing. These questions were asked to the relevant managers and supervisors to investigate and validate the reasons for shortcomings relating to the seven Lean principles.

Each interview was recorded, while the author made written notes in a table displaying each predetermined question. The responses were transcribed from audio recordings, as well as the written notes taken during the interview session.

These results are analysed and interpreted in Chapter 5 under the reasons for misunderstanding of each principle. The results are displayed in table 23 below:

Table 23: Follow-up Interview Questions & Answers

Follow-up Interview Questions					
Interview Question	**Purpose of the Question**	**Managers & Supervisors Responses**			**Related Lean Principle**
		1	**2**	**3**	
1. How do you ensure that your employees know what the customer requires and what he/she deems as valuable?	To investigate reasons why customer value is unknown	Key Performance Indicators (KPI's) serve as measurables of what the customer wants/expects. Induction training further addresses what the customer requires.	The agreed Service Level Agreement (SLA) are measured on a weekly basis, and discussed during morning meetings. Key Performance Indicators (KPI's) are also known and discussed during the morning meeting. When SLA or KPI's are not met, its also discussed to all employees.	Service Level Agreement (SLA) and Key Performance Indicators (KPI's) are seen as "adding value and what the customer requires." And by adhering to these measures, customer expectations are met. This is then displayed in the warehouse for all employees to see.	Value
2. How do you make sure the warehouse processes (output) are in line with what the customer requires?	To determine whether customers are considered when processes are designed	Alignment of KPI's with what the customer wants. No formal meetings held with customer to get their views.	Monthly operations meeting held between the customer and Management of the warehouse. KPI's are presented and discussed.	Weekly review meetings are held between the customer and the Manager to ensure it is still in line with what they want. If changes are necessary, the Manager then ensures they are made.	
3. How do you ensure a culture of continuous improvement within the warehouse?	To determine whether a CI culture exists, and if all employees participate	Monthly quality meetings held where possible improvements are discussed. Management believes that a CI culture can't be forced on employees (top-down approach), and that it should start on the floor. But no training or CI documentation is in place for this. Management further believes that Lean training will aid in creating a CI culture.	The biggest CI development was as a result of the customers' input, and to a lesser extent the 3PL. A quality meeting is held amongst Supervisors and Management on a monthly basis, where failures are discussed. This is then communicated during the morning meeting.	This is mainly done only when a non-conformance happens, or an error is picked up within a certain process. There is currently no proactive CI programmes or documentation. Biggest factor influencing a CI culture is lack of dicipline.	Continuous Improvement
4. How often are continuous improvement events held?	To investigate whether a CI culture exists, and if all employees participate	No such events are held.	No such events are held.	No such events are held.	
5. Do you have an active employee engagement/suggestion programme? If so, how often are these ideas assessed and communicated to employees?	To investigate whether employees are really "engaged" with follow through of ideas	No, seen as a "complaint" box. Suggestions can come from the monthly quality meeting, but nothing formal and communicated.	A suggestion box is available, but hardly/never used. Opportunity for ideas are there, but not used by employees. However, suggestions may also come from the monthly meeting.	Yes, a suggestion box is used for this purpose. Ideas have been taken into consideration and actioned. Involvement of employees during this process can increases staff morale.	

6. Who is involved in development of the SOP's for each process? How often is it reviewed/updated?	To inspect whether the employees actually using them are involved in development and improvement	All SOP's were developed by an Industrial Engineer (not part of the warehouse). But going forward, employees actually working in the areas are to develop it. Reviewed once a year.	Supervisors (Team Leaders) engage with Managers to develop SOP's, and to a lesser extent the Material Handlers in that work area. Updated minimum once a year.	The process is "walked" with the person responsible (by management), wereafter it is updated if necessary. Formal review once a year.	Standardised Work/Processes
7. Are SOP's displayed in each area?	Visual reminder	Not displayed, only available on the company intranet, and not inside the warehouse.	Not displayed, but available in a file to employees.	Not currently, but will be displayed on a general notice board.	
8. Are employees trained on SOP's? If so, how often?	To confirm that training of SOP's exists	Trained during induction or when new employees join the warehouse.	Each employee should be trained once a year on all processes.	Each employee is trained once a year on all processes.	
9. Are KPI's explained to (understood by) the shop-floor employees? Are they involved in discussions thereof?	To confirm if shop-floor workers are aware of what measures are important and tracked	Certain KPI's are explained to individuals, but only those that they deal with directly. They are thus aware of some KPI's, but not as a whole.	It is discussed during the morning meeting and displayed on the notice board. Understanding thereof by all employees are not clear however.	No, not explained, but management is aware that it is a requirement.	Visual Management
10. How do you ensure employees are aware of the required tasks to be performed? And how do you guarantee it is completed on time?	To investigate why daily tasks may not be completed on time	Daily targets are discussed by Supervisors to Material Handlers during team talks. Supervisors walking the floor encourages Material Handlers. Furthermore, non-monetary incentives are given when tough targets are reached.	Daily requirements are discussed in the morning meeting. KPI's are also clear on what is expected.	Daily requirements are discussed in the morning meeting. It is further the responsibility of the Supervisor to ensure Material Handlers are on-track with what is required. "Multi-skilled" Material Handlers enables them to shuffle resources around to eleviate bottlenecks.	Flow & Pull
11. How do you instil a problem solving mindset within the warehouse? Are employees trained on structured problem solving techniques?	To explore why problem solving has not been adopted by shop-floor workers	Material Handlers and Supervisors aren't trained on structured problem solving techniques, only Managers. An honesty policy is relied on to make Managers aware when problems occur. Managers feel that personalities may restrict them from instilling this mindset, due to resistance to change.	Material Handlers have an idea of problem solving techniques, but no formal training or use thereof. When a problem does occur, it's mostly resolved by Management themselves. Resolved problems are captured on the company intranet, but not shared amongst Material Handlers and Supervisors.	Material Handlers and Supervisors aren't trained on structured problem solving techniques. This is done by Management, while the explanation of the problem may be given by a shop-floor employee.	Quality Assurance
12. How do you maintain a clean and neat warehouse?	To investigate what measures are put in place to ensure this / Reasons why the warehouse may not be clean	Weekly housekeeping "audits" are performed by Supervisors. Monthly "audits" by Management. Shortcomings are then communicated to Material Handlers (but nothing formal).	Each Material Handler has a dedicated aisle/area that they are responsible for. Supervisors are responsible to review areas daily and ensure cleanliness.	Each Material Handler has a specific location that he/she is responsible for. A checklist is then used by a Supervisor/Management to "audit" each area once a week.	Workplace Organisation
13. How do you make sure that employees adhere to warehouse signage and demarcation?	To investigate what measures are put in place to ensure this	Belief is that if the Supervisors and Managers adhere to this, then Material Handlers will as well. General discussions are held to ensure employees know what is required.	This is covered in the induction training. If new signage is erected in the warehouse, it is discussed in the morning meeting.	A "Toolbox talk" is done once a week, where the warehouse safety rules and regulations are discussed. Training is mainly only completed during induction.	

5. Discussion of Results

5.1 Introduction

The purpose of this section is to analyse the data acquired from the 24 questions in the group-administered questionnaire, which is presented and displayed in Chapter 4. The analysis is presented in the same sequence as laid out in the foregoing section as well as the questionnaire. It highlights reasons for misunderstanding each principle, including the significance of the findings, new discoveries and potential impact. This is to further validate the outcomes of the questionnaires, based on the results received from the follow-up interviews.

The author chose to show the average grading of each warehouse with regards to each Lean principle. This is done in order to depict the similarities in grading for the different warehouses, as well as to illustrate the gap between the three employment levels. Important to note as well, is that only the Managers from warehouse A and C had formal Lean training prior to the start of this research. This is apparent when comparing their grading with the rest of the participants.

The combined average grading for all warehouses in line with each Lean principle and methods were investigated and are discussed in order to satisfy the research question and objectives.

5.2 Participants

A total of 43 warehouse employees from the 3PL, across four warehouses partook in the group-administered questionnaire (a purposive sample), as detailed in the research methodology in Chapter 3.

Table 24 indicates the split of participants with regards to the three employment levels:

Table 24: Split of Employment Levels

Employment Level	Number of Participants	Average Split
Managers	7	16%
Supervisors	6	14%
Material Handlers	30	70%
Total	43	100%

5.3 Shortcomings of Results

The author would like to highlight and discuss the following points as potential shortcomings of the results that have been gathered. Although these limitations were mentioned and mitigated during the study, it is important to note that they might still have influenced the accuracy of the results. They are:

- **Language Competency**

  During this study, three different employee levels were investigated, with the lowest level being Material Handlers. This was done by utilising a group-administered questionnaire to ask specific questions regarding Lean methodologies within warehousing. This allowed the author to be present during each data gathering session, to answer any questions or clarify any uncertainties. Furthermore, a matric qualification is the minimum requirement to be employed by the 3PL, along with a 90% pass mark for an ABET English literacy test. The above was done to mitigate any risk that language proficiency might have on the results. This being said, language competency (or lack thereof) was still a possible source of discrepancy and perhaps warrants further investigation.

- **Follow-up Interviews**

  As mentioned in the previous chapter, semi-structured follow-up interviews were conducted with one Manager and one Supervisor of three of the four warehouses. This was completed with both participants present during each session. DiCicco-Bloom & Crabtree (2006) support this approach where multiple participants are interviewed simultaneously. However, the fact that both participants were present during the interview process may have influenced each other's ideas and answers. Additionally, Material Handlers might be at a disadvantage seeing that they were not part of the follow-up interviews, and wasn't given a chance to justify their answers.

- **Sample Size**

This research strategy was based on a purposive sample, using a qualitative methodology. Welman et al. (2005) also states that a purposive sample is an effective method when working with a small sample size, where the participants share very similar traits and/or characteristics. Although the author believes that the results gathered is an accurate reflection of the 3PL's Lean understanding, it should be noted that it remains a relatively small sample size, meaning the results can be easily impacted by individual scores.

However, looking at the research question, the aim of this report was to show the gap in Lean understanding which is evident, even considering the small sample size.

5.4 Considering the Average, Mode, Median and Range of the Results

In the results section of this report, the grading have been measured using the average (or mean) of the data. This can be problematic, as any values too high or low can influence the rest of the results. Due to this possible disadvantage, the mode, median and range have also been calculated to ensure an accurate representation of the results that have been gathered.

Since the use of an average can be influenced by outliers, the median has also been used to derive a central tendency and ensure that the results are truthful. It can further indicate a more accurate picture of the true average. The actual scores received for all questions relating to each Lean principle have been used for this calculation. This is discussed later in this section.

The mode is the grading received most often for a particular Lean principle, while the range is an indication of the spread of the data. Table 22 in chapter 4 is displayed again below, to discuss these results:

Table 25: Summary of Results

Lean Principle	Managers					Supervisors					Material Handlers				
	Avg. Grading	Mode	Median	Range	Grading Category	Avg. Grading	Mode	Median	Range	Grading Category	Avg. Grading	Mode	Median	Range	Grading Category
Value	3.1	4	3	3	Understood	3.0	3	3	3	Understood	1.6	1	1	3	Partially Understood
Continuous Improvement	2.9	4	3	3	Understood	2.6	3	3	3	Understood	1.7	1	1	3	Partially Understood
Standardised Work / Processes	3.1	4	3	2	Understood	2.9	3	3	3	Understood	1.7	1	1	3	Partially Understood
Visual Management	2.6	4	3	3	Understood	2.4	1	2	3	Partially Understood	1.3	1	1	3	Not Understood
Flow & Pull	2.8	4	3	3	Understood	2.6	1 & 4	2	3	Understood	1.7	1	1	3	Partially Understood
Quality Assurance	3.1	4	3	2	Understood	2.8	3	3	3	Understood	1.7	1	1	3	Partially Understood
Workplace Organisation	3.3	4	3	3	Understood	2.3	2	2	3	Partially Understood	2.0	1	2	3	Partially Understood
AVERAGE	**3.0**				**Understood**	**2.6**				**Understood**	**1.7**				**Partially Understood**

- **Managers**

  As seen in table 25, the mode for all Lean principles was 4. This shows that the answers received were most often 100% correct, or “Fully Understood” by Managers. However, the median for all Lean principles was 3, which is a better reflection of reality. If you compare the median to the average grading that has been used, it’s evident that they’re very similar, as using either method provides a grading category of “Understood” for all Lean principles. The use of an average here is thus acceptable.

  As stated earlier, the range gives an indication of the spread of the grading. With a very small variety of possible scores of 1, 2, 3 or 4; it’s expected that the range will be 3 (the difference between the minimum and maximum score received). This was true for five out of the seven Lean principles, with the exception of Standardised Work / Processes and Quality Assurance that had a range of 2. One could argue that at a managerial level the range should be less than that of the other levels, as there shouldn’t be any questions that they can’t answer. But this shows that there remain doubts with certain questions regarding Lean among Managers, and further serves as evidence to include them in the ongoing journey to become truly Lean.

- **Supervisors**

The results received for Supervisors are the most sporadic of the three employment levels. The average, mode and median are very similar for the Value, Continuous Improvement, Standardised Work / Processes and Quality Assurance principles, with a mode and median of 3 and an average of approximately 3 for all of them. Continuous Improvement has an average grading of 2.6, which indicates that its grading is understated compared to the median. However, it is still a Lean principle that is "Understood". The rest of the principles mentioned above were also "Understood" by supervisors.

The Visual Management and Flow & Pull principles received the most irregular grading of all principles. Visual Management has a mode of 1; meaning that most answers received were wrong. The main reason for this is due to the inability to answer questions relating to the Value Stream Mapping method. With an average of 2.4, and a median of 2, it is apparent that the average grading is higher. Again, this is because of higher scores received for the other Lean method, Metrics & KPI Boards. This justifies a further discussion, which is dealt with in section 5.5.4 and 6.2.1.

The Flow & Pull principle has a mode of 1 and 4, showing an equal number of wrong and correct answers. Most of the wrong answers relate to the Levelled Flow & Work method, and right answers to the Layout & Zones method. The Layout & Zones method scored well, increasing the average of the Flow & Pull principle. This is also visible in the difference between the average and the median received, of 2.6 and 2 respectively. From the results gathered it's clear that Supervisors should focus on the Levelled Flow & Work method, as it received the most answers with a grading of 1.

The Workplace Organisation principle received the worst average grading among Supervisors of 2.3. This is supported by both a mode and median of 2. According to table 26, using either method provides a "Partially Understood" grading category for this principle.

Similar to the range from the managers' grading, is a range of 3 for supervisors. Once more, this is due to the limited variety of the possible grading.

- **Material Handlers**

  The mode calculated for all Lean principles for the lowest employment level was 1. Contrary to the mode for Managers, this shows that the answers received most often were wrong, or "Not Understood" by Material Handlers. In agreement with this is a median of 1 for all but one Lean principle. When considering the average and median for each principle, it's clear that each principle has a higher average than median. By looking at the median in isolation, six out of the seven principles will be deemed as "Not Understood". Although this may not be surprising, it's definitely noteworthy. It shows that the majority of the Material Handler sample does not understand these six Lean principles, serving as further evidence that there exists a big gap between the Material Handler and the other two employment levels.

  The Workplace Organisation principle is the only one with an average and median of 2, and also the Lean principle that scored the highest grading among Material Handlers.

  As with both the Manager and Supervisor levels, a range of 3 was recorded for all principles.

The main purpose of this research was to identify the current understanding of key Lean principles among warehousing employees, as well as to illustrate the gap in Lean knowledge between the three employment levels. Comparing the average with the median further ensures that the average grading calculated is an adequate representative of the actual population.

Considering either the average or median, it is evident that such a gap does exist. The possible reasons for, and how to address and minimise this gap, is discussed in details in the subsequent section.

5.5 Understanding of the Seven Key Lean Principles

This section analyses and explains the results displayed in Chapter 4. Each one of the seven Lean principles, as well as their related Lean methods will be discussed.

As outlined previously in this report, the research aims to show the current understanding of the three employment levels on the key Lean principles within the warehousing industry, and to further illustrate the gap in Lean knowledge. The grading criteria set out in Chapter 3 has been used to determine whether Lean principles and methods are 1) Not Understood, 2) Partially Understood, 3) Understood or 4) Well Understood.

The grading criteria from Chapter 3 are highlighted below:

Table 26: Grading Criteria and Description of Categories

Grading Category	Description	Average Grading Level
1. Not Understood	The Lean principle / method is not known, misunderstood or explanation / answer to the question is below a grading level of 25%.	$1 < \text{grading} \leq 1.5$
2. Partially Understood	The Lean principle / method is only partly understood, where the participant is aware of it, but explanation / answer is at a grading level below 50%.	$1.5 < \text{grading} \leq 2.5$
3. Understood	The Lean principle / method is known and the participant is able to explain / answer the question correctly. However, some shortcomings exist and the answer is below a grading level of 75%.	$2.5 < \text{grading} \leq 3.5$
4. Well Understood	The Lean principle / method is well known and fully understood. The participant is able to explain / answer the question without any shortcomings. The answer is above a grading level of 75%.	$3.5 < \text{grading} \leq 4$

5.5.1 Value Principle Results Discussion

Customer expectations and requirements (value) are summarised in a Service Level Agreement (SLA), and measured using Key Performance Indicators (KPI's) as agreed upon between the 3PL and the client. Two of the three respondents also hold monthly meetings with the client to discuss the status of the agreed over KPI's. This is seen as aligning customer value with the warehouse output.

It is clear that Managers (and Supervisors) understand the importance of what the customer deems as valuable, but a true understanding by Material Handlers is still unclear. Communicating what the customer wants (not only using KPI's) and why they want it is further necessary to ensure a full understanding of the value principle.

As listed many times in this report and reaffirmed by Bicheno and Holweg (2009), is that Lean starts with the customer and how they perceive value. The understanding of the value principle is vital if one wishes to be successful with Lean. Directly related to adding value to the customer is the elimination of waste. Properly educating employees on waste elimination can have a significant impact on the value that is transferred to the client.

Based on the results from both the questionnaire and follow-up interviews, the author concludes that the main reason there exists a knowledge gap between the employment levels is due to inadequate training and lack of necessary involvement from management.

One can also argue that because Material Handlers aren't directly involved with the client during meetings and negotiations that this gap exists. Managers (and to a certain extent Supervisors) have frequent gatherings with the client, enabling them to better understand customer value.

It is thus important for Managers to be actively involved in educating Material Handlers on customer value, ensuring that efforts are aligned with their expectations.

5.5.2 Continuous Improvement Principle Results Discussion

Very few participants understood what a continuous improvement (CI) event is (or the definition of continuous improvement for that matter). The reason for this is because employees have never participated in a continuous improvement event before. This is quite significant as continuous improvement should be at the heart of any warehouse operation. This has been confirmed to be true however, by all respondents in the follow-up interviews.

The clear lack of understanding of continuous improvement and its benefits, illustrates why participants didn't perform well on this principle. Continuous improvement is part of the 3PL's quality management system, but there is no proactive CI programme. A re-active approach has been confirmed by the follow-up interviews, where improvements are only made once an error, problem or failure has been identified. The potential impact that lack of continual improvement can have on an operation should be noted. Customer requirements, businesses and industries are ever changing and in order to thrive as an operation, one needs to constantly advance.

Employee suggestions are another way of initiating continuous improvement ideas from the shop-floor. However, the follow-up interviews show that two out of three respondents are not in favour of a suggestion programme. Managers' historical experience indicates that it has not been used or is only used as a complaint box. Employees should be encouraged (and possibly incentivised) by management to participate, as this is another method of ensuring a continuous improvement culture. Employees will feel engaged when they can submit ideas and see them implemented.

While Managers understand this principle, it is not entrenched and enforced down to Supervisors and Material Handlers. It is not part of their approach when performing processes within the warehouse. It has been further established that Managers received the necessary training on the topic of continuous improvement, while Supervisors and Material Handlers have not, thus creating this gap amongst employees.

5.5.3 Standardised Work / Processes Principle Results Discussion

Only when employees understand what is required from them, and there is a standard process in place, can it be enhanced. Participants were unclear of the purpose and importance of standard operating procedures (SOP's), demonstrating their lack of understanding of this principle.

Two respondents from the follow-up interviews confirmed that the employees actually using the SOP's are not directly involved with their development or improvement. This is mainly done either by Managers and Supervisors themselves, or by independent Industrial Engineers. Material Handlers should be directly involved when SOP's are created. This will not only engage the shop-floor employees, but will serve as the backbone of continuous improvement activities.

Furthermore, all respondents confirmed that the SOP's are not currently displayed within each area. This may not currently be seen as a potential risk, but in order to ensure sustainability and consistency (especially when new employees join); SOP's should be visual within a work area.

This principle is among those with the largest gap between Material Handlers and the other two levels, showing that something as fundamental as SOP's aren't understood. This is a curious discovery, as it is an imperative part of executing a process. Standardising as far as possible will eliminate frequent errors and lead to an optimised operation.

It is evident from the questionnaire results, as well as the above why a gap in knowledge and understanding between employees exist.

5.5.4 Visual Management Principle Results Discussion

The most common misconception from the questionnaire was the purpose and benefits of a value stream map. During all sessions, the questions participants had, most often related to this concept. The reason therefore is simple; hardly any of the participants have ever heard of a value stream map, and even fewer know the purpose and benefits thereof.

This was an interesting finding, as a VSM is essentially a visual display of the current processes. When explained in this way, employees had a better understanding of what it entails. With the necessary Lean training however, the correct terminology, awareness and use of value stream mapping, can easily close this gap.

When taking a closer look at the actual scores attained for the Metrics & KPI Boards and Value Stream Mapping Lean methods independently (figure 26), it's clear that participants performed better with the first. The low scores received for the Value Stream Mapping method decreases the average of the Visual Management principle. It makes sense to address this method first, to ensure that understanding the principle is achieved.

Furthermore, the follow-up interviews confirmed that although most Material Handlers are aware of KPI's, the true understanding of each measurement is still uncertain. One of the respondents stated that KPI's aren't explained to shop-floor employees, while they are the ones responsible for meeting the required performance.

As mentioned in the value principle above, KPI's (and SLA) are used to ensure customer requirements are met. It is thus critical that all Material Handlers are involved in the discussion and education thereof, to thoroughly understand what each measurement means and why it's needed. This again, can be achieved with the proper training together with on-going participation of all warehouse employees.

5.5.5 Flow & Pull Principle Results Discussion

The questions relating to Levelled Flow & Work were poorly answered by participants. As with the foregoing Lean principle, the low scores for this Lean method impacts the average grading received for the Flow & Pull principle. On the contrary, the Layout & Zones questions were the best graded method among Material Handlers, showing that they have a better understanding of the importance of a properly laid out warehouse.

Similar to the VSM question from the previous principle, terminology possibly played a role in answering the Levelled Flow & Work questions, as very few participants have heard of a pull system before. For future research, one might consider approaching questions relating to this principle differently, to make sure all participants fully understand the question. The purpose of these questions were to capture the importance of planning daily work in advance, and based on customer demand (pull), in order to balance and optimise the flow within the warehouse.

All respondents from the follow-up interviews stated that clear communication channels are in place to ensure employees are aware of the daily requirements. This is deliberated during each warehouses' morning meeting, where daily targets are discussed. If the necessary targets from a previous day have not been reached, they are discussed in the next meeting and form part of that day's target.

Even though daily targets (and KPI's) are discussed and displayed, it is regarded as a re-active approach. There is no visual display of dynamic targets throughout the day. It also doesn't ensure that employees are continually aware of how they are tracking with what is expected, and fully understanding the value thereof.

Managers are then under the impression that employees are aware of the required task throughout a particular day. This ultimately creates the gap between the actual and the target. This principle also closely relates to visual management, and the proper display of the necessary information to keep track of actual performance versus the expected output.

5.5.6 Quality Assurance Principle Results Discussion

The main reason there exists a gap of knowledge between the employment levels is because there is no formal problem solving techniques currently implemented. There is also no training available to educate employees on such techniques. This has been confirmed by all respondents during the follow-up interviews.

This is a curious finding, as problem solving is a daily occurrence in warehouse operations. Logic tells us that this would be the first step (when training) for any employee working on the shop-floor. As with SOP's, problem solving tools are fundamental in a warehouse operation. Cultivating employees on how to solve problems is a big step towards creating a Lean environment.

When a problem does present itself, management takes it upon themselves to solve the issue. Once resolved, there is also no feedback to Material Handlers to educate them on the matter to ensure it is repeated. This consequently creates a gap of understanding between the employment levels. Adequate training and feedback on approaching and solving problems are essential to close this gap amongst employees and promote a culture of Lean.

5.5.7 Workplace Organisation Principle Results Discussion

While Managers grasped the importance of workplace organisation (a clean and well demarcated warehouse), Supervisors and Material Handlers did not. The key misconception by Supervisors and Material Handlers relates to the orderliness of the warehouse.

Based on results received from the questionnaire, they mainly believed that workplace organisation only refers to a clean (free of rubbish) area. Although this is true, it is about much more. Proper organisation within the workplace is about a clean and neat warehouse, with appropriate signage and demarcation that indicates a place for material, tools, machines and equipment, with the intention of minimising travel, movement and guesswork for employees. This will also assist in the prevention of errors and accidents from occurring.

The follow-up interviews established that sound measures (weekly housekeeping “audits”) are currently in place to ensure a clean and neat warehouse. General meetings are held to discuss signage and warehouse safety as well. With both these measures in place, it’s unclear why such a gap in understanding still exists between the employment levels.

The author believes that the most effective way of ensuring that this principle is understood, is through continuation of the above measures, along with constant follow-up.

5.5.8 Results from Warehouse D

When you look at the results from warehouse D, it is evident that the management from this facility repeatedly achieved very low scores. This is markedly different from the management scores from the other three warehouses. There is also no specific reason for their poor results, as all factors were consistent during the data gathering sessions. The logical explanation is that the managers from warehouse D are not as knowledgeable on Lean as their counterparts.

Although these scores are not ideal when considering the total average (as it slightly skews the results), the overall outcome still reflects a gap in Lean knowledge between the different employment levels, as was sought after. Even when each warehouse is looked at individually, the knowledge gap among employees is still clear.

5.6 Summary

The purpose of the questionnaire and the research as a whole was to identify the current understanding of key Lean principles among warehousing employees in a third party logistics provider (3PL) in South Africa, as well as to illustrate the gap in Lean knowledge. The employees' understanding were sought after, and not the Leanness of the warehouse itself. The results from this research are not surprising, as a difference in Lean knowledge was expected among the employment levels.

This research can ultimately be used to form the essential Lean training material needed to close the gap between the abovementioned employment levels and to ensure the success of an on-going pursuit to be truly Lean.

The different levels who partook in this questionnaire were Managers (Branch Managers and Operations Managers), Supervisors (Inventory Supervisors and Team Leaders) and Material Handlers (Material Handlers and Admin Clerks).

Each Lean principle, with the associated Lean methods was discussed in line with the results gathered from the questionnaire.

Based on the extensive data analysed, it is evident that there is a material gap between the three employment levels in the 3PLs warehousing operations. Table 27 below summarises these results:

Table 27: Average Grading for All Principles

Principles Combined	Employment Level		
Grading	**Managers**	**Supervisors**	**Material Handlers**
Average Grading	3.0	2.6	1.7
Grading Category	Understood	Understood	Partially Understood

Managers and Supervisors are categorised as understanding the Lean principles, but key gaps still remain within certain principles and methods.

Managers "Understood" all principles. Supervisors "Understood" most principles, with a "Partially Understood" grading category for Visual Management and Workplace

Organisation. While Material Handlers “Partially Understood” all principles, except for Visual Management which is “Not Understood”.

It’s obvious that Managers understand the Lean principles and the importance thereof. However, it is mostly Material Handlers who are involved with the identified principles on a daily basis that struggle to understand. Their partial understanding of the key Lean warehousing principles makes optimising the current operation challenging. This is presumably due to a lack of proper training within the warehouse, as is highlighted in the research.

5.6.1 Final Thoughts

It is clear from the section above that there exists a real gap in knowledge between Managers, Supervisors and Material Handlers. And that most of the current Lean knowledge sits with Managers (and partly Supervisors). The challenge it seems remains with transferring this knowledge down to the Material Handler level.

This is certainly an indication that appropriate and on-going training is lacking. Further investment into employee education and training is an essential part of ensuring a Lean culture.

As stated previously, both Piatowski (n.d.) and Staats & Upton (2011) believe that the involvement of Managers is key to the success of Lean. And that managerial involvement can create the behaviour and culture needed to successfully deploy Lean. The author would further like to stress the importance of “buy-in”, participation and contribution from Managers within a warehouse. Lean has a greater chance of success if all employees are involved.

6. Conclusion and Recommendations

6.1 Introduction

This research report was conducted using the seven key Lean principles in warehousing as identified from former research. The central research question is:

What is the current gap of understanding of a 3PL's warehouse employees on key Lean principles in warehousing?

The following list presents the main objectives reached by the completed research:

- The key Lean principles and methods within warehousing based on previous research.
- How well the identified Lean warehousing principles and methods are understood by shop floor workers (Material Handlers and Admin Clerks).
- How well the identified Lean warehousing principles and methods are understood by warehouse management (Managers, Supervisors and Team Leaders).
- Which specific Lean principles and methods are well understood, understood, partially understood and unknown or misunderstood. Thus illustrating the gap of Lean knowledge between the employment levels.
- Why there exists a gap among the three employment levels.

6.2 Conclusion

This research report has identified which specific Lean principles and methods are well understood, understood, partially understood and not understood by warehousing employees in a 3PL in South Africa.

It was discovered that there exists a significant gap in Lean knowledge between the three employment levels in warehousing. The model developed to test Lean knowledge in warehousing is a useful tool with the potential for broader application. The results from this study will serve as the initial “benchmarks” for best practice, that can used in future research.

This newly found information can further be utilised when developing Lean training material for these employees, and be the first step towards increasing knowledge on Lean (the development of training material is out of scope for this research).

6.2.1 Most Significant Lean Principles

What is apparent from the research and from chapter 5 is the correlation between the seven Lean principles. Although some may be classified as more important than others, it is how each principle interacts and supports one another that are significant. It should thus be sought after to improve all principles, with their relevant Lean methods, in order to create a warehouse that is truly Lean.

This being said, the author has identified the following two principles as the most substantial:

1. Continuous Improvement

Bicheno and Holweg (2009) believe that continuous improvement is critical in a warehouse environment to remain competitive, optimise the processes, improve material flow and to ultimately cut cost.

Sobanski (2009) further states that the continuous improvement principle is more significant than any other principle, as it engages employees through problem solving.

It is thus critical to ensure that a continuous improvement culture is educated and maintained within a warehousing environment.

2. Visual Management

Value Stream Mapping is used to clearly show activities that add value, that do not add value, and steps that involves just waiting (Jacobs et al, 2009).

Bicheno and Holweg (2009), state that mapping the value stream is a great tool to generate new ideas. It provides a better understanding of how material and information flow is connected. It may also be used to identify shortcomings in a process and opportunities to improve.

By allowing all employees to be part of mapping the value stream and provide suggestions, it can be used to visually show the impact of certain processes within the warehouse. It will further illustrate what adds value to the end product or service, ultimately leading to a clearer and more productive operation.

6.3 Recommendations

The following recommendations for future research is summarised below:

- Repeating this study with a different sample (both in size and geographical location) can lead to refining best practices in the warehousing industry.

- Possibility of combining Lean initiatives with other improvement methodologies such as Six Sigma and Theory of Constraints (TOC), in order to enhance operational performance.

- The compilation and development of Lean training material especially for warehouse employees, based on the newly found research from this study, with the main focus on the Lean principles set out previously in this chapter. Along with methods to properly and continuously train employees.

- Investigating whether there is a link between Lean knowledge in warehousing and the actual Leanness of a warehouse operation.

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Appendix A – Blank Lean Questionnaire

SCHOOL OF MECHANICAL, INDUSTRIAL & AERONAUTICAL ENGINEERING

To whom it may concern,

My name is Xander Swart, I am a part-time MSc Engineering student in the School of Mechanical, Industrial and Aeronautical Engineering at the University of the Witwatersrand.

I am currently undertaking a research project, with the title of: “The current understanding of lean principles in the warehousing industry of South Africa.”

You are being asked to participate in a warehousing group-administered questionnaire. You have the right to query any concerns regarding this questionnaire at any time. The questionnaire will take approximately 45 to 60 minutes of your time.

Participation is voluntary and you can withdraw at any stage during the questionnaire. If you choose to participate in this questionnaire, please answer all questions to the best of your knowledge. Please do not write any identifying/personal information on the questionnaire (i.e. name, surname, contact information, etc.).

By signing this form, you give permission to use the information captured in this questionnaire. This will not impact or affect your current job/position in any way. ***All information gathered is for research purposes only and will be kept confidential.***

Thank you for taking the time to assist with this research project. Should you require any additional information regarding the study or completion of the questionnaire, please do not hesitate to ask.

Researcher (Xander Swart) Contact Details: 072 831 6001 or xswart@gmail.com.

Supervisor (Teresa Hattingh) Contact Details: 011 717 7374 or teresa.hattingh@wits.ac.za.

Signed: _____

Date: _____

Lean Questionnaire

- Current Position:_____
- Years of experience (working in the warehousing environment)? _____
- Have you previously had Lean training?
  - Yes / No
- If yes, when? _____

1. Value

- **Customer Value**

1. Why is it important to know what the customer sees as value?

2. Why is it important to know who your customer is?

- **Seven Wastes**

1. What is the definition of a waste?

2. Why is it important to identify and eliminate all wastes in the warehouse?

2. Continuous Improvement

- **Continuous Improvement Events**

1. Explain what you understand under a continuous improvement event?

2. Why do you think continuous improvement activities are important?

- **Employee Suggestions**

1. What do you think is the purpose of an employee suggestion programme?

2. How would an employee suggestion programme benefit you as an employee?

3. Standardised Processes

- **Standard Operating Procedures (SOP's)**

1. What is the main purpose of a Standard Operating Procedure (SOP)?

2. Why is it important to have a Standard Operating Procedure (SOP) visible and on display in the warehouse?

- **Standardised Work / Planning**

1. What is the purpose of balancing work and activities within the warehouse?

4. Visual Management

- **Metrics and Key Performance Indicator (KPI) Boards**

1. Why is it important to track and display key metrics (such as on-time shipment, customer satisfaction, inventory accuracy, picking productivity and accuracy etc.) and KPI's in the warehouse?

- **Value Stream Mapping**

1. What is the main purpose of Value Stream Mapping?

2. How would Value Stream Mapping benefit you as an employee?

5. Flow & Pull

- **Levelled Flow and Work**

1. What is the main purpose of a pull system within a warehouse?

2. Why is it important to level the flow of material and work within a warehouse?

- **Layout and Zones**

1. What are the benefits of grouping similar items in the same zone within a warehouse?

2. What are the benefits of placing the fastest moving items in locations closest to the receiving and dispatch areas?

6. Quality Assurance

- **Quality Metrics**

1. Why is it important to have corrective and preventive action procedures (CAPA) in place for processes within a warehouse?

- **Problem Solving and Error Proofing Methodology**

1. What is the importance of having a structured problem solving procedure (5Why's, root cause analysis, etc.) in place to determine the root cause?

2. Why is it important to have built-in quality checks in all processes within a warehouse?

7. Workplace Organisation

- **Cleanliness**

1. What is the importance of proper housekeeping (keeping all areas in the warehouse clean)?

- **5S and Signage Boards**

1. What are the main benefits of an active 5S programme in the warehouse?

2. What is the main purpose of appropriate signage (sign boards) in all areas within a warehouse?

Appendix B – Lean Questionnaire with Model Answers

Lean Questionnaire

1. Value

- **Customer Value**

1. Why is it important to know what the customer sees as value?
    a. *Model Answer - It enables the worker / company to create a product and / or service that is valuable to the customer, and that the customer is willing to pay for. To provide the customer with a product or service that they expect and want.*

2. Why is it important to know who your customer is?
    a. *Model Answer – In order to give the customer / next process / next company a product and / or service that is acceptable in terms of quality, value and price (as deemed by the customer). Meeting the requirements of the customer.*

- **Seven Wastes**

1. What is the definition of a waste?
    a. *Model Answer - Anything other than the minimum activities and materials necessary to get the job done immediately, right the first time and to the satisfaction of the customer. Any non-value adding activity in the process.*

2. Why is it important to identify and eliminate all wastes in the warehouse?
    a. *Model Answer – To create a process / product / service that is value-adding, waste free and satisfactory for the customer. It increases efficiency and productivity in the warehouse. Most important it saves time and money.*

2. Continuous Improvement

- **Continuous Improvement Events**

1. Explain what you understand under a continuous improvement event?
    a. *Model Answer - This is improvement activities and documentation of those activities where employees directly impacted by changes, are involved in developing solutions for improvement. Definition of CI also accepted: Continually improving and eliminating waste from a process by finder better, faster, cheaper ways of doing something that is still at acceptable quality.*

2. Why do you think continuous improvement activities are important?
    a. *Model Answer – It empowers employees to get involved and provide ideas and thoughts for sustained improvements. It strives to always improve the service provided to a customer, in terms of quality and cost.*

- **Employee Suggestions**

1. What do you think is the purpose of an employee suggestion programme?
    a. *Model Answer - To formally capture, document, track, recognise and reward employee ideas. As well as encourage employee participation and improve employee motivation.*

2. How would an employee suggestion programme benefit you as an employee?
    a. *Model Answer – It provides an open platform for all employees to list improvement ideas and suggestions, ultimately leading to increasing job satisfaction, improving morale and increasing employee engagement.*

3. Standardised Processes

- **Standard Operating Procedures (SOP's)**

1. What is the main purpose of a Standard Operating Procedure (SOP)?
    a. *Model Answer – To have a standard process for all operators to perform each task with the best method.*

2. Why is it important to have a Standard Operating Procedure (SOP) visible and on display in the warehouse?
    a. *Model Answer – It creates visual direction and reminders to employees on how to properly perform a certain task or process. It further creates awareness and enhances safety in the warehouse.*

- **Standardised Work / Planning**

1. What is the purpose of balancing work and activities within the warehouse?
    a. *Model Answer – To ensure all work, workers and equipment within the warehouse are equally loaded in order to perform at their optimum.*

4. Visual Management

- **Metrics and Key Performance Indicator (KPI) Boards**

1. Why is it important to track and display key metrics (such as on-time shipment, customer satisfaction, inventory accuracy, picking productivity and accuracy etc.) and KPI's in the warehouse?
    a. *Model Answer – It graphically depicts and communicates the actual performance and outcomes versus what is expected. It further helps to identify continuous improvement opportunities.*

- **Value Stream Mapping**

1. What is the main purpose of Value Stream Mapping?
    a. *Model Answer – To visually map a process (or part of a process) to show activities that are value adding and non–value adding. It is further used to create continuous improvement activities within these activities / processes.*

2. How would Value Stream Mapping benefit you as an employee?
    a. *Model Answer – It will enable them to clearly see the process / activities and create a platform for discussions and improvement suggestions, ultimately increasing employee involvement and job satisfaction. It will also assist in identifying and eliminating non-value adding activities.*

5. Flow & Pull

- **Levelled Flow and Work**

1. What is the main purpose of a pull system within a warehouse?
    a. *Model Answer – It manages the effective flow of inventory by reducing waste related to work in progress and keeps material moving in concurrence with customer / daily demand. It further balances the activities for different processes and assists with activity and resource planning.*

2. Why is it important to level the flow of material and work within a warehouse?
    a. *Model Answer – To ensure that the movement of material and work is stable in all functions in the warehouse, in order to reduce bottlenecks and waste. It also ensures work is completed on time.*

- **Layout and Zones**

1. What are the benefits of grouping similar items in the same zone within a warehouse?
    a. *Model Answer – It allows for optimal planning of work required per process, equipment needed, racking configuration and worker and equipment movement. It makes picking and binning activities easier and optimises storage.*

2. What are the benefits of placing the fastest moving items in locations closest to the receiving and dispatch areas?
    a. *Model Answer – It minimises the travelling distance, movement and motion associated with picking an order or performing a put-away task. Ultimately ensuring a faster picking and put-away process.*

6. Quality Assurance

- **Quality Metrics**

1. Why is it important to have corrective and preventive action procedures (CAPA) in place for processes within a warehouse?
    a. *Model Answer – It ensures that the correct steps are followed when an employee is presented with a problem and that the same mistakes are not made repeatedly. It minimises incidents from re-occurring.*

- **Problem Solving and Error Proofing Methodology**

1. What is the importance of having a structured problem solving procedure (5Why's, root cause analysis, etc.) in place to determine the root cause?
    a. *Model Answer – It provides an official process to detect and resolve problems as they occur.*

2. Why is it important to have built-in quality checks in all processes within a warehouse?
    a. *Model Answer – It enables workers to quickly detect problems or defects to ensure customers aren't serviced with incorrect items. It also eliminates the number of rework to be performed by early detection of a problem / defect. Ultimately increasing the quality of a product/service.*

7. Workplace Organisation

- **Cleanliness**

1. What is the importance of proper housekeeping (keeping all areas in the warehouse clean)?
    a. *Model Answer – It enhances the work environment, reduces the risk of making errors, reduces waste, makes the job easier, increases safety and ensures the warehouse looking neat and professional.*

- **5S and Signage Boards**

1. What are the main benefits of an active 5S programme in the warehouse?
    a. *Model Answer – To ensure there is a place for everything and everything is in its place. By sorting material, machines and equipment, setting them in order to minimise travel, movement, and motion, ensuring its clean and standardised and all the above is sustained. Employees feel a sense of responsibility and accountability within their workplace.*

2. What is the main purpose of appropriate signage (sign boards) in all areas within a warehouse?
    a. *Model Answer – Signage minimises the guesswork of employees and serves as a tool to indicate where material and equipment needs to be staged or when and where products need to be moved. It also enhances safety by mapping out areas and processes for easy identification and awareness.*

Appendix C – Letters of Consent

Letter of Consent – Group-Administered Questionnaires

Dear Participant,

I am a part-time MSc student in the School of Mechanical, Industrial and Aeronautical Engineering at the University of the Witwatersrand.

You are being asked to participate in a warehousing group-administered questionnaire. You have the right to query any concerns regarding this questionnaire at any time.

Participation is voluntary and you can withdraw at any stage during the questionnaire. If you choose to participate in this questionnaire, please answer all questions to the best of your knowledge.

Please do not write any identifying/personal information on the questionnaire (i.e. name, surname, contact information, etc.).

By signing this form, you give permission to use the information captured in this questionnaire. This will not impact or affect your current job/position in any way. All information gathered is for research purposes only and will be kept confidential.

Thank you for taking the time to assist with this research project. Should you require any additional information regarding the study or completion of the questionnaire, please do not hesitate to ask.

Researcher (Xander Swart) Contact Details: 072 831 6001 or xswart@gmail.com.

Supervisor (Teresa Hattingh) Contact Details: 011 717 7374 or teresa.hattingh@wits.ac.za.

Signed:

_____

Date:

_____

Letter of Consent – Follow-up Interview

Dear Interviewee,

I am a part-time MSc student in the School of Mechanical, Industrial and Aeronautical Engineering at the University of the Witwatersrand.

You are being asked to participate in a follow-up interview regarding the outcomes of the warehousing group-administered questionnaire conducted earlier in this study. You have the right to query any concerns relating to this interview at any time.

Participation is voluntary and you can withdraw at any stage. If you choose to participate, please answer all questions to the best of your knowledge.

By signing this form, you give permission to use the information captured during the follow-up interview. You further give consent that the interview may be recorded to ensure accurate capturing of data. This will not impact or affect your current job/position in any way. ***All information gathered is for research purposes only and will be kept strictly confidential.***

Thank you for taking the time to assist with this research project. Should you require any additional information regarding the study, please do not hesitate to ask.

Researcher (Xander Swart) Contact Details: 072 831 6001 or xswart@gmail.com.

Supervisor (Teresa Hattingh) Contact Details: 011 717 7374 or teresa.hattingh@wits.ac.za.

Signed:

_____

Date:

_____

Appendix D – Company Consent Form

9 September 2014

To whom it may concern,

Consent to use [redacted] Case Study Research

I, [redacted] hereby give Alexander D. Swart (ID: 8903095026081), consent to [redacted] warehousing personnel to gather the necessary data, as well as give him permission to use the data to complete his Masters dissertation.

The data gathered will form part of his MSc dissertation report titled, THE CURRENT UNDERSTANDING OF LEAN PRINCIPLES IN THE WAREHOUSING INDUSTRY OF SOUTH AFRICA.

Anonymity (regarding company name and any owner/manager/employee names) and confidentiality of information provided will be assured and respected. The data will be gathered during the 2014 year.

Signed: [redacted]

Date: 09 Sept 2014

Appendix E – Typical Answers and Grading of the Questionnaire

Lean Principle	Lean Practice	Question	Type of Answers Received	Marks Given for the Answer	Comments
Value	Customer Value	Why is it important to know what the customer sees as value?	a. It means there is quality in the warehouse / They are paying for the service / To describe how to handle the material. b. Enable us to handle the product that the client is satisfied with / To deliver certain services or quality. c. To align the warehousing processes with the client needs / Ensure effective response to client requirements.	a. 1 b. 2 c. 3	Although "c" answers are correct, they're missing the fact that it should create value to the client and that they're willing to pay for it.
		Why is it important to know who your customer is?	a. Not saying something wrong to the client / To treat the customer nicely. b. Know what to sell to them (target market) / Ensure timely, reliable service. c. Understand the clients needs, building relationships, providing relevant service / Ensuring you know their expectations and keep them happy.	a. 1 b. 2 c. 3	Key words / phrases: Meeting / exceeding customer requirements, better understand what they want, provide quality outputs, adding value.
	Seven Wastes	What is the definition of a waste?	a. Used items such as boxes, plastic, etc. / Something of no use / Unwanted material. b. Unexpected occurance that reduces productivity / Something in the warehouse that is unnecessary. c. Something that is not needed or not used during work duties / Not using space, infrastructure in a more effective way.	a. 1 b. 2 c. 3	Expected answers should have focused more on non-value adding, require minimum effort, etc.
		Why is it important to identify and eliminate all wastes in the warehouse?	a. Prevents injury / It is bad for your health. b. To remove it and make space / Can cause a hazard and take up space. c. The company can lose money and creates clean work environment / Eliminates carelessness and creates a better working environment.	a. 1 b. 2 c. 3	Expected answers should include the fact that it enhances productivity, saves money and time.
Continuous Improvement	Continuous Improvement Events	Explain what you understand under a continuous improvement event?	a. Always move forward / Making the client happy. b. Improve on what you are doing / Improvement in the warehouse eliminates mistakes c. When you see something wrong, you identify and fix it / Work in progress, that is currently working but can be done better.	a. 1 b. 2 c. 3	Answers relating to the definition of CI were also accepted.
		Why do you think continuous improvement activities are important in the warehouse?	a. Because we are learning things / Make the business stable. b. To improve and grow the company / It ensures better business c. Keep clients satisfied, and workers happy / Workers can improve their skills by attending improvement activity discussions.	a. 1 b. 2 c. 3	Customer satisfaction, improving productivity, reducing cost were key phrases that were looked for.
	Employee Suggestions	What do you think is the purpose of an employee suggestion programme?	a. To indicate how to handle a client / To have a feel of what's happening in the team. b. Shows what the employee thinks and creates trust among workers / Sharing worker experiences. c. Identify and suggest where progress and improvement can take place / Promotes employee engagement in the concept of CI.	a. 1 b. 2 c. 3	Key words / phrases: Employee ideas, suggested changes / improvements, employee engagement.
		How would an employee suggestion programme benefit you as an employee?	a. To upgrade employees. b. To network with employees and improve knowledge / Eliminates problems in the workplace. c. A place to say my views and iron out problems / Gives the employee greater influence and involvement, and contribution.	a. 1 b. 2 c. 3	Key words / phrases: Engagement, providing changes / solutions, solving problems.
Standardised Work / Processes	Standard Operating Procedures (SOP's)	What is the main purpose of a Standard Operating Procedure (SOP)?	a. To bring improvement in the company / To align with SABS / To keep the client happy b. For everybody to do what is expected / To guide employees on what to do. c. Ensuring accurate processing and reduced training time / To allow a new worker to know how each area operates.	a. 1 b. 2 c. 3	Key words / phrases: Standard method, shows how a task is to be completed.
		Why is it important to have a Standard Operating Procedure (SOP) visible and on display in the warehouse?	a. To show emergency exits / To know right from wrong b. To eliminate mistakes / Everybody will do what they're supposed to do. c. For everyone to follow the guidelines and know what is expected / Standard procedure that can be viewed at any time / Facilitates awareness in the relevant	a. 1 b. 2 c. 3	Key words / phrases: Constant reminder of the process, explains how tasks should be performed, uniform process.
	Standardised Work / Planning				
		What is the purpose of balancing activities and work within the warehouse?	a. To make sure the client doesn't complain / To keep everything in order / Helps planning ahead / Ensuring employee participation. b. Overcompensation in a step can negatively effect processes further down / To smooth operations. c. Work must not rest upon one person or department / Enhancing the workforce and minimising operational pressure on staff.	a. 1 b. 2 c. 3	Key words / phrases: Balancing load, spreading out work / activities, perform tasks better and faster, equally loaded workers.

Lean Principle	Lean Practice	Question	Type of Answers Received	Marks Given for the Answer	Comments
Visual Management	Metrics & KPI Boards	Why is it important to track and display key metrics (such as on-time shipment, customer satisfaction, inventory accuracy, picking productivity and accuracy etc.) and KPI's in the warehouse?	a. To keep clients' business / To track quantities. b. Increases picking productivity and accuracy / To identify any weakness, opportunities or threats in the operation / Helps to rectify errors. c. It states the performance of staff and targets (progress) / Shows where we did well and where there are problems.	a. 1 b. 2 c. 3	Key words / phrases: Planned vs. actual performance, shows improvement opportunities.
	Value Stream Mapping	What is the main purpose of Value Stream Mapping?	a. Helps to measure what needs to be done / Shows the flow of information. b. To minimize any delays. c. It shows activities in the warehouse.	a. 1 b. 2 c. 3	VSM questions received the worst grading, very few acceptable answers received. Only a limited few have heard of VSM before.
		How would Value Stream Mapping benefit you as an employee?	a. It will eliminate mistakes / It will help with adhering to shipment times b. Helps understand the business and what is expected from the employer and client / Assists the worker to excel at his job, know how to avoid problems and shows how long tasks should take. c. Identifies opportunities in the warehouse to improve.	a. 1 b. 2 c. 3	
Flow & Pull	Levelled Flow & Work	What is the main purpose of a pull system within a warehouse?	a. To keep everything in order and running as planned / To limit demand of the customer. b. Things can run properly and smoother / To move stock in the warehouse to create extra space. c. It ensures the input and output balances.	a. 1 b. 2 c. 3	Key words / phrases: Balancing activities and work, creates flow.
		Why is it important to level the flow of material and work within a warehouse?	a. Ensure availability of stock / So that you don't put anything anywhere. b. To meet the targets that have been set. c. To keep all activities balanced / To make sure all departments finish their work.	a. 1 b. 2 c. 3	Key words / phrases: Eliminate waste, completing task in required timeframe, faster processes.
	Layout & Zones	What are the benefits of grouping similar items in the same zone within a warehouse?	a. Helps identify what you are looking for. b. Easy to find products to pick / Speeds up procedures / Easy access to what you're looking for / Prevents incorrect picking. c. Enables the picker to pick the right stock, and avoid any discrepancies to the client / Minimizes wrong picking and avoids mixing of product / Prevents wrong supply and eliminates time wasting when looking for a product.	a. 1 b. 2 c. 3	Questions relating to Layout & Zones scored the highest grading among Supervisors and Material Handlers.
		What are the benefits of placing the fastest moving items in locations closest to the receiving and dispatch areas?	a. Those items are ready to be loaded onto trucks / For good delivery. b. Makes the job easier for the receiving and dispatch teams / For time management. c. Easy accessable and will not waste time / To spend little time to supply the parts to clients, because they have the highest demand.	a. 1 b. 2 c. 3	
Quality Assurance	Quality Metrics	Why is it important to have corrective and preventive action procedures (CAPA) in place for processes within a warehouse?	a. It is important to make good delivery / So that you can be accurate and deliver the best. b. To prevent errors such as picking, receiving, checking, etc. / To prevent errors / To avoid sending wrong stock to client. c. Assists in recognising weak points or failings in the system which allows workers to rectify it / To find a solution when a mistake is made and to prevent it.	a. 1 b. 2 c. 3	Key words / phrases: Assists the problem solving process, eliminates errors from re-occurring.
	Problem Solving & Error Proof Methodology	What is the importance of having a structured problem solving procedure (5Why's, root cause analysis, etc.) in place to determine the root cause?	a. So that everyone is treated fairly and understood / Without it we wouldn't have any control. b. For the company to know how, when and why the problem happened / To prevent different kinds of problems / To understand how to approach a problem. c. Problems are solved quickly / To easily identify errors and mistakes.	a. 1 b. 2 c. 3	Key words / phrases: Alignment of problem solving techniques, quicker problem solving.
		Why is it important to have built-in quality checks in all processes within a warehouse?	a. To make sure the client is always happy with the service / To make sure that everything we do is done well / For safety in the work environment. b. In order to supply good quality goods / To make sure everyting is working properly and if something is broken to fix it. c. Improved customer service, satisfaction and process efficiency / To prevent items from getting lost in the warehouse and to check that stock has been shipped.	a. 1 b. 2 c. 3	Key words / phrases: Delivering better quality, service the correct parts / product.
Workplace Organisation	Cleanliness	What is the importance of proper housekeeping (keeping all areas in the warehouse clean)?	a. To make sure there is no obstruction. b. For safety and to access stock / To make the warehouse neat and tidy and prevent loss of items. c. To prevent errors and accidents from occurring / Reduces injuries and creates clean work environment.	a. 1 b. 2 c. 3	Key words / phrases: Free from waste, efficient work environment, preventing errors.
	5S & Signage Boards	What are the main benefits of an active 5S programme in the warehouse?	a. To help the warehouse run in a clean manner / Identifies what to expect in the warehouse. b. Employees will know what is expected in their work area, and creates a safe environment / Constantly remind the staff of the culture in the warehouse / Sort and keep the warehouse clean. c. To make sure everything is in place and where it should be.	a. 1 b. 2 c. 3	Key words / phrases: Increased productivity, place for everything and everything in its place.
		What is the main purpose of appropriate signage (sign boards) in all areas within a warehouse?	a. To identify how may people are in the warehouse. b. To know where to go during an emergency / To control and give direction to different areas / To know about health and safety around the warehouse. c. It's visible, to know where to find things you're looking for / Shows you where to go, prevents incidents and provides information.	a. 1 b. 2 c. 3	Key words / phrases: Indicates escape routes / exits, easy and quick communication tool.

Appendix F – Graded Questionnaires

SCHOOL OF MECHANICAL,
INDUSTRIAL & AERONAUTICAL
ENGINEERING

To whom it may concern,

My name is Xander Swart, I am a part-time MSc Engineering student in the School of Mechanical, Industrial and Aeronautical Engineering at the University of the Witwatersrand.

I am currently undertaking a research project, with the title of: "The current understanding of lean principles in the warehousing industry of South Africa."

You are being asked to participate in a warehousing group-administered questionnaire. You have the right to query any concerns regarding this questionnaire at any time. The questionnaire will take approximately 45 to 60 minutes of your time.

Participation is voluntary and you can withdraw at any stage during the questionnaire. If you choose to participate in this questionnaire, please answer all questions to the best of your knowledge. Please do not write any identifying/personal information on the questionnaire (i.e. name, surname, contact information, etc.).

By signing this form, you give permission to use the information captured in this questionnaire. This will not impact or affect your current job/position in any way. ***All information gathered is for research purposes only and will be kept confidential.***

Thank you for taking the time to assist with this research project. Should you require any additional information regarding the study or completion of the questionnaire, please do not hesitate to ask.

Researcher (Xander Swart) Contact Details: 072 831 6001 or xswart@gmail.com.

Supervisor (Teresa Hattingh Contact Details: 011 717 7374 or teresa.hattingh@wits.ac.za.

Signed: [redacted]

Date: [redacted]

Lean Questionnaire

- Current Position: Branch Manager
- Years of experience (working in the warehousing environment)? 10
- Have you previously had Lean training?
  - Yes / No
- If yes, when? August 2014.

1. Value

- **Customer Value**

1. Why is it important to know what the customer sees as value?

This is to make sure the customer gets what they want or expect and that they dont get empty promisses.

A 3
3

2. Why is it important to know who your customer is?

Then you know what they expect, do and want. Also helps you manage them better.

4
4

- **Seven Wastes**

1. What is the definition of a waste?

Waste is anything in a process or procedure that is duplicated and/or is time consuming that waste time and money. Things customers are not willing to pay for.

4
4

2. Why is it important to identify and eliminate all wastes in the warehouse? 4 4

~~To reduce lead time to clients, saving money and reduce customer effected services.~~

Reduce cost and improve lead time

2. Continuous Improvement

- **Continuous Improvement Events**

1. Explain what you understand under a continuous improvement event? 4 4

The process of continually improving a service or procedure to eliminate waste.

2. Why do you think continuous improvement activities are important? 4 4

This will eliminate waste and creates opportunities for teams to work together and create new ideas in getting tasks completed.

- **Employee Suggestions**

1. What do you think is the purpose of an employee suggestion programme? 3 3

To get employee involved in trying to resolve matter or new ideas.

2. How would an employee suggestion programme benefit you as an employee? 1 1

My experience with this is that it turns into a complains preogramme if not managed properley

3. **Standardised Processes**

- **Standard Operating Procedures (SOP's)**

1. What is the main purpose of a Standard Operating Procedure (SOP)? 4 4

This is to standerdise the procedures for functions actioned by farious operations of the same nature.

2. Why is it important to have a Standard Operating Procedure (SOP) visible and on display in the warehouse? 4 4

for staff to understand it and also to be used as a quick reference.

- **Standardised Work / Planning**

1. What is the purpose of balancing work and activities within the warehouse? 3 3

To spread the work load evenly.

4. Visual Management

- **Metrics and Key Performance Indicator (KPI) Boards**

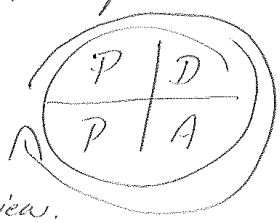
1. Why is it important to track and display key metrics (such as on-time shipment, customer satisfaction, inventory accuracy, picking productivity and accuracy etc.) and KPI's in the warehouse? 4

To track where you are, how well you have done and also to identify problem areas. 4

- **Value Stream Mapping**

1. What is the main purpose of Value Stream Mapping? 1

Value stream mapping is the processed followed for example 1



Plan, Do, Act, Preview.

2. How would Value Stream Mapping benefit you as an employee? 1

Assist in following the stream mapping. 2
will help you not miss a step or process.

5. Flow & Pull

- **Levelled Flow and Work**

1. What is the main purpose of a pull system within a warehouse?

4

The purpose of the pull system is to make sure there is a continues supply of parts in the production line.

4

2. Why is it important to level the flow of material and work within a warehouse?

4

this is to prevent bottle necks ~~en~~ to create a proper flow.

4

- **Layout and Zones**

1. What are the benefits of grouping similar items in the same zone within a warehouse?

3

Bin maintenance is easier. Picking will be done quicker.

3

2. What are the benefits of placing the fastest moving items in locations closest to the receiving and dispatch areas?

4

Fast moving products don't stand ~~exact~~ much in a warehouse thus you want to get it out asap. Fast moving products are A-class product thus is in high demand and picking needs to be done swiftly.

4

6. Quality Assurance

- **Quality Metrics**

1. Why is it important to have corrective and preventive action procedures (CAPA) in place for processes within a warehouse? 4

This is to correct any actions or procedures that might have gone wrong and to 4 prevent this from happening.

- **Problem Solving and Error Proofing Methodology**

1. What is the importance of having a structured problem solving procedure (5Why's, root cause analysis, etc.) in place to determine the root cause? 3

This assist you to get to the root cause 3 of the problems as most only know how to deal with the simtoms of problems.

2. Why is it important to have built-in quality checks in all processes within a warehouse? 3

To prevent errors. 3

7. Workplace Organisation

- **Cleanliness**

1. What is the importance of proper housekeeping (keeping all areas in the warehouse clean)?

4 4

This encourages better flow in the workplace
Health and safety issues are looked after
and every thing will be in its place.

- **5S and Signage Boards**

1. What are the main benefits of an active 5S programme in the warehouse?

3 3

An effective 5s programme improves your
house keeping and health an safety issues.
In turn it helps with productivity in the
warehouse.

2. What is the main purpose of appropriate signage (sign boards) in all areas within a warehouse?

4 4

To make of steaff aware of dangers, obstacles
processes, procedures and safety.

SCHOOL OF MECHANICAL,
INDUSTRIAL & AERONAUTICAL
ENGINEERING

To whom it may concern,

My name is Xander Swart, I am a part-time MSc Engineering student in the School of Mechanical, Industrial and Aeronautical Engineering at the University of the Witwatersrand.

I am currently undertaking a research project, with the title of: "The current understanding of lean principles in the warehousing industry of South Africa."

You are being asked to participate in a warehousing group-administered questionnaire. You have the right to query any concerns regarding this questionnaire at any time. The questionnaire will take approximately 45 to 60 minutes of your time.

Participation is voluntary and you can withdraw at any stage during the questionnaire. If you choose to participate in this questionnaire, please answer all questions to the best of your knowledge. Please do not write any identifying/personal information on the questionnaire (i.e. name, surname, contact information, etc.).

By signing this form, you give permission to use the information captured in this questionnaire. This will not impact or affect your current job/position in any way. ***All information gathered is for research purposes only and will be kept confidential.***

Thank you for taking the time to assist with this research project. Should you require any additional information regarding the study or completion of the questionnaire, please do not hesitate to ask.

Researcher (Xander Swart) Contact Details: 072 831 6001 or xswart@gmail.com.

Supervisor (Teresa Hattingh) Contact Details: 011 717 7374 or teresa.hattingh@wits.ac.za.

Signed: [redacted]

Date: [redacted]

B

Lean Questionnaire

- Current Position: Picker
- Years of experience (working in the warehousing environment)? 4 years
- Have you previously had Lean training?
  - Yes / (No)
- If yes, when? N/A

1. Value

- **Customer Value**

1. Why is it important to know what the customer sees as value?
   To see and know that there is order, communication and success.

2. Why is it important to know who your customer is?
   For knowing who you are dealing with, helps you be not in danger or risk, since strangers or unknown people are not garanteed and not safe to work with.

- **Seven Wastes**

1. What is the definition of a waste?
   Is something ~~are~~ is not in good condition, is useless and have no value just belong to big or toilet needs to be thrower away.

2. Why is it important to identify and eliminate all wastes in the warehouse?

To keep warehouse clean, neat and in good condition and order, then you must remove wastes. 1

2. Continuous Improvement

- **Continuous Improvement Events**

1. Explain what you understand under a continuous improvement event?

Is an event whereby we come up with new ideas and combine them to help the company to grow up each an every time. 1

2. Why do you think continuous improvement activities are important?

To see the success, the past must not be the same as the presence, the presence must be greater than the past and the future must be greater than the presence. 1

- **Employee Suggestions**

1. What do you think is the purpose of an employee suggestion programme?

~~To manage or keep order, rules and values to his/her employ~~

To show feeling and new ideas employees can have. 2

2. How would an employee suggestion programme benefit you as an employee?

- Might come things you always wanted to say. And ~~from~~ freely you.
- You can have a freedom of speech.
- You can learn more and more from others.

3. Standardised Processes

- **Standard Operating Procedures (SOP's)**

1. What is the main purpose of a Standard Operating Procedure (SOP)?

-To make things equal.
-To see company performance.

2. Why is it important to have a Standard Operating Procedure (SOP) visible and on display in the warehouse?

-People or employees to see how do they do or ~~their~~ performance goes.
-To know and ~~obb~~ understand the S.O.P better.

- **Standardised Work / Planning**

1. What is the purpose of balancing work and activities within the warehouse?

-To make people enjoy what they are doing.
-To encourage and make employee that ~~their~~ they being recognised.
- ~~To Avoid many mistake~~
- To Avoid so many queries ~~are~~ or many mistakes during working hours.

4. Visual Management

- **Metrics and Key Performance Indicator (KPI) Boards**

1. Why is it important to track and display key metrics (such as on-time shipment, customer satisfaction, inventory accuracy, picking productivity and accuracy etc.) and KPI's in the warehouse?

- To see peoples mistakes and fix it on time.
- To see performance.
- To build a better future for a company.
- To see that you are being recognised.
- To see the success of a business

- **Value Stream Mapping**

1. What is the main purpose of Value Stream Mapping?

- To see to do better than the other.
- To see where or which part the person is good at.
- To grow up people spirit of working.

2. How would Value Stream Mapping benefit you as an employee?

- people outside they will respect you because of your company success.
- To see your performance.

5. Flow & Pull

- **Levelled Flow and Work**

1. What is the main purpose of a pull system within a warehouse?

To able to receive the right or correct quantities and correct product. 1

2. Why is it important to level the flow of material and work within a warehouse?

- To send the correct material on time to customers. 2

- Short to do a right thing at the first time and always.

- **Layout and Zones**

1. What are the benefits of grouping similar items in the same zone within a warehouse?

To keep it level and look good and neat. 2

2. What are the benefits of placing the fastest moving items in locations closest to the receiving and dispatch areas?

The process goes quick and easy for everyone. 2

6. Quality Assurance

- **Quality Metrics**

1. Why is it important to have corrective and preventive action procedures (CAPA) in place for processes within a warehouse?

To do everything right everytime. 1

- **Problem Solving and Error Proofing Methodology**

1. What is the importance of having a structured problem solving procedure (5Why's, root cause analysis, etc.) in place to determine the root cause?

So we can learn from problem then we not do it again. 2

2. Why is it important to have built-in quality checks in all processes within a warehouse?

To help to see that each and every department goes correct. 1

7. Workplace Organisation

- **Cleanliness**

1. What is the importance of proper housekeeping (keeping all areas in the warehouse clean)?

- To Avoid dangers that ~~can~~ can be made by waste.

- To be seen as neat and clean employees to ourselves and to others outside e.g clients.

2

- **5S and Signage Boards**

1. What are the main benefits of an active 5S programme in the warehouse?

- make us not to ~~be to~~ forget our values
- Keep us as employee in orde All the time.
- Help us to able to handle or show visitors and customers that we are clean, neat and we have an order as our company values.

2. What is the main purpose of appropriate signage (sign boards) in all areas within a warehouse?

- To keep a reminder to us as employees.
- for customers or visitors to see ~~that~~ what is what and what that particular place is for.

2