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Sustainability of lean manufacturing principles in a production system

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of the

UNIVERSITY of JOHANNESBURG

by

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December 2018

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Declaration

I Qawekazi Sinxoto declare that the work presented in the minor dissertation titled “Sustainability of lean manufacturing principles in a production system” is my own work and all the work of others has been acknowledged accordingly.
Abstract

Research reveals that sustainability of lean is a subject worth studying. Lean sustainability is subject to the ability of the organisation to maintain the energy and interest of the established pilots, keeping up with improvement ideas and unleashing the capabilities of the teams to implement lean. Research acknowledges that upon implementation of lean in the organisation sustainability is a major challenge.

The research focus is on investigating the factors that affect the practice of lean manufacturing principles in a manufacturing environment and to examine the application of the principles as suggested in literature. The literature highlights best practices paramount in the integration of lean principles in an organisation to ensure sustainability. In this regard, the main argument denoted in literature is centred on organisational culture, leadership involvement and the manner with which lean principles are practised in the organisation. In addition to this, research reports that the answer to the issue of sustainability is subject to the adoption of the Toyota philosophies to sustain lean.

The research explores the application of lean principles in the organisation under consideration in relation to what is proposed in literature. The case study is based on an automobile manufacturing organisation. The research conducted is structured into five main themes of investigation being, shop-floor meeting, training, value streams, problem solving and shop-floor coaching. Without overlooking the other themes of the research, the research reports that of all the observed themes with different observable items the main themes which need attention are shop-floor meetings, training and problem solving. The analysis of the entire research reveals that if the manner with which training is conducted improves could alleviate many other problems as training proves to be the main contributor towards other factors.
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List of Abbreviations
TPS Toyota Production System
VPS Value added-Production System
CIP Continuous Improvement of Processes
Chapter 1: Introduction of the study

1. Problem Background

Organisations are often faced with the challenge of operating in a dynamic and competitive environment. It is for this reason why organisations have to seek improved approaches to enhance efficiency and remain relevant in the competitive space (Blažić, et al., 2017). Lean manufacturing is suggested to be a useful tool for improving efficiency in an organisation (Mapfaira, et al., 2016). It aims at simplifying and organising the workplace; therefore, promoting elimination and reduction of waste from the processes throughout the organisation (Mapfaira, et al., 2016). The lean manufacturing principles and methods which form the main foundation of the lean philosophy have been associated with efficient processes which promote productivity (Fliedner, 2008). An efficient production system is usually characterised by flexible delivery times, standardised methods of carrying out duties, defect free processes, robust processes with less waste to mention a few aspects. Prieto-Avalos (2014) puts into perspective that what appears to be a positive approach towards realising this goal is through the practise of lean principles and techniques.

Substantial literature has mostly focused research on the benefits of implementing lean manufacturing principles in an organisation. This literature expatiates more on the successful, tested approaches to be considered when implementing lean manufacturing in organisations. Researchers have acknowledged the amount of effort needed towards the implementation of a successful lean manufacturing programme; however, limited research has been devoted towards the difficulties experienced to sustain lean manufacturing once implemented in a production system. Jørgensen and others (2007) mention that the sustainability of lean is a subject worth looking into with regards to the manner of maintaining the energy and interest of the established pilots, execution of improvement ideas and unleashing the ability of teams in the organisation to implement lean. Despite the suggestion that lean sustainability is a subject essential to research Mwacharo (2013), reveals that it is; however, a challenge to maintain implementation. In addition to the claims made by Mapfaira and others (2016) outlining that lean manufacturing is a systematic approach used to improve productivity in organisations, a point worth noting is the issue of implementation and adoption. This indicates the necessity of adopting the Toyota philosophies of sustaining lean (Mapfaira, et al., 2016). This point is further substantiated by Woods and Robert (2008) cited in Murti (2009) who concede that sustaining the benefits from implementing lean upon inception has become a challenge for a greater number of organisation. A recent study conducted by Lean Enterprise Institute revealed that only 46% of the 999 individuals who took part in the study indicated
their attempt towards lean implementation early while 4% indicated advanced (Murti, 2009).
In addition to this, Womack and Jones (1996) cited in Poksinska and (2013) explain that understanding and implementing the lean tools in different contexts is somewhat achievable but the reality is many organisation are not able to sustain lean. In the beginning a lot of lean initiatives attempt to result in favourable outcome; however, eventually fail to sustain them (Bhasin & Burcher, 2006). A sustainable implementation of lean requires a change in the organisational culture (Bhasin & Burcher, 2006). Particularly, the interest of this research is focusing on the automotive production environment whereby the lean manufacturing principles have been introduced and implemented; however, there is an evident difficulty to sustain the practice of these principles within the daily business.

1.1. Research Objective

- To identify the factors that affect the practice of lean manufacturing principles in a manufacturing environment and to examine the application of the principles as suggested in literature.

1.2. Research Questions

- What are the main aspects which contribute towards the sustainability of lean manufacturing principles in a manufacturing environment?
- How should manufacturing organisations incorporate lean in the daily business to achieve sustainable results?

1.3. Research Justification

Current research mostly focuses on the benefits of implementing lean manufacturing principles; however, overlooks the challenges pertaining to the sustainability of daily lean routine work in manufacturing organisations. Moreover, the results acquired from this research will contribute towards the work of other researchers on the essentials aspects of lean manufacturing philosophy necessary to sustain the application of lean principles in any manufacturing environment.

1.4. Research Design

In purpose of understanding the underlying contributors the factors hindering the production associates from performing routine lean activities put in place to maintain an efficient lean production system the qualitative research approach will be explored. The qualitative research will help to gather information on the understanding and opinions of others on the presented research problem. The literature will be used as the main framework for reviewing how the organisation under study practises the application of lean principles; therefore, identifying any evident gap.
The choice of research method to be used in this research aims at gathering credible information straight from the source. The techniques to be used to gather information that substantiates the argument presented in this paper will be in the form of contact sessions with shop-floor workers using observations.

The outcome from the observations in turn will be analysed and used to solicit possible proposals essential to mitigate the factors hindering the sustainability of lean principles; therefore, establishing a sustainable application of these principles.

1.5. Research Plan
The aim of this study is to gather information on the aspects likely to contribute towards the unsustainability of the lean principles; therefore, establishing an approach to mitigate the lack thereof.

**Literature study:**

- Perform a literature study on what other researchers have found on the difficulties behind sustaining lean in a production system. This approach will help to understand the insights and opinions previous researchers have established with regards to the subject matter.
- The literature will be used to study what the researchers propose as best practices manufacturing organisations should follow or consider when applying the lean principles in order to evidence positive results.

**Observation:** A designated period of 8 weeks will be allocated towards observing what happens on the production shop-floor on a daily basis. The observations will be conducted focusing on the application of lean principles within the organisation consideration.

1.6. Research Outline

**Chapter 1:** This chapter introduces the background of the problem, research objects, research questions, and the justification of the research, research design and plan.

**Chapter 2:** This chapter focuses on the literature study, it reveals what other authors have found concerning sustainability of lean shop-floor routine work.

**Chapter 3:** This chapter focuses on the methodology to be employed when conducting the research and outlines the appropriate procedure to be used for data collection.

**Chapter 4:** This involves the analysis of the results attained from data collection which then substantiates the deductions made from the study.
Chapter 5: This chapter mainly proposes measures to be considered in purpose of alleviating and answering the research questions and summarises the learnings of the research study.

1.7. Conclusion

Chapter one of this paper establishes the fundamentals with which the research problem and background is based. This chapter further looks into the desired outcome from the objectives and translates the research problem into essential research questions which form an integral part of the lean sustainability literature and framework for the research study. The reason why sustainability of lean manufacturing has been considered and the manner in which the study will be conducted is briefly described in the chapter.
Chapter 2: Literature Study

2. Introduction
The purpose of this chapter is to build a literature for the research argument under consideration. The goal of the literature review is to source and understand the knowledge of the previous researchers on lean sustainability in a manufacturing context, looking into the possible factors pertaining to lean challenges on shop-floor. The comprehension of the work of the previous research forms a fundamental approach towards answering the posed research questions. Equally, important this literature study forms a basis with which the research methodology will be conducted. The theory presented in the literature study will be used to form a framework with which the research methods will be used to gather information on the study therefore, attaining results which substantiate the presented argument.

2.1. Lean Background
The lean concept emerged when the founder of Ford, Henry Ford established an assembly line. This assembly line was a simulation of an ideal production system with an improved manufacturing process. The improved car manufacturing process was in the form of a process which could facilitate mass production rather than individual production (Hobbs 2004) referenced in (Mwacharo, 2013). Although the improvement of the car manufacturing process exhibited ideal results such as waste elimination in the form of resources used to manufacture the cars, time and misuse of space due to individual cars production assemblies, mass production was not a best practice (Mwacharo, 2013).

The lean concept emerged during post war years in Japan. This is when Toyota motor company was established. The post war effect had a negative impact on the company’s financial advantage. The financial challenges were attributed to the difficulty of the company to sell the production units and make profit (Mwacharo, 2013). Despite the challenges, Toyota motor company was faced with significant competition based in United States, companies such as Ford and General Motors. These companies were already well established in the industry and had mastered the systems of mass production. When Toyota had successfully emerged the market in pursuit of recovering, it focused efforts towards adapting ideas, practices and principles developed by Motor Vehicle Programme of the Massachusetts Institute of Technology (MIT) (Agrogiannis & Agrogiannis, 2015).

During this period Toyota devoted most of the time towards learning the best practices to be used within the manufacturing processes, it understood that the mass production is not the best neither sustainable approach for the Japanese market (Coetzer, 2017). Toyota managed to establish sustainable approaches towards the manufacturing processes and this led to the
incorporation of some practices in the book “The Machine that Changed the World” written by Womack and others (1999). This book was written in purpose of scrutinising Toyota’s mass production system. The authors’ content of the book aimed at exploring new lean production concepts in comparison to what Toyota had already established within the manufacturing process and what they found was in contrary to what the United States and Europe based companies were practising. From the findings Womack et al. (1999) concluded it was evident that these companies needed to move away from the traditional approach; being, mass production system to remain relevant in the competitive space (Agrogiannis & Agrogiannis, 2015). This was the evolution of the Toyota Production System (TPS) also known as Lean Production (Womack, et al., 1990) cited in (Coetzer, 2017).

2.1.1. Lean management versus lean production

In the early stages of adoption of lean production by Western companies the focus was merely on production owing to the original intended purpose and the companies merely strived to identify waste in the processes and introduce the pull principle (Agrogiannis & Agrogiannis, 2015). While the lean concept was still new, the companies realised that the results they had anticipated upon implementation of lean were not evident. The companies held a notion that the lean concept will help them gain back their competitive advantage but instead achieved efficient production methods. Attaining the competitive advantage almost did not transpire because the processes of these companies were still mass production system driven; therefore, never experienced the sufficiency of lean production and deemed it inefficient (Agrogiannis & Agrogiannis, 2015). Despite the dispute on lean production it was eventually realised that the lean production concept is not strictly exclusive to production but can be applied in the various industries. This was when Lean Management emerged.

Martinez-Jurado and Moyano-Fuentes (2014); Parkes (2015) cited in Terzic & Pitzalis (2017) describe Lean Management as the concept integrated within different industries with the aim of improving the organisations’ competitiveness. The advantage of lean management to different organisations is that it can be used as a tool to manage responsibilities (Pascal, 2002) cited in (Terzic & Pitzalis, 2017). According to Kumar (2014) lean management is a management philosophy originated from the Toyota Production System in purpose of mitigating the difficult financial challenges the organisation experienced (see 2.1). Despite the outline Terzic and Pitzalis (2017) made on how lean management originated from TPS (lean production), the perspective from Kumar (2014) does not distinguish between lean management and lean production therefore, suggests that these two concepts serve the same purpose.
2.2. Defining Lean

Mwacharo (2013) defines lean as a set of tools and techniques employed and sustained by various companies with the aim of achieving increased production and the entire customer value chain without overlooking elimination of waste. Lean is a philosophy that aims at getting rid of waste in all the units of a production system and according to the intended need of the end user its purpose could be reduction and elimination of incurring unnecessary cost in the form of non-value added steps therefore improving efficiency and quality (Elbert, 2013) referenced in (Sidinile, 2014).

Lean or lean manufacturing is a methodology used to identify and do away with waste in the form of non-value added activities when subjecting the product through the production operations strictly upon demand by the customer (Greg, 2006).

These three definitions suggest that lean involves a certain required way of thinking that is enhanced by the application of tools which assist in eliminating unnecessary waste thus, achieving increased productivity. In addition to this, for an organisation to evidently experience the gains of lean, it should focus on value-added work that will mainly benefit the customer.

2.3. Types of wastes

Lamb (2013) explains that lean manufacturing is a managerial thinking approach stemming from the Toyota Production System. The concentration of this philosophy at most is to do away with different forms of waste in any production operation. During the years when Toyota was investigating ways to improve the efficiency of the production process, the discovery from the study conducted in Ford revealed seven possible types of wastes in a production process (Coetzer, 2017). The seven wastes outline the different forms in which waste can be incurred in a manufacturing process (Lamb, 2013).

- **Transportation:** Whenever a product is flowing in a production process it faces possible realities which could negatively impact on the quality. These possible realities come in the form of damages and product getting lost in the process which in turn could result in increased time the final product spends in the production process (Lamb, 2013).

- **Inventory:** Inventory is in the form of raw materials, work in progress and finished goods. All of these types of raw material represent tied up profit or income as no value added work is being done on them therefore, considered as waste.

- **Motion:** Lamb (2013) explains that excessive movement of operators when performing operations could lead to strain and this could contribute towards an increased probability of unnecessary accidents. He further explains that the unnecessary motion of machine could wear it down thus resulting to waste in the production process.
Waiting: In this type of waste, time and space appear to be significant for instance, if a product spends time in a production system not being processed waste in the form of waiting time and space utilisation will be experienced (Lamb, 2013).

Over-processing: This type of waste transpires when more operations than necessary are dedicated towards a product as well as expensive over engineered tools.

Overproduction: Lamb (2013) outlines that this type of waste is usually perceived as the most undesirable since it significantly leads to other types of waste such as surplus inventory and vast space utilisation. Overproduction occurs when more is produced than the existing demand.

Defects: This type of waste is in the form of unnecessary cost incurred because of damages due to part handling and defects resulting from transportation (Lamb, 2013).

In additional to the above types of waste described from a manufacturing point of view, Sidinile (2014) further mentions the types of waste experienced in the service sector. These types of waste are similar to the ones likely to occur in the manufacturing sector. The service sector types of waste are describe below:

- Delay
- Duplication
- Unnecessary movement
- Out of stock
- Errors
- Manual Processing
- Unclear communication

2.4. Lean principles

Coetzer (2017) outlines that according to Womack and Jones (1996) there are five main principles of lean manufacturing. These principles follow a systematic approach as the implementation of one principle forms a foundation for the implementation of the other and form a foundation in which lean is successfully implemented in organisations. The principles form a basis with which the tools and techniques are practised. Borris (2012) further brings the view that lean is interpreted from customer’s point of view more than the manufacturer’s thus, the principles are defined from the customer’s perspective. Below the main lean principles are describe:
Figure 1: The five main lean principles

- **Specify Value**: The first step towards implementing successful lean is to identify what the customer defines as value (Womack and Jones 1996) referenced in (Devin, 2012). When an organisation understands what is it that the customer perceives as value with regards to the product, it becomes much easier to define value chain throughout the processes from inception until completion and delivery of the product. This understanding of the entire value chain is important for establishing exactly what the customer is prepared to pay for (Devin, 2012).

- **Value stream**: This principles aims at studying each step of a production process from beginning to end in purpose of eliminating any form of waste. Ideally, the analysis of each process step, waste identification and elimination should improve the efficiency of the entire value chain therefore, achieving short lead times between order placement and order delivery (Borris, 2012). According to Cottyn (2014) the value stream is not only used to map material flow, it is also used to map information flow with the purpose of indicating and controlling the flow of material. The material flow of the complete unit is followed backward from the final processing to the first processing step. This approach is helps to separate value adding steps from non-value adding steps therefore, eliminating apparent waste. The value stream mapping requires five core steps executed by a special team being; identifying the product family, mapping the current state, mapping the future state, defining a work plan and executing the work plan (Cottyn, 2014). Erikshammar (2017) explains that the value stream exercise requires a careful selection of the team and that the usual mistake is selecting irrelevant candidates for the exercise (Erikshammar, et al., 2014). Rother and Shoock (1999) further explains that it is usually not common to have a person in an organisation with the in depth knowledge of the value stream that is; a person who understands the entire flow of material and information for the product. This usually allows each department to handle a part according to the needs of the department not
from a value stream perspective. Rother and Shoock (1999) suggest the need of having an individual, a value stream manager that will mainly run with the responsibility of understanding a specific product family for the value stream and realising the identified improvements (Rother & Shook, 1999). In order for the individual to have a better chance of realising the identified improvements from the future state map across the departments he or she must directly report to the organisation’s leader. In return the leader should lead and support the value stream team towards the mapping and implementation of the future state value stream. Cottyn (2014) outlines that the analysis of the current state map requires certain data in the form of cycle time at each process, change over time, uptime and number of operators available during analysis. After the analysis of the current state, a future plan and lean transformation plan is developed. The lean transformation plan is suggested to comprise of improvement opportunities. These improvement opportunities are made transparent on the future state map, represented by kaizen bursts and driven by Deming’s cycle. This cycle follows a four stage methodology being; Pan, Do, Check, Act (PDCA).

Devin (2012) explains that the value stream satisfies three significant management responsibilities:

- **Problem solving:** This involves concept development, design and product launch.
- **Information management:** This outlines all the tasks necessary to produce the product from inception to finish.
- **Physical transformation:** This involves the processing of the raw materials into a finished product that has been delivered to the customer.

- **Make the product flow:** This is the next principle to execute upon defining the value of the product from the customer’s point of view that is; identifying the actual value added work the customer is willing to pay for and defining all the essential steps to be followed from start to finish when producing a product. The principle simply describes the manner with which the components passing each sub-process should feed smoothly and steadily from one sub-process to the next without delays, interruptions and defects until a complete unit is attained (Agrogiannis & Agrogiannis, 2015; Vermeulen, 2014). In addition to this, Agrogiannis & Agrogiannis (2015) make reference to the work of Hendry Ford on the intermediate product flow in a production system. This concept established by Ford was sufficient enough as it yield significant results in those years even to the point of influencing the establishment of an inventory management concept, Just In Time (JIT). Creating conditions for value to flow smoothly through the stream.

- **Pull:** The sufficiency of the pull principle is mainly influenced by the demand. The idea behind the pull principle is simply producing or providing mainly what the customer has
requested (Vermeulen, 2014; Borris, 2012). If the demand from the customer is not clear there is a highest possibility of running the risk of producing less or more of what the customer actually needs. If more of what the customer needs is produced non-value added work becomes the apparent result and should there be no demand on the surplus products produced this could result in unnecessary waste in the form of space utilisation, scrap and material (Borris, 2012).

- **Pursue Perfection**: Vlachos and Bogdanovic (2013) explains that in reality the fifth lean principle namely, seeking perfection is generally challenging to establish but worth pursuing. The main objective of this principles is to constantly improve the production elements such as quality, delivery and cost to mention a few (Bhasin & Burcher, 2006). The continuous improvement of the essential production elements is achieved through the total elimination of waste that is, getting rid of all the non-value added work the customer is not willing to pay for (Vlachos & Bogdanovic, 2013). The continuous improvement (kaizen) approach follows a four cycle method referred to as Plan, do, Check, Act (PDCA). This method is by means of improving the production operations in an organisation in the form of identifying the best approaches for waste elimination and value creation ideas for the customer (Vlachos & Bogdanovic, 2013) cited in (Abuelkassem, 2017).

- **Respect for people**: An organisation centred on the application of the lean philosophy to run the production operations perceives the people as the most important entity within the organisation and will engage them the best of ability in purpose of unleashing the potential capabilities within the individuals (Liker, 2004; Oppenheim, et al., 2011) referenced in (Devin, 2012). Liker (2004) mentions that the considerable amount of time devoted towards the implementation of lean principles potentially leads to technical solutions and the certain culture essential to the organisation. Moreover, it is suggested that the implementation of lean principles mainly based on tools is likely not to yield any favourable results in terms of the lean culture significant for sustaining benefits of lean application and best practices. It is also worth highlighting that the implementation of lean tools in an organisation should support the relevant principles (Scherrer-Rathje, et al., 2009) referenced in (Devin, 2012).

### 2.5. Lean Tools

- **Visual control**: Visual management is a concept used to enhance improvements in an organisation. When a company seeks to improve performance, it can employ this tool by means of focusing on what is really critical to the organisation. Through the use of graphical illustration a company can focus the attention of the entire organisation towards improved performance. The essential information made transparent should be
relevant and easy enough to understand so as to help everyone to achieve the desired improvement (Reis, et al., 2016).

The figure below illustrates the triangle of visual management depicting the connection between shared knowledge and responsibility (Hines, et al., 2011) cited in (Reis, et al., 2016)

![Visual Control Triangle](Image)

**Figure 2: Visual Control adapted from (Dennis, 2005).**

Vermaak (2008) further explains the application of visual control tool in an organisation.

- Simple visual indicators should be used to indicate whether people are adhering to the defined standard.
- The use of computer screens should be eliminated especially if it diverts the focus of the worker.
- An easy to understand visual management system should be put in place within the work area to illustrate the pull and flow of work.
- The use of paper to run reports should be reduced.

- **Kanban:** Is a pull system in place used to control inventory for meeting the demand employs cards or bins. A manufacturing plant comprises of different processes therefore, has buffers in-between the processes. The Kanban concept works by means of pulling inventory which feeds into the downstream process, this assist in managing material flow difficulties in a manufacturing process (Zhanga & Chen, 2016) cited in (Viljoen, 2015). This process occurs through a two-bin system or cards used to trigger the automatic pull of inventory. This concept is best implemented in cell manufacturing whereby one unit is moved from one operation to the next before it becomes a complete unit. The objective behind the application of a Kanban approach is to prevent overstocking the lines and delays from one process to the next process (Viljoen, 2015).

- **Standardisation of work:** Standardisation of work is a tool used to achieve product stability in terms of quality, cost and delivery. When the work is done in a uniform way it is easy to avoid mistakes like scrap and rework (Martin, 2014). This tool aims at forming a basis with which standards are continuously improved. Standardisation of
work forms an integral part of kaizen which allows the operator to logically improve the engineering standards to daily, easy to apply standards (Imai, 2012) cited in (Viljoen, 2015). Standardised work provides the best work practices for executing an operation. The level of detail could be up to the time required to complete the task, description of the tools and methods necessary for performing the work accordingly or the degree to which deviation can be permitted (Viljoen, 2015; Martin, 2014). This detailed document can be subjected to change as the process improves. This explains that a standard is a foundation for continuous improvement (Roth, 2014). There are conditions standardised work should fulfil to be deemed reliable. The first condition is in the form of the standardised work being developed from an up to date job description. Secondly, the outline on how the work will be executed should be as realistic as possible, quick, safe and efficient. Thirdly, each explanation of process steps should be clear, easy to understand and perhaps have an illustration for better comprehension. Forthly, all the operators should be thoroughly trained on the standard in order to be able to perform the work as expected. The fifth condition requires that the standardised work is made transparent and easily noticeable within the work area. Last but not least the operator that is going to run with the standard should contribute with his or her craftsmanship towards the development of the standard (Roth, 2014).

- **5S**: The 5s activity is one of the lean manufacturing basic tools used as the foundation to instil lean culture in an organisation. This is the most adapted tool in organisations in purpose of establishing consistency in operations therefore, maintaining the culture of continuous improvements. It is an approach employed to maintain a well organised, clean and efficient defect free work environment (Filip & Marascu-Klein, 2015). Houa and others (2018) suggest that before a new production processes is implemented the meaning of 5s and the direction on how the 5s will be implemented in order to bring the expected benefit should be defined. He further explains 5s as follows:

  - **Sort**: This involves going through all the material, tools and machines with the purpose of identifying all the unwanted items and keeping strictly all the wanted items. This first activity results in a boosted morale of the workers as the workplace becomes more noticeable.
  - **Set in order**: Aims at organising the items in a sequence that best influences the workflow of the workers and facilitates easy accessibility of the items.
  - **Shine**: This deals with cleaning the workplace not only after the shift but establishing a regular routine of tidying up to keep the work area neat. This assist in easy noticing of problems.
  - **Standardise**: This activity involves establishing the best methods to be practised by the team and sustaining them with ease through continuous improvement.
Sustain: This last step of the 5s activity results in some set of procedures to be followed by the workers in order to maintain the established best practises.

2.6. Lean Sustainability

Sustainability is defined as the ability to meet today’s needs without jeopardising the ability to meet the needs of the future generations (Resta, et al., 2014; Gort, 2008). In the context of this section sustainability refers to the ability to maintain the reliability of production processes in a company through the implementation of lean manufacturing which equips the individuals of the organisation with useful tools and techniques necessary to sustain the processes. Lean manufacturing aims at implementing the continuous improvement mind-set which promotes waste reduction, establishing efficient processes and reduces chances of incurring unnecessary costs in an organisation. This manufacturing philosophy provides companies with the tools essential to remain relevant in the diverse market space around the world (Alves & Alves, 2015). Ideally, these set of tools are used to drive the organisation in the direction of a convenient economic state and this works well to the advantage of people as well (Peto, 2012). The companies which embrace lean manufacturing have been able to improve their competitive advantage (Martínez-Jurado & Moyano-Fuentes, 2014). Moreover, Jadhav and others (2014); Reis and others (2016); Kumar and Abuthakeera (2012) assert that the sustainability of any organisation is to have a substantial advantage over competition, taking into consideration the rise on technological advances and established markets around the globe. This could be achieved through the lean manufacturing as it is one of the most essential approaches employed to improve quality however, majority of the lean implementations eventually arrive to failure and a significant amount of these lean initiatives are less sustainable, if sustainable at all (Jadhav, et al., 2014). This point is further sustained by Martínez-Jurado and Moyano-Fuentes (2014) who explain that even though a meaningful number of companies have implemented lean manufacturing however, some companies have not experienced the anticipated results or rather sustainable results over a notable period of time.

In light of the organisation fighting for competitive position in the global market, it is essential to note that the credibility of each organisation lies in the ability to provide exceptionally good quality products, instant delivery of products in right quantities through the application of lean manufacturing principles and techniques (Kumar & Abuthakeera, 2012). Additionally, in this regard the main objectives of lean manufacturing are outlined as follows:

- Major reduction of waste in the value chain.
- Minimised space utilisation for inventory.
- Establishing an efficient production system.
Establishing an efficient inventory supply management system.

Improve the flexibility of the production areas.

Furthermore, Alves and Alves (2015) outline that the above mentioned goals are the centre of continuous improvement as well as the five main lean manufacturing principles to achieve value creation for the customer.

In purpose of achieving sustainable practise of lean manufacturing in organisations. Alves & Alves (2015) expands on the claims by Mann (2010) who explains that the apparent transition from the traditional methods of production to lean production in the form of application of lean tools, improved material flow and standardised methods, merely constitute 20 percent of the entire lean philosophy and the remaining 80 percent is attributed to cultural transformation and is generally challenging to administer throughout the organisation. This transformation is in the form of traditional beliefs to lean hourly; and daily routines, ways of dealing with problems and managing tasks (Mann, 2010).

In view of lean manufacturing being a set of tools and methods to eliminate waste Alves & Alves (2015) explains that it is worth mentioning that lean manufacturing is simply centred around a transformed way of thinking and performing daily work; therefore, requires a strong cultural change essential for sustaining the lean principles and beliefs. Sidinile (2014) and Mann (2010) highlight that organisations miss the chances of establishing a sustainable lean system due to much focus given on lean tools and physical changes when implementing lean instead of focus on lean culture. It is suggested that the application of methods is more or less the apparent part of lean manufacturing philosophy (Dombrowski & Mielke, 2013).

### 2.6. Lean Culture

Organisational culture is a set of inferences and beliefs which the organisation has developed over the years of dealing with challenges (Schein, 1984) cited in (Lotz, 2013). Schein (2010) cited in Smith (2016) suggests that leadership is the main driver behind developing and transforming a culture. According to Zarbo (2012) the majority of lean adopters employ certain improvements and tools prescribed by the quality specialist to deal with projects; however, this follows a top-down approach. He suggests that this approach overlooks the essential factors pertaining to Toyota’s positive lean results in the form of a workplace culture driven by knowledgeable employees, with well-defined structures which facilitate consistent practice of desired behaviours and incentive schemes to promote engagement amongst the employees at all levels. In addition to this, Achanga et al. (2006) referenced in Goodyer et al. (2011) maintain that organisational culture is one of the core contributors towards lean success. In turn, Lotz (2013) explains that the success of lean culture is suggested to rely on the people in the organisation since respect for people is one of the elementary pillars of lean. Equally
important, Wilson (2010) delineates that the Toyota culture has always been the benchmark for uncompromising respect for the people hence, today has the best lean culture.

Zarbo (2012) further explains that a successful lean culture of continuous improvement is attained when employees are able to sustainably perform their daily duties and achieve impressive quality targets in the absence of a team leader. Equally important, it is indicated that culture change takes a considerable amount of time to establish; therefore, suggests lean as a long term solution.

Deming’s 14 management principles provide a premise with which leaders can create a culture of continuous improvement as adapted by the TPS. The Toyota culture is explained as a culture that allows employees to be:

1. In charge and improve their own work; and develop their own standardised work.
2. Interested to contribute towards developing their own standardised work.
3. Permitted to improve their own standardised work.

Zarbo (2012) quotes Dr Jeffrey Liker who explains that upon implementation of lean in organisations usually there is a great focus on the tools of improvement; however, these tools are not designated for process improvement. They are used to make problems transparent. According to Wilson (2010) a healthy culture is achieved when the beliefs, the way people think and act is uniform throughout the organisation. He makes reference that this type of behaviour is an integral part of Toyota’s culture which has resulted in the development of unique principles such as “Kanban” and “Autonomation”.

Looking at culture from a management’s perspective the cultural practice in Toyota is trying to enforce the understanding that should a company fail, this should be attributed to the failure of the management team. It is highlighted that some organisations in the other parts of the world have a management that takes credit when things are going well however, not take accountability when things go bad (Wilson, 2010). Toyota’s culture from the shop-floor workers perspective reveals the culture of best work practices which suggests that when a defect has occurred the entire production line should be shut down and only when the source of the defect has been found will the line be operated again. This principle is referred to as jidoka, it is the responsibility and right of the worker to apply it when necessary (Wilson, 2010). This culture of encouraging employees to take accountability of the problems in their processes and improving continuously is attributed to different attitudes and behaviours (Lotz, 2013). Essentially, culture has significant dimensions in the form of noticeable behaviours or the manner with which people do things; however, it has not escaped to mention that it is rather important for an organisation to comprehend culture at a theoretical perspective prior to translating it in a practical level namely kaizen culture (Miller, et al., 2014)
2.6.1. Kaizen Culture

Kaizen simply refers to changing for good, better known as continuous improvement (Miller, et al., 2014). According to Rathilall (2011) continuous improvement suggests finding better methods of executing production. Continuous Improvement is a management concept that should be used in purpose of driving cultural shift in the workplace (Sundara, et al., 2014). Bicheno (2004) referenced in Rathilall (2011) explains that continuous improvement is an important aspect of lean that needs to be implemented in all the levels of the organisation. It takes into consideration all the processes being, internally or externally. In support of this explanation Bhuiyan and Baghel (2005) cited in Rathilall (2011) asserts that the culture of maintaining improvements should be the main basis of continuous improvement. This culture of maintaining improvements comes in the form of small incremental improvement and the involvement of everyone in the organisation (Ohno, et al., 2009) referenced in (AdedejiI, 2011). Kaizen remains the most influential approach in lean manufacturing (Glover, et al., 2015). In a case whereby escalation of problems doesn’t prove to be sufficient, the kaizen approach facilitates a platform in the form of kaizen events whereby all the relevant people regarding the problem are brought together. Farris and others (2008) cited in Glover and (2015) describe kaizen event as a systematic approach in an improvement form employed by the designated team to improve a specific work area within a defined timeline. The main goal of kaizen events is to determine problems, brainstorm possible solutions and deploy resources accordingly (Martin, 2014). Rathilall (2011) makes reference of various authors who maintain that the participation of production employees and leaders in continuously improving the processes and products is essential for continuous improvement. Along similar lines, Miller, et al. (2014) explains that kaizen provides the organisation and the people with tools and philosophies essential for continuous improvement. It aims at determining the method with which people perform work and outlines how workers; and leaders can achieve productivity through mindset shift on the traditional perception of things (Ohno, et al., 2009) referenced in (AdedejiI, 2011).

It is highlighted that leaders with adaptive cultures are required to lead, steer the organisation and find a ways to define the daily work; thus, achieving the kaizen culture. The sustainability of the kaizen culture is denoted by the transition from defining how things are done to what and why things are performed in a particular way, some organisations fail to sustain the effort put towards establishing a kaizen culture. Sustaining a kaizen culture requires the development of behaviours and mindsets with the aim of making continuous improvement a tradition; therefore, establishing daily practice (Miller, et al., 2014). de Haan et al. (2010) cited in Jadhav et al. (2014) explain that developing and allowing the workers to express their own craftsmanship and skills on their daily responsibilities will lead to a positive outcome. In the
same light, Bantom (2011) delineates the reasons why the service industry would put in place a kaizen culture:

- **Lower cost**: The service industry is subjected to more variety than the manufacturing sector. In manufacturing it is normal to produce the same product as per customer demand. Manufacturing avoids variety due to cost implications involved however, the service industry has to cope with variety for example a call centre having to handle different types of customer cases.

- **Immediate results**: Kaizen uses small incremental steps to solve a considerable amount of problems with the aim of reducing waste or improving processes. This results in the attainment of quicker solutions.

- **Energises employees**: The success of kaizen depends on the motivation of the workers to come up with small improvements in order to improve their workplace and take part in the entire kaizen change initiative. Kaizen should simply motivate, empower and provide knowledge enrichment.

Habidin and Hashim (2013) explore another view which highlights that some organisations have tried to put kaizen initiatives in place; however, have not been successful with achieving the expected results owing to certain barriers and challenges experienced upon implementation. These factors are highlighted as follows (Pay, 2008) cited in (Habidin, et al., 2013):

- No understanding of lean.
- Cultural change not received well.
- Having the right positions but with no right people in place.
- Perceiving lean as the process improvement approach instead of a holistic improvement programme.

2.7. Lean Leadership

According to Dombrowski and Mielke (2013) lean leadership is not appropriate for lean production system or neither just a supplementary concept. In true sense it is essential for establishing a continuous improvement of the lean production system including all the operations. It is the apparent gap between lean tools, the actual application and the continuous improvement of the organisations (Orr, 2005; Mann, 2009) cited in (Dombrowski & Mielke, 2013). Lean leadership is the systematic approach for establishing sustainable implementation and continuous improvement. This approach delineates the coordination of employees and leaders towards achieving the same goal being perfection (Dombrowski & Mielke, 2013). Moreover, it worth mentioning that lean transformation involves everyone in the organisation not just production; however, this active participation of all the department should
be steered by the leaders (Alefari, et al., 2017). A lean leader should be an individual with the interest to develop the leadership skills essential to positively influence the workers to the extent to which they are able to improve and manage with challenges and targets at all levels; therefore, contributing towards continuous improvement and long term objectives in the organisation. On the same note, Liker (2006) explains that it is easy to spike the interest of leaders towards recognising the benefits of lean in the organisation but what usually leads to failed efforts is the inability of the executive members to take action and give full support. The essentiality of the executive leader’s involvement in driving lean in an organisation is further supported by the claims made by the investigation conducted by Worley and Doolen (2006) cited in De Vries (2015) which reveals that management support has got a significant effect on lean implementation both positively and negatively. Additionally their study revealed that there is a correlation between lean implementation and communication in the organisation. Again, they indicate that channelling a beneficial lean mind shift towards the successful implementation of the lean philosophy is quite challenging (Worley & Doolen, 2006) cited in (De Vries, 2015).

2.8. Lean leadership model

The lean leadership model emerged in Toyota. This model is perceived as the reference model for all the other organisations that aspire to implement lean and comprises of four stages (Trenkner, 2016).

2.8.1. Self-improvement

People who are born to lead take on the possibilities and opportunities to improve themselves and their subordinates. They should have the suitable behaviour which fits well into Toyota’s values through participation in Gemba with the objective of understanding the actual situation and take part in problem solving (Trenkner, 2016). Toyota has established the most important lean values in the organisation known as the True North. These values ignite a positive attitude challenges, kaizen, genchi genbutsu, team work and respect for humanity. According to Emiliani (2008) cited in Poksinska and others (2013) lean leadership could possible result in managerial competencies if centred on lean beliefs that influence certain behaviours.

2.8.2. Coaching and stimulating the development of others

Leaders are aware of the strengths and weaknesses of the people; however, learn to attain and focus on the positive results through limited involvement. The aim of this stage is to stimulate the employees’ capabilities by encouraging them to take control of any situation; thus, achieving desirable results (Trenkner, 2016). It is the mandate of the leaders to transfer the cultural beliefs and values of an organisation, they should encourage and stimulate the culture of learning and sharing knowledge (Mann, 2005) referenced in (Poksinska, et al.,
2013). Ehni and Kersten (2015) make claims that the third and the fourth level of the 4P model focus on people’s skills such as cooperation between operator and leaders. This cooperation forms a foundation for continuous improvement at shop-floor level and has been overlooked in western lean manufacturing approaches. In purpose of feeling this gap, Ehni and Kersten (2015) make reference to a study done made by Liker and Franz (2009); Rother (2009) which aimed at understanding the structure of improvement processes at Toyota and how these processes could be integrated into the daily routine on shop-floor. Liker and Franz’s study revealed the use of the Toyota Business Practices approach for continuous improvement. This method follows 8 steps and a PDCA approach (Ehni & Kersten, 2015):

- Define the ideal state with regards to the problem (plan)
- Analyse the current state (plan)
- Do a root cause analysis (plan)
- Define the target state (plan)
- Plan a suitable approach (plan)
- Conduct experiment (do)
- Study results (check)
- Standardise, adapt and transfer knowledge of the solution (act).

Toyota has adapted this approach on shop-floor and is practised under the supervision of a coach. This method is known as Toyota kata. It assumes specific learning such as (Ehni & Kersten, 2015):

- People learn through small steps over a long period of time.
- Learning should be conducted by a coach.
- Learning should be conducted through learning by doing.
- The small learning steps should form an integral part of the bigger picture.

This method is motivated by the martial arts procedure where by motion is repeated continuously until it becomes second nature (Ehni & Kersten, 2015). Toyota kata comprises of two type of katas; namely, improvement kata and coaching kata. Improvement kata is used to develop daily improvement and coaching kata coaches on these daily improvement with the help of a coach or leader. An improvement kata card can be used to facilitate the improvement and learning process. The first set of three questions on the card focuses on understanding the target condition and these questions are known as framing questions. The second set of two questions; the next experiment focuses on rapid experiments in pursuit of solving the topic under consideration. The last question focuses on reflecting on the outcome attained in relation to the explored measures from the experiment (Soltero, 2012).
In a case study conducted by Carvalho and others (2013) in a certain organisation it was evidenced that the organisation integrated Toyota kata through training the employees on the methodology, defining starting condition, workers; and coach defining the target condition for lead times and conducting daily meetings between the team and coach to check progress following the PDCA cycle. The training on improvement kata and coaching kata took four hours and involved both top; and middle management and some of the workers. With the aim of visually managing progress a board was made available next to production and with the help of frames, questions were posed to help employees understand the current and target conditions:

**FRAMING QUESTIONS**

1. What is the target condition? (The challenge)
   - What do we expect to be happening?
   - List the conditions (w/o adjectives).
2. What is the actual condition now? (Go & See)
   - Is the description of the current condition measurable?
   - Block diagram, same every cycle?
   - Takt, cycle times, cycle times vary?
3. What is hindering you from reaching the target condition? What are you addressing now?
   - Compare current vs. target conditions.
   - Focus on one obstacle at a time. Forget about solving the biggest hindrance for now; keep digging and you’ll find it.

**THE NEXT EXPERIMENT**

4. What is your next step? (Start of next PDCA cycle)
   - Take only one step at a time, but do so in rapid cycles.
   - The next step does not have to be extraordinary. What is important is to take a step.
   - Many next steps are further analysis, not countermeasures.
   - If next step is more analysis, what do we expect to learn?
   - If next step is a countermeasure, what do we expect to happen?

**PREPARE FOR REFLECTION**

5. When can we go and see what we have learned from taking that step?

*Figure 3: Improvement kata card adapted from (Soltero, 2012).*
of the coach the ideal lead time was identified as a performance indicator to tackle improvement (Carvalho, et al., 2013).

2.8.3. Supporting daily kaizen processes
The concept of leadership development should be practised by leaders within the lower ranks focusing on the application of standards, objectives and visual management; for instance, the leader should make time for Gemba to check indicators of visual management and define the gap between the current condition and the target condition (Trenkner, 2016).

2.8.4. Creating the vision and coordinating objectives
Pokinska et al. (2013) describe this stage as creating True North vision. At this stage the leaders should strive towards steering the agreed target, integrating objectives and ways of attaining the objectives (Trenkner, 2016). The goals towards achieving the True North are described at all management levels but to achieve the target the leaders need to be equipped with relevant tools and methods (Liker & Convis, 2011). The main tools of lean production are leader standard work, visual controls, daily accountability on processes and discipline. In this instance leader standard work outlines all the activities that form part of the daily routine such as Gemba walks and daily checks of performance indicators (Pokinska, et al., 2013).

Dombrowski and Mielke (2013) highlight five lean principles:

![Five principles of lean](image_url)

*Figure 4: The five principles of lean adapted from (Dombrowski & Mielke, 2013; Dombrowski & Mielke, 2014).*
2.8.5. Improvement Culture

This principle looks at long term planning and highlights the ideal behaviour and attitude necessary to work continuously towards achieving perfection. Perfection is almost impossible as it would mean there is no waste, defects and inventories in the production process (Dombrowski & Mielke, 2013).

2.8.6. Self-Development

Some essential attributes of a leader are mainly dependent on the leader’s personality and some require the willingness to learn and develop them. The transformation to leadership demands certain leadership skills. The PDCA is the tool used by a mentor to develop both leaders and workers in small improvements cycles (Liker & Convis, 2011).

2.8.7. Qualification

This is an elementary task in lean leadership. It equips employees with the necessary skills for taking part in continuous improvement. The continuous improvement of processes must complement the continuous development of subordinates. According to Liker and Convis (2011) qualification is not strictly confined to classroom training but rather should take place on shop-floor on a daily basis. Conveniently, coaching is the best approach to challenge the employees to come up with solutions for the actual problem. The well-established method in industry is Toyota Kata. This method provides an appropriate structure for coaching and improving; therefore, establishing daily routines which result into a sustainable continuous improvement of processes (Rother, 2010) cited in (Dombrowski & Mielke, 2013). Liker (2006) highlights a perspective worth considering that the role of a lean coach is not an easy one as people see lean as another additional task and suggest that this role should be cared in the hands of the line management rather than the staff members.

Furthermore, Piatkowski (2004) gives a view on how Toyota conducts training. He discovered that there is close to little written about TPS in the form of books or operating manuals; however, brochures and handouts are the only form of script available. This is because Toyota advocates the importance of a spoken word to transfer knowledge from one generation to the next. Toyota works on the development of in-house trainers from the experienced employees such as the team leaders, managers, engineers and senior executives. This form of training approach is in the form of classroom training; however, ends on the shop-floor to observe the actual processes. Equally important, Toyota has in house consultants which help the senior managers improve the major departments but, each leader has the responsibility to train the employees nearly every day. In addition to this, Piatkowski (2004) outlines that all the newly appointed leaders and managers are expected to spend a day working on the line. If there is a new employee or promoted manager, the expectation is to have an experienced mentor side.
by side to teach the individual on TPS. This approach has proved to be authentic as everyone
gets the same message and teaching with regards to TPS philosophy. Again, he explains that
all new employees including office employees have to go through an orientation training for
five days. The training comprises of classroom training and practical exercises on basic TPS
principles. This is in turn followed by on the job training for about six to eight weeks, this is not
strictly on the job content alone but, it also covers how the employees should work according
to TPS rules. Ultimately, when the employees have completed the training, they have the
elementary knowledge on the basic TPS principles such as single piece flow, pull, Kanban,
takt time, types of waste, kaizen and; identifying and solving problems. Arbós and Nadal
(2006) indicate that line workers gain their knowledge from training conducted previously,
induction training and experiential that is, learning by doing.

2.8.8. Gemba

Genchi gembutsu namely Gemba is one of the main tools in lean. This tool is by means of
encouraging managers to go and see the clear state of what is happening in purpose of getting
explains that there are notable methods of partaking in Gemba, those who actually take part
in Gemba walks should be mindful at all times by seeking the essential information such as
asking why, observing and offereing the necessary support. The idea behind the Gemba
should be to observe how is work performed, pose open-ended questions, be open minded
and coach the workers on the simpler methods of performing the work. Smith (2016) further
explains Gemba as a Japanese term which means “at the real workplace”. Gemba is by means
of making time to understand a situation outside one’s area of responsibility with the purpose
of applying knowledge that will solve the problem. Ndou (2009) outlines another view on the
Gemba concept. He explains that prior to the implementation of lean manufacturing,
organisations must use Gemba to steer the implementation process. This approach works
best as it involves going to the actual place to source credible information than using the
traditional methods which involve holding meetings in the offices and discuss opinions (Ndou,
2009).

The application of the Gemba principle takes into consideration the Ohno circle in the form of
an imaginary or real circle. The leader steps into the circle with the aim of observing the
process with failures (Dombrowski & Mielke, 2013). The observation of the process could
possibly take some hours until the process with problems is understood; therefore, the
decision on possible improvements will be influenced by apparent facts. The logic behind the
Ohno circle suggests that leaders should go on the shop-floor and get their hands dirty to
improve the process. This concept also suggests that the leaders should have their offices
located close to shop-floor in appreciation of the shop-floor operations in the organisation.
Dombrowski and Mielke (2014) explain that Gemba is the time which leaders can use to practically develop their employees through their daily work routine on the shop-floor instead of using artificial examples for training. This could possibly lead to interruptions of production flow; therefore, simulated areas for learning close to the actual process should be used to develop the employees. When the senior managers spend time at Gemba, it is not only for their personal gain and learning but this approach serves as an opportunity to coach the employees to develop their problem solving skills. A common mistake that executive management do is solving the problem for the employees instead of coaching them on problem solving without having preconceived ideas on the actual root cause and possible solution (Dombrowski & Mielke, 2014).

2.8.9. Hoshin Kanri

Hoshin Kanri is the fifth principle in lean leadership. This principle is applied in the form of a template which gives a holistic overview of the strategies, goals and initiatives in the organisation. In the template the interrelations of the elements are illustrated and each improvement project is formed on the premises of the organisation's strategic goals (Boutros & Purdie, 2014). Hoshin is a phrase used to express yearly plan and targets throughout the organisation. This plan is used in conjunction with the daily continuous improvement activities as it is used by leaders to check progress in relation to targets. This is done in pursuit of establishing the True North (Liker & Convis, 2011).

In addition to the five lean principles, Dombrowski and Mielke (2014) developed a diamond model which forms an integral part of the lean leadership. The diamond model is a four stage learning cycle applied towards reaching the North star values.
Step 1: This is the stage whereby the leader is expected to see the need towards self-development and align the development towards the True North values. At the first step, leaders have to acknowledge the need for self-development and True North values.

Step 2: This stage involves the leader’s effort towards practically developing the subordinates.

Step 3: The third stage takes the continuous improvement of processes approach to instil learning; and development of the leader and the employees.

Step 4: This stage takes into consideration the development of aspirations and setting of targets form the continuous improvement engagements.

2.9. Problem solving meeting

Christiana and others (2015) delineate that allowing individuals to tackle real problems with no currently existing solutions could be an effective way of building the required competency. Finding ways to address the problem and reaching a sustainable solution to the problem...
contributes towards the development of the necessary competencies. Nowadays, experience is the normal approach of finding a solution to a problem as well as relying on executives who assume the role of experts instead of working on structured problem solving. According to Arbos and Nadal (2006), the considerable amount of knowledge essential for solving problems is found amongst the line workers not the engineers; therefore, in this way the line workers become knowledge workers; however, training and learning are necessary to enhance the skill. Furthermore, Wojtaszak (2015) highlights that the involvement of the workers working with the process is a basic principle in problem solving methodology. The problem solving process denotes a procedure from when the problem is first noticed, resolved and until the measure is put in place to prevent it from occurring again as well as the details on when to escalate. Christiana et al. (2015) highlight that in the problem solving process, problem complexity is an important factor to be looked into. The complexity is categorised into simple problems which can be solved by the operator, semi-complex problems which can be solved by team leader including the team as well as support functions and complex problems which need the attention of the managers. In the same view, Wojtaszak (2015) maintains that in attempt of resolving the problem, the resolution process requires a team approach and should start at the bottom of the hierarchy, the operator level to the level of engineers; however, simple problems can be entrusted in the hands of the operator. The higher is the complexity of the problem the higher escalated in the hierarchy; therefore, it is important to classify the problems according to categories of complexity for problem solving and escalation purposes. Normally when a team leader is unable to solve a problem due to complexity, the team leader uses an opportunity in the shop floor meeting to present the problem to other departments involved. During this time the problem is escalated to the relevant people who in turn will be responsible for solving the problem; thus, following the PDCA cycle until the problem is closed. Liker (2004) makes reference to Taiichi Ohno’s work who found that the reality of problem solving lies in the ability of finding the root cause to the problem than identifying the source. He suggests that Toyota incorporates the five why methodology as part of the seven practical problem solving steps. Prior to the application of the five why problem analysis, structured problem solving requires thorough understanding of the problem and situation. The five why analysis compels individuals to search deep about the root cause of the problem without having to settle for temporary solutions to the problem (Wojtaszak, 2015). Liker (2004) explains that those responsible for knowledge transfer of this knowledge found that thorough understanding of the situation is the most difficult part of problem solving before the actual application of the five why approach. The thorough understanding requires going to the actual place where the problem is occurring; that is, going Gemba with the possibility of using a pareto analysis for prioritising the number of transpiring problems according to severity,
frequency and source of occurrence. This nature of classification helps with understanding which problems need the most attention in terms of problem solving. It is suggested that the entire problem solving process comprises of 20% tools and 80% mind-set application; however, in the traditional companies this notion is vice versa. The figure below represents the problem solving process applied in Toyota. The problem solving process is presented in the form of an A3 report which follows the PDCA cycle to track progress. The A3 form usually contains the necessary information and visuals about the problem. The application of the form begins during the observation of the current situation in pursuit of understanding the real problem. This form is then presented to top management for final decision making strictly within the proposed agenda time. The advantage of using an A3 report is in data presentation format and structured approach to solving problems; thus, resulting to efficient meetings (Likер, 2004). Wojtaszak (2015) indicates that although there is a standard format of the A3 report, it is however, flexible enough to allow organisation which have adopted the use of the A3 report tweak it to suit the intended use.

![A3 Report Problem Solving format adapted from (Astor, et al., 2016).](image)

2.10. Requirements for sustaining lean implementation

According to Mann (2010) cited in Williams (2012) “The purpose of lean management is to sustain a lean production system.” The leader has the mandate to find ways of sustaining lean concepts in the workplace through undivided support, motivation and engagement in the lean activities. It is the responsibility of a leader to motivate the staff to carry out the daily work to the required standard and sustain the activities through following the daily routine. Lean management is a systemic approach which demands certain elements and management effort
in order to be implemented successfully. Below are the practices necessary for achieving a sustainable implementation of lean:

- Leaders need to perform daily leader standard work which provides structure on maintaining lean management routine and production implementations (Williams, 2012).
- Visual controls provide the essential information on the issues in the workplace such as root cause analysis to problems. The information on visual control should be updated on a daily basis (Williams, 2012).
- Walks on shop-floor should be conducted every now and then with the aim of checking the work in progress and understanding the current production status (Williams, 2012).
- The organisation’s lean management approach should be reviewed and examined every now and then. This should be done to assess the status of the target condition and identify areas which need more focus in order to improve (Williams, 2012).

Furthermore, Schlichting (2008) cited in Roth (2012) explains that leaders should strive to maintain operational stability through standardised work of the daily tasks. This approach sends a clear communication to the team that there is a certain way of performing tasks and there will be no favourable outcome if everyone chooses his or her own way of working. Standardised work has a significant influence on the lean journey in an organisation; therefore, should mark the starting point for all other elements. The standardised work forms a basis for daily routine on shop-floor. Schlichting (2008) mentions during lean implementation the focus is usually on the work cells; however, suggests that it is essential to establish a daily routine into the day of the supervisors. This way the expectations of the supervisor are clearly indicated and this introduces stability within the operations and the team can easily follow the standardised work.

Below are the examples of standard work of supervisors’ daily routines:

- Take part in weekly Gemba walks with the team leader.
- Manage the shift handover process on a daily basis.
- Ensure to attend the morning meetings on a daily basis.
- Perform quality sign off as often as possible in a day.
- Perform shop-floor visits as often as possible in a day.

Equally important, Sidinile (2014) highlights another view worth mentioning with regards to sustainability. He mentions that the only way to maintain lean initiatives is through continuous application of the improvements in the form:

- Conducting daily or weekly meetings.
- Standardising and describing all the processes.
Defining a process of collecting feedback from the support functions.

Conducting reviews to identify any issues or challenges.

Communicating and couch subordinates on lean concepts on a daily basis through the application of lean tools to achieve sustainable improvements.

2.11. Lean Barriers and Failures

The most ordinary mistake that organisation make when implementing lean is having the idea that the main purpose of lean is waste reduction and headcount. The reduction inventory without addressing the core factors could result in more problems and the organisation would relapse back to the old state. The reduction of labour could have a bad influence on how the workers perceive lean and lead to a bad connation associated with lean implementation (Mwacharo, 2013). Below some of the aspects which hinder the successful implementation of lean in an organisation are highlighted:

- Lack of management commitment

The lack of commitment from top management comes as a result of:

- Insufficient knowledge and lack of understanding of lean.
- Not having a clear understanding on the lean approach and the advantages.
- A general fear and uncertainty on the change process.

The implementation of lean should be fully supported by top management. Top management should devote the necessary time and resources towards coming up with a plan on how to manage with the changes imposed by the implementation of lean (Kumar, 2014).

- Resources

Lean implementation requires resources in the form of manpower and financial resources. In order to bear the fruits of implementing lean in an organisation it is necessary to invest financially, conducting training sessions, devote time and designate human resources (Leite, et al., 2016).

- Behaviour and engagement

It is essential to have everyone’s involvement in the implementation process as it helps to study the behaviour of the people and the positives from the behaviour patterns which could be useful in lean implementation. This factor is highly influenced by the culture which in turn influences the behaviour of the people. The fall back of the organisation to the old ways is attributed to lean barriers (Leite, et al., 2016).
Knowing on lean manufacturing

Whatever role the lean implementer assumes in an organisation, the fundamental knowledge of lean is worth considering since it could manifest into an obstacle towards lean implementation if the individual is not knowledgeable enough. In organisations, usually the knowledge transfer of lean to the employees is associated with a significant sum of financial investment. This view is owed to the indication that organisations which invest a lot of money towards lean implementation process are likely to achieve a favourable outcome since this process might require the expertise of a lean expert (Ebrahim, 2011).

2.12. Sampling approach

Non-probability sampling is a procedure which does not afford entities of a population an equal chance to be included in a sample. This type of sampling design allows the researcher to deliberately choose the entities for the study (Kothari, 2004). The selected entities are treated as representatives of the larger population. Owing to the reason that non-probability sampling is not based on random choice of entities, the results may not be absolutely authentic to generalise for the rest of the population (Antonius, 2013). The research notes that in non-probability sampling, the researcher is capable of selecting a sample which will give the desired outcome therefore; obtaining biased results. It is for this reason non-probability sampling is usually not used in large investigations (Kothari, 2004). In a case whereby the researcher is concerned about gathering elementary information within a short period of time and without incurring much costs, non-probability sampling is normally used (Sekaran & Bougie, 2016; Antonius, 2013).
Chapter 3: Research Methodology

3. Introduction
The purpose of this chapter is to explain the research method used to conduct data collection. The literature study of this research forms a theoretical framework that substantiates the presented research argument. The presented theory provides the research concepts of focus for conducting the research. This chapter begins with the background of the company under consideration followed by the presentation of the case, the explanation of the research methods used for the study and the reasons for their selection.

3.1. Research design
The research design in this study follows a qualitative approach. (Hughes, 2006). This approach is integrated into this research study with the purpose of investigating a certain event of interest in detail (Hughes, 2006). The research team hosts contact sessions with the participants with the aim of gathering data from the source of occurrence and have a thorough understanding of the study under consideration. This research design provides methods which permit the research team to focus on the behaviour and experiences of the participants with regards to sustainability of lean on shop-floor. In purpose of conducting an in depth study, the research employs data collecting methods such as participant observation.

Prior to conducting the study, the plan is to conduct face to face contact sessions with the participants from the different departments namely, logistics, body shop, paint shop and assembly. The research team will join planned sessions of activities to experience how lean principles are practised in the organisation taking into account what is suggested in literature. This is means of collecting data that substantiates the research. The contact sessions are at random intervals, in an unstructured manner; however, a thorough background of the research and purpose of the research are thoroughly explained in order to put at ease the participants and gain their trust; therefore, attaining the participants’ full engagement.

3.2. Case study
A case study is the exploration of a single case that can be easily distinguished from other multiple perspectives. The case is usually a subject of study in the form of a specific event or an individual (Kruth, 2014). The nature of this study method is interpretive; therefore, suggested to be the first preference over other qualitative methods (Kothari, 2004). Through the employment of a case study, the researcher is able to explore and attain more than a quantitative statistical analysis and appreciate the emerging behavioural patterns revealed through the participants’ involvement. Taking into consideration both quantitative and qualitative approach in the case study usually helps to substantiate the outcome through...
thorough observation and analysis of the research study. It is for this reason Zainal (2007) argues that the limitations the quantitative method revealed in the form of in depth analysis of social and behavioural challenges resulted in the introduction of a case study as a research method which then brought an advantaged in research.

3.3. Research study
The case study for this research is based on an Automobile company in South Africa situated in the geographical area of Rosslyn, north of Pretoria. This company was established about 40 years ago and has made a considerable impact since inception to date. This automobile company is an intrinsic part of a larger organisation and contributes roughly 25% of the total production for both local and international market. In pursuit of running production successfully, the company is comprised of four major departments being, logistics, body shop, paint shop and assembly.

- **Logistics**
  
The main function of this department is to provide the necessary parts and materials required in each production process.

- **Body shop**
  
  This is where the production of each unit begins in skeleton form. The car panels are welded together to bring them into the desired frame.

- **Paint shop**
  
  In this department the frame is painted as per customer requirements.

- **Assembly**
  
  This department comprises of the main assembly line whereby the sub-assemblies are performed on the unit and moves from one process to the next process until completion.

The company’s pride lies with the good quality products for the customers; therefore, from a lean perspective has established a concept termed “clean production” which is not only concerned with inputs and outputs from the production but also focuses on the processes. This clean production has been adopted as a Value added Production System (VPS) which focuses on processes and aims at eliminating all sorts of wastes. VPS is the steering function that facilitates optimisations in the company in terms of providing tools and methods in production and non-production areas for a better lean understanding and attaining a positive lean mind-set.
To enjoy the benefits of lean upon the implementation, the company based the introduction of the lean philosophy with the focus on certain tools and techniques which assist in achieving process stability, transparency and standardised approach on how to deal with day to day activities. These tools include:

- **The 1-5-20**: This is a tool used to note and escalate problems on the shop-floor. This tool is used by both by the process leader and process supporter.
- **Continuous improvement of processes sheet**: This is a sheet the process supporter promptly uses to document ideas for improving the work area thus, improving the efficiency of the team.
- **Process boards**: The process boards are used by both the process supporter and process leader to visualise information with regards of the area in the form of daily problems and challenges, improvements from the team, updating the daily targets etc.
- **Gemba meetings**: These are meetings held by managers and leaders on the shop-floor with the aim of solving problems. On the other hand these meetings are organised by the process leader in each department, on a daily basis in purpose of pulling the support of other support functions to solve problems beyond the process leader’s capability.

The shop-floor structure in entirety, in all the departments is formed by different levels; being, the line manager, production engineer, lean integrators also known as VPS integrators, process leader, process supporter and the operator. The process leader is responsible for people leadership in his or her area of responsibility and ensures that issues outside the process supporter’s scope are taken care of. The process supporter is the lead associate, flexible enough to deal technical issues in his or her area of responsibility and ensures everyone in the team is able to run with production throughout the day. These are the production associates who have been capacitated with the understanding and application of each tool in order to run with day to day activities; however, there are significant challenges with keeping up with the daily functions which; therefore, leads to an unsustainable application and impact of these tools.
The aim of this research study is to answer the following research questions presented in chapter 1:

- What are the main aspects which contribute towards the sustainability of lean manufacturing principles in a manufacturing environment?
- How should manufacturing organisations incorporate lean in the daily business to achieve sustainable results?

3.3.1. Observation

According to Schensul (2014), the direct observation of participants is suggested to be a recommended elementary qualitative research method. Farquhar (2013) suggests that the observation of participants has the potential of influencing the answer to the research questions at hand in an unbiased manner compared to information gathered from interviews as an incorrect recall of events is likely to occur (Farquhar, 2013). In this study the observations of participants are conducted with the aim of gathering enough data that supports the study under consideration. The ultimate result is to gather field notes collected over a period of eight weeks, on a weekly basis within the different departments.

What the literature advocates in terms of best work practice with regards to selected lean principle for the purpose of this study is then used to evaluate the level of practice of these elements in the selected organisation of interest for all the departments. The same observation items are used for the different areas in order to attain unbiased data. Through field observation the observer is then able to understand the daily application of each principle.
within each process leader area and identify the gap evidenced through the literature presented in the paper. Resulting from the researcher’s close engagement and involvement in each department’s day to day activities, the learnings gathered from the observations are then integrated into the study in order to interpret the current state of practice of the principles by the shop-floor; therefore, revealing findings about the research.

### 3.3.2. Observation design

The observable elements or themes with specific observable items to satisfy the research questions are classified into five categories. Under each theme there items that the observer focuses on during the study with the guidance of the existing literature. The themes subject to observation comprises of the following categories:

- **Category A: Shop-floor meetings**

This section of the research looks into how meetings should occur in a lean organisation. The literature explains that conducting meetings in the form of Gemba is a paramount step towards the implementation and sustainability of lean. The significance of holding shop-floor meetings is to gather information on the reality of what is actually happening on shop-floor. Understanding the current situation on shop-floor requires a full participation of leaders in studying the processes and the transpiring problems. The significant problems in the processes serve as an opportunity to show case best practices by developing the employees through their day to day work. Table A below probes into the important aspects of meetings on shop-floor. A detailed version of the table on shop-floor meetings is found in appendix A.

**Table 1: Category A: Shop-floor meetings**

<table>
<thead>
<tr>
<th>Extracted literature for the observed item</th>
<th>Reference</th>
<th>Observed item</th>
<th>Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding current state through Gemba.</td>
<td>(Thorhallsdottir, 2016)</td>
<td>Managers take part in Gemba meetings.</td>
<td>A1</td>
</tr>
<tr>
<td>Gather information from the actual source.</td>
<td>(Ndou, 2009)</td>
<td>The Gemba meetings take place where the problem occurred.</td>
<td>A3</td>
</tr>
</tbody>
</table>
### Category B: Lean training for qualification

This section of the research studies the necessary lean qualification process in the organisation as recommended in literature. The literature focuses attention on different domains in which training can take place in the process of qualifying employees. Although training can be held in a sit in set up, it is suggested that training focusing on practical existing processes through coaching is far more sufficient. The table below explores content on how organisations such as Toyota conduct lean training to qualify the employees as well as the structure of the training academy in terms of the training content, trainers, consultants and coaches to advocate knowledge transfer. A detailed version of the table on lean training is found in appendix A.

<table>
<thead>
<tr>
<th>Leaders conduct process observation (Dombrowski &amp; Mielke, 2013).</th>
<th>Managers dedicate special hours to observe the process with problems</th>
<th>A4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involvement through hands on experience to improve process. During Gemba time managers take an opportunity to be hands on to improve the process.</td>
<td></td>
<td>A5</td>
</tr>
<tr>
<td>The offices of the managers are located close to shop-floor</td>
<td></td>
<td>A6</td>
</tr>
<tr>
<td>People development through coaching. (Dombrowski &amp; Mielke, 2013)</td>
<td>Leaders use Gemba time to develop their employees through their daily work.</td>
<td>A7</td>
</tr>
<tr>
<td>Simulated areas close to process.</td>
<td>Simulated areas are available to train workers on the job.</td>
<td>A8</td>
</tr>
<tr>
<td>Present complex problems to other departments. (Christiana, et al., 2015).</td>
<td>Team leaders use the meetings to present and escalate problems he or she could not solve.</td>
<td>A9</td>
</tr>
<tr>
<td>Structured agenda used to present problems. (Liker, 2004)</td>
<td>Shop-floor meetings are used to have standard time to present to managers problems in an A3 format.</td>
<td>A9</td>
</tr>
</tbody>
</table>
Table 2: Category B: Lean training

<table>
<thead>
<tr>
<th>Extracted literature for the observed item</th>
<th>Reference</th>
<th>Observed item</th>
<th>Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification training not bound to classroom set up</td>
<td>(Liker &amp; Convis, 2011)</td>
<td>Training is conducted on shop-floor a daily basis.</td>
<td>B1</td>
</tr>
<tr>
<td>There is less written Toyota Production System.</td>
<td>(Piatkowski, 2004)</td>
<td>Learning is facilitated through brochures and spoken word.</td>
<td>B2</td>
</tr>
<tr>
<td>Trainers developed from experienced employees.</td>
<td>(Piatkowski, 2004)</td>
<td>People responsible for training are experienced managers, engineers and team leaders</td>
<td>B3</td>
</tr>
<tr>
<td>New leaders and managers Work on the line.</td>
<td>(Piatkowski, 2004)</td>
<td>Newly appointed leaders and managers spend a day working on the line. Promoted managers and new employees have side by side experienced mentors teaching them on TPS.</td>
<td>B4 B5</td>
</tr>
<tr>
<td>Orientation training for employees.</td>
<td>(Piatkowski, 2004)</td>
<td>New employees and office employees go through an induction training for at least five days.</td>
<td>B6</td>
</tr>
<tr>
<td>Classroom and practical training on Toyota Production System.</td>
<td>(Piatkowski, 2004; Arbós &amp; Nadal, 2006)</td>
<td>Induction training is in the form of classroom training and practical exercise. The second part of the training is on the job training for not less than six weeks. The training provides learning on principles such as single piece flow, pull, Kanban, takt time, types of waste, kaizen and; identifying and solving problems.</td>
<td>B7 B8 B9</td>
</tr>
</tbody>
</table>
➢ **Category C: Value stream**

This section of the research looks into the importance of having well described processes in order to achieve a smooth flow of production. The failure to map processes step by step can easily emit unnecessary waste. This could possibly have a significant impact on the entire value chain in the form of longer lead times. Mapping the processes goes beyond depicting the flow of material, it involves focusing on value added work by focusing on main components of value stream proposed in literature. An active value stream should have specific input data essential for initiating improvements of the entire value chain. Table C below studies the different observable items predominant in a value stream. A detailed version of the table on value streams is found in appendix A.

*Table 3: Category C: Value streams*

<table>
<thead>
<tr>
<th>Extracted literature for the observed item</th>
<th>Reference</th>
<th>Observed item</th>
<th>Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Studying each process step from beginning to end.</td>
<td>(Borris, 2012)</td>
<td>Each process step of the process has been identified from beginning to end</td>
<td>C1</td>
</tr>
<tr>
<td>Separate value adding steps from non-value adding.</td>
<td>(Cottyn, 2014)</td>
<td>Waste has been identified and eliminated from the process</td>
<td>C2</td>
</tr>
<tr>
<td>The five main steps of value stream.</td>
<td>(Cottyn, 2014)</td>
<td>The product family has been identified.</td>
<td>C3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The current state has been mapped.</td>
<td>C4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The future state has been mapped</td>
<td>C5</td>
</tr>
<tr>
<td>The value stream manager responsibility.</td>
<td>(Rother &amp; Shook, 1999)</td>
<td>A value stream manager has been assigned</td>
<td>C6</td>
</tr>
<tr>
<td>Plant leader influencing improvements.</td>
<td>(Rother &amp; Shook, 1999)</td>
<td>The value stream manager reports to the plant leader.</td>
<td>C7</td>
</tr>
<tr>
<td>Plant leader supports value stream team.</td>
<td>(Rother, 1999)</td>
<td>The plant leader supports the value stream towards the realisation of the future state.</td>
<td>C8</td>
</tr>
<tr>
<td>Current state map requires certain data.</td>
<td>(Cottyn, 2014)</td>
<td>Current state cycle time has been identified.</td>
<td>C9</td>
</tr>
</tbody>
</table>
Current state uptime has been identified. C10

The number of operators available have been identified. C11

Future plan transformation plan development. (Cottyn, 2014) The plan for improvements for the future state is developed. C12

Improvement opportunities made transparent. The improvement opportunities are made transparent in the form of kaizen burst on the future state map and follow the PDCA cycle. C13

➢ Category D: Structured problem solving

This section of the research investigates the method with which problems are dealt with in the organisation. Problem solving is suggested to be a sufficient approach for developing the competencies of employees in order to eliminate the dependency on the experience of experts and executives to solve problems. The literature highlights the importance of involving shop-floor employees, identifying levels in which problems are solved, using the correct tools and defining how problems outside ones scope should be handled to achieve effective problem solving. Table D below explores different observable items which suffice problem solving. A detailed version of the table on problem solving is found in appendix A.

Table 4: Category D: Problem Solving

<table>
<thead>
<tr>
<th>Extracted literature for the observed item</th>
<th>Reference</th>
<th>Observed item</th>
<th>Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience used to find solutions.</td>
<td>(Christiana, et al., 2015)</td>
<td>Structured problem solving is followed when solving problems</td>
<td>D1</td>
</tr>
<tr>
<td>Problem solving knowledge found in line workers.</td>
<td>(Arbós &amp; Nadal, 2006)</td>
<td>The knowledge of workers is utilised to solve problems</td>
<td>D2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Workers working with the process are involving in the problem solving process</td>
<td>D3</td>
</tr>
</tbody>
</table>
Problem solving requires a team. (Wojtaszak, 2015) Problem solving is a team approach. D4

Problem complexity escalation. (Christiana, et al., 2015) Problems are classified according to categories of complexity. D5

Problem escalated to relevant people and tracked using PDCA. (Christiana, et al., 2015) The team leader escalates unsolved problems to the relevant people. D6

The problem follows the PDCA cycle until it is closed D7

The five why analysis employed to search root cause. (Wojtaszak, 2015). The five why analysis is used to find the root cause D8

Prioritisation of problems according to severity. (Liker, 2004) The pareto analysis is used to prioritise the urgent problems. D9

Composition of problem solving process (Liker, 2004) The problem solving process is 20% tools and 80% mindset. D10

A3 report to present problems. (Liker, 2004) A form such as the A3 report is used to document problems and follows a PDCA cycle. D11

A3 flexible to be tweaked and adopted by organisations. (Wojtaszak, 2015) A form like an A3 report has been adopted to suite business need. D12

Category E: Shop-floor Coaching

This section of the research looks into how coaching is used to encourage active involvement of employees in continuous improvement. Coaching is by means of developing the employees by the leaders through asking the right questions which stimulate the imperative thought process during problem solving and improvement of processes. The literature highlights the role of a leader in coaching and the application of useful methodologies during the learning process. Table E below explores different observable items which are in important in shop-floor coaching. A detailed version of the table on coaching is found in appendix A.
Table 5: Category E: Shop-floor coaching

<table>
<thead>
<tr>
<th>Extracted literature for the observed item</th>
<th>Reference</th>
<th>Observed item</th>
<th>Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulate employees’ capabilities</td>
<td>(Trenkner, 2016)</td>
<td>Employees are encouraged to take control of improvements.</td>
<td>E1</td>
</tr>
<tr>
<td>Continuous improvement eight step method.</td>
<td>(Ehni &amp; Kersten, 2015)</td>
<td>Continuous improvement is an eight step process: Define the ideal state, analyse the current state, do a root cause analysis, define the target state, plan a suitable approach, conduct experiment, study results, standardise, adapt</td>
<td>E2</td>
</tr>
<tr>
<td>Caching approach used to challenge employees.</td>
<td>(Rother, 2010) cited in (Dombrowski &amp; Mielke, 2013)</td>
<td>Coaching is sued to challenge employees to solve their own problems.</td>
<td>E3</td>
</tr>
<tr>
<td>Toyota kata is used to establish daily routines leading to improvement ideas</td>
<td></td>
<td></td>
<td>E4</td>
</tr>
<tr>
<td>An improvement kata card used to facilitate the improvement and learning process.</td>
<td>(Soltero, 2012)</td>
<td>An improvement kata card is used to ask certain set of questions</td>
<td>E5</td>
</tr>
<tr>
<td>Training Toyota kata methodology with start and target state defined.</td>
<td>(Carvalho, et al., 2013)</td>
<td>Time has been dedicated towards training top management, middle management and workers on Toyota kata.</td>
<td>E6</td>
</tr>
<tr>
<td>The current condition and target condition has been defined for current problems.</td>
<td></td>
<td></td>
<td>E7</td>
</tr>
<tr>
<td>Daily meetings take place between the team and coach to check progress using the PDCA method.</td>
<td></td>
<td></td>
<td>E8</td>
</tr>
<tr>
<td>Visual boards available next to production to manage progress.</td>
<td>(Carvalho, et al., 2013).</td>
<td>Coaching boards are available next to production.</td>
<td>E9</td>
</tr>
</tbody>
</table>
3.3.3. Checklist

The checklist or recording sheets make use of printed forms that facilitate a structure for recording observation in the form of yes or no or rating scale to show the quality of any observable data. This data collection method is essential for documenting data on certain observable items, attributes or actions (Prowell & Steels, 1996). The collection and recording of data is influenced by the observable items for each principle discussed in the literature. These are the principles practiced by the organization to drive the participation of the associates in lean initiatives. The checklist for collecting the data in a structured manner is presented in appendix B. Each checklist focuses on a specific category, specifies the observable item and which department is being observed as per element.

3.4. Participants

The study under consideration is conducted in a single company which consist of various departments. These are a combination of logistics, assembly, paint shop and body shop. The sample for the study is 24 participants their participation was selected based on their current involvement on the activities happening on shop-floor on a daily basis (Sargeant, 2012). The inclusion criteria for the participants in each department comprises of one line manager, one production engineer, 2 process leaders, 2 process supporters and the participation of the support functions in each department. The inclusion criteria for the sample at shop-floor is mainly kept to the selected participants since they are the ones which run with a daily routine that employs lean tools and are the ones the researcher interacts with throughout the observation period. The selection of the criteria by the researcher follows a non-probability sampling approach (Kothari, 2004). In this type of sampling the researcher deliberately chose the participants according to their availability and planned time for the activities to take place in all the departments. This way the observer sought the in depth understanding of the study; therefore, addressing the gap presented in the argument.

Table 6: Observations sampling

<table>
<thead>
<tr>
<th>Participant</th>
<th>Logistics</th>
<th>Body shop</th>
<th>Paint shop</th>
<th>Assembly</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Manager</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Production Engineer</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Process Leader</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>
3.5. Validity
Validity of a study is usually dependent on the degree at which the study is able to measure what it is anticipated to identify and describe (Miller, 2012). The validity of the study in this research can be achieved through direct observation of the occurrence of each identified element more than once and recording accordingly the actual events taking place within the work environment. The approach of the observations is structured and observable items in the checklist are standardised; therefore, used to observe in all the departments in the same manner. The observation of the selected element according to literature takes place over a period of eight weeks in order to note any apparent trend with each observable data. Again, the researcher keeps the number of participants being observed the same in all the four departments to avoid prejudice results.

3.6. Conclusion
The aim of this chapter is to define the methodology used to answer the research questions presented in this study; therefore, supporting the research argument. The outline of the company and the research study gives an overview and understanding on the context of the research. The research design is means of denoting the steps to be considered prior to planning and conducting the entire research. The description of the data collection method provides an apparent picture of the approach employed to source information leading to the significant results for the study under consideration.
Chapter 4: Data Analysis and Results

4. Introduction
The purpose of this section is to present and interpret the results from the study. Chapter three of the research presented the significant aspects of lean paramount to a lean practising organisation. The data from the observations represents findings which reflect the importance of lean manufacturing principles in the organisation. In purpose of understanding the imperative aspects for sustaining lean principles, different categories which bring about insightful themes of learning on these principles are explored. The different themes explored in this research are shop-floor meetings, training, value streams, problem solving and hop-floor coaching. The data collection process happened over a period of eight weeks. The research team used this time to study the application of each principle in the different departments being, logistics, assembly, paint shop and body shop. The observation of each principle comprises of a certain number of observable items, for example shop-floor meetings comprises of 10 observable items. Training comprises of 10 observable items, value streams comprises of 11 observable items, problem solving comprises of 13 observable items and coaching comprises of 10 observable items. The fulfilment of each principle in the departments depends on the extent to which the principle is applied on shop-floor however, taking into consideration what is suggested in literature.

4.1. Shop-floor meetings analysis
The purpose of this section is to explore the manner with which shop-floor meetings are conducted. The literature presents the important aspects of shop-floor meetings which promote effective engagement on shop-floor.

Table 7: Shop-floor meetings

<table>
<thead>
<tr>
<th>Item No</th>
<th>Logistics</th>
<th>Assembly</th>
<th>Paint Shop</th>
<th>Body shop</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>A2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>A3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>A4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
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<tr>
<td>A5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>A6</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>A7</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
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<tr>
<td>A8</td>
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<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>A9</td>
<td>2</td>
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<td>3</td>
</tr>
<tr>
<td>A10</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1</strong></td>
<td><strong>7</strong></td>
<td><strong>4</strong></td>
<td><strong>5</strong></td>
<td><strong>17</strong></td>
</tr>
<tr>
<td><strong>Total %</strong></td>
<td><strong>10%</strong></td>
<td><strong>70%</strong></td>
<td><strong>40%</strong></td>
<td><strong>50%</strong></td>
<td><strong>43%</strong></td>
</tr>
</tbody>
</table>
Table 7 above presents the observation results of each observed item under the shop-floor meetings theme. The results from the observation indicate that only 43% of the observable items prove to be positive. Interestingly, these results reveal a significant positive contribution of 70% is attributed to the approach used in assembly to conduct meetings whereas logistics has the least positive contribution of 10%. A detailed analysis of each observed item is found in the section below.

Figure 8: Shop-floor meetings

Figure 8 represents the specific observable items in relation to shop-floor meetings. Table 7 represents the outcome of each observed item in each department. The outcome is either a yes or no, the yes being represented by a 1 and the no being represented by a 2. A detailed description of the items observed is found in APPENDIX B.

Observable item A1 reveals that the organisation takes part in Gemba meetings which; therefore, suggests that the departments acknowledge the importance and impact of Gemba meetings in the daily business; however, observable item A2 reveals that only assembly department uses the Gemba time to coach the workers. The idea behind the Gemba walk should be to observe how is the work performed, pose open-ended questions, be open minded and coach the workers on the simpler methods of performing the work (Thorhallsdottir, 2016).
The research team, when making an observation with regards to observable item A3, the research denotes that assembly, body shop and paint shop departments conduct the meetings exactly where the problem occurred. In as much as managers take part in Gemba meetings, the results as represented by observable item A4 indicates that managers, across the departments do not dedicate special hours towards observing any process with problems. This denotes that managers never take enough time to gather real facts on a problem but instead rely on their expertise to reach a diagnosis. According to Dombrowski and Mielke (2013) the application of the Gemba principle takes into consideration the Ohno circle in the form of an imaginary or real circle. The leader steps into the circle with the aim of observing the process with failures. The observation of the process could possibly take some hours until the process with problems is understood; therefore, the decision on possible improvements will be influenced by apparent facts. Adopting this approach during Gemba meetings can improve the quality and effectiveness of the meetings; therefore, achieving a better understanding of what is happening on shop-floor.

Managers do not take the opportunity to improve processes through hands on involvement. This is evident from observable item A5 results. This finding indicates that there is a gap between the management team and the reality of what is happening on the shop-floor. The literature advocates that the logic behind the Ohno circle suggests that leaders should go on the shop-floor and get their hands dirty to improve the process (Dombrowski & Mielke, 2013). Taking into consideration this approach could improve the standard of problem solving in the entire organisation as it will promote gathering facts and studying comprehensively the process prior to attempting to solve the problem.

Observable item A7 further indicates that none of the leaders use Gemba time to develop employees through their daily work; however, observable item A6 reveals that only assembly department has training islands available next to the actual process for on the job training. This denotes that the organisation perceives Gemba meetings as a platform to discuss the current problems not to focus on other aspects such training of employees by the leaders on the daily job and spending time on the shop floor observing the process with problems. This finding could be attributed to the less engagement of the managers in terms of practical experience on the job to improve the process with problems. Dombrowski and Mielke (2014) explain that Gemba is the time in which leaders can use to practically develop their employees through their daily work routine on the shop-floor instead of using artificial examples for training. This could possibly lead to interruptions of production flow; therefore, simulated areas for learning close to the actual process should be used to develop the employees. When the senior managers spend time at Gemba, it is not only for their personal gain and learning but this approach serves as an opportunity to coach the employees to develop their problem
solving skills. The research team, through observable item A8 learns that most of the managers in the departments, assembly, paint shop and body shop have located their offices closer to shop-floor. This indicates that most of the managers have an understanding and appreciation of shop-floor processes (Dombrowski & Mielke, 2014).

The research team, through observable item A9 discovers that in relation to the escalation process the organisation has integrated in place the use of a structured problem escalation tool. This tool is known as the 1:5:20 days escalation tool. This tool promotes the method with which problems should be escalated from one level in hierarchy to the next until the problem is closed. The process supporter is expected to solve a problem that arises within four days, if not on the fifth day the problem is escalated to the team leader. The team leader has a period of fourteen days to solve the problem, if it is not solved on the twentieth day the problem is escalated to the production engineer.

The research team discovers that in assembly, paint shop and body shop departments the team leader is entrusted with the task of escalating unsolved problems to the relevant people; however, this is not the case with logistics department. The research team learns that in the logistics department problems are hardly handled by the team leader. The responsibility to escalate problems which cannot be solved lies with the lead associate; that is, the process supporter. The production engineer has the responsibility to solve and give feedback on the problem to the process leader. In assembly, paint shop and body shop the problem escalation follows an ideal step by step process; for example, the process supporter is given an opportunity to attempt solving the problem then in a case whereby the problem is outside the process supporter’s scope, he or she is expected to escalate the problem to the process leader.

The research team further learns that a good practise by the three departments is that process leaders take it upon themselves to schedule a shop-floor meeting for discussing the problems they are currently facing outside the Gemba meetings. The process leader uses this meeting to invite all the relevant people from the support structures who will give factual input towards resolving the problem in a structured approach, using the structured problem solving form. If the problem cannot be solved in the process leader shop-floor meeting, the problem is escalated to the production engineer.

Significant evidence proved by observable item A10 shows that in assembly and body shop departments, shop-floor meetings are used to have standard time to present to managers problems following an A3 report format. In the organisation the form is referred to as structured problem solving sheet. The process leaders from the departments have secured standard time for presenting structured problem solving and the managers have blocked this time on their
calendars to ensure availability. During this time the team leader takes an opportunity to present to management the problems he or she is currently running with in the area as well as the status of the problems in a structured manner. This finding implies that the managers in the two departments steer the direction of improvements to come from shop-floor workers.

4.2. Training analysis

This section of the research explores the standard and quality of training conducted in the organisation in relation to what is suggested in literature.

Table 8: Training

<table>
<thead>
<tr>
<th>Item No</th>
<th>Logistics</th>
<th>Assembly</th>
<th>Paint shop</th>
<th>Body shop</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>B2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>B3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>B4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>B5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>B6</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>B7</td>
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<tr>
<td>B8</td>
<td>1</td>
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<td>1</td>
<td>4</td>
</tr>
<tr>
<td>B9</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>B10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4</strong></td>
<td><strong>5</strong></td>
<td><strong>3</strong></td>
<td><strong>3</strong></td>
<td><strong>15</strong></td>
</tr>
<tr>
<td><strong>Total %</strong></td>
<td><strong>40%</strong></td>
<td><strong>50%</strong></td>
<td><strong>30%</strong></td>
<td><strong>30%</strong></td>
<td><strong>38%</strong></td>
</tr>
</tbody>
</table>

Table 8 above presents the observation results of each observed item under the training theme. The results indicate that only 38% of the observable items prove to be positive. It is worth noting that the analysis of the results proves that the same knowledge gap between paint shop and body shop exists. The two departments record a 30% positive contribution towards the overall proposed effective training approach whereas assembly applies 50% of the approach. A detailed analysis of each observed item is found in the section below.
Figure 9 represents the specific observable items in relation to qualification training. Table 8 represents the outcome of each observed item in each department. The outcome is either a yes or no, the yes being represented by a 1 and the no being represented by a 2. A detailed description of the items observed is found in APPENDIX B.

Through observable item B1, it can be seen that none of the departments conduct training on the shop-floor. This finding demonstrates that most of the training is done in a classroom engagement and could be the reason why the organisation is struggling to sustain lean through consistent application of the principles in the daily business. The literature highlights that qualification is not strictly confined to classroom training but rather should take place on shop-floor on a daily basis. Conveniently coaching is the best approach to challenge the employees to come up with solutions for the actual problem (Liker & Convis, 2011).

Again, through observable item B2 the research demonstrates that in the entire organisation training is conducted through spoken word however, there are no brochures used to provide information to the employees. The research team learns that each time training is conducted, the trainees ask for brochures that they can take with for further referral but the brochures are never available. Piatkowski (2004) argues that there is close to little written about Toyota Production System in the form of books or operating manuals however, brochures and handouts are the only form of script available. This is because Toyota advocates the
importance of a spoken word to transfer knowledge from one generation to the next. If the organisation considers the development of training brochures for future referral.

Observable item B3 shows that only the assembly department has managers, engineers and team leaders who take the responsibility to train their employees. In this regard, the research reveals that at managerial level the assembly general manager is the only manager that uses every opportunity to train the employees on lean principles. This proves that the assembly department has seen the significance of upskilling and engaging the employees in production philosophies in purpose of sustaining the adopted lean principles. As evidenced by the research team the rest of the departments rely heavily on the capacity of the VPS integrators from the main VPS department. The literature reveals that Toyota works on the development of in-house trainers from the experienced employees such as the team leaders, managers, engineers and senior executives. This form of training approach is in the form of classroom training however, ends on the shop-floor to observe the actual processes (Piatkowski, 2004). To improve the level of knowledge of the employees in the entire organisation, the individual departments should work towards having their own trainers from the skilled managers and engineers in order to drive the embedment of the principles within the daily business.

Through the involvement of the research team with the participants, observable item B4 reveals that in the entire organisation none of the new leaders and managers spend a day working on the line upon appointment. This finding highlights that the organisation assumes that on the job learning is only applicable to the employees that directly work with the processes. Piatkowski (2004) outlines that all the newly appointed leaders and managers are expected to spend a day working on the line. This finding relates to observable item B1 which sought to find out the form of training conducted in the organisation. If the managers and leaders are not expected to go through on the job training upon appointment, this indicates that practical training in the organisation with regards to induction training on the principles is not seen as a priority; therefore, reveals an evident gap on how training is conducted in general. Arbós and Nadal (2006) indicate that line workers gain their knowledge from training conducted previously, induction training and experiential; that is, learning by doing.

Observable item B5 shows that in all the four departments newly promoted managers and new employees do not have side by side experienced mentors teaching them on VPS principles. This again reveals the relation to observable item B1 which indicates that the organisation lacks with regards to practical training plan after engaging and sharing knowledge with the employees on VPS principles in the classroom set up. The literature proposes that if there is a new employee or promoted manager, the expectation is to have an experienced mentor side by side to teach the individual on TPS. This approach has proved to be authentic
as everyone gets the same message and teaching with regards to the Toyota Production System philosophy (Piatkowski, 2004).

Through observable item B6 and B7 research indicates that only a half of the observed departments; being, assembly and logistics take their new line workers through VPS induction training; however, none of the new office employees go through induction training. This means that the major concern in the organisation is to achieve a lean organisation strictly focusing on the direct areas. This does not demonstrate the best approach for an organisation that aims at sustaining the lean production philosophy. Piatkowski (2004) explains that all new employees including office employees have to go through an orientation training for at least five days.

Through observable item B8 the research team learns that the organisation has recently, about four months ago considered to incorporate VPS induction training for all new line workers; however, the management team and office employees are not obliged to it. This finding shows that for as long as the training is not enforced at all the levels of the organisation in all the departments, the organisation has high chances of having employees with limited knowledge and interpretation of VPS; therefore, impacting realisation and sustainability of lean principles.

Significantly, as seen from the research observable item B9 on employees taking part in on the job training indicates that all the departments subject their employees to hands on experience; however, this is mainly done by line workers. This means that the only people with vast knowledge and experience on the processes and product are those executing the job on a daily basis which; therefore, limits the knowledge base of the indirect workforce on the product.

Observable item B10 shows that the induction training in place for all the departments comprises of basic knowledge on principles such as takt, one piece flow, pull, kaizen, Kanban and problem solving. This finding denotes that the organisation concedes the necessity of having basic knowledge on the highlighted principles. In addition to this, the research team learns that the organisation has developed a VPS centre facility whereby the training is conducted and these principles have been translated into practical games for better learning. This facility is means of encouraging both office and line employees to take part in learning provided by VPS integrators.
4.3. Value stream analysis

This section of the research explores the standard and quality value stream map in the departments in relation to what the literature supports.

Table 9: Value stream

<table>
<thead>
<tr>
<th>Item No</th>
<th>Logistics</th>
<th>Assembly</th>
<th>Paint shop</th>
<th>Body shop</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
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<tr>
<td>C2</td>
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<td>1</td>
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<td>1</td>
<td>4</td>
</tr>
<tr>
<td>C3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>C4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
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</tr>
<tr>
<td>C6</td>
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<td>2</td>
<td>0</td>
</tr>
<tr>
<td>C7</td>
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<td>2</td>
<td>2</td>
<td>0</td>
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</tr>
<tr>
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<td>3</td>
</tr>
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</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>Total %</td>
<td>38%</td>
<td>62%</td>
<td>54%</td>
<td>54%</td>
<td>52%</td>
</tr>
</tbody>
</table>

Table 9 above presents the observation results of each observed item under the value streams theme. The results indicate that only 52% of the observable items prove to be positive. Remarkably, the analysis of the results confirms that degree to which processes are made transparent in body shop and paint shop is the same. The processes in the departments prove to have 54% of the effective elements suggested in literature when mapping the current and future state of the processes, the processes in assembly proves to have 62% element and 38% in Logistics. A detailed analysis of each observed item is found in the section below.
Figure 10: Value streams

Figure 10 represents the specific observable items in relation to value streams. Table 9 represents the outcome of each observed item in each department. The outcome is either a yes or no, the yes being represented by a 1 and the no being represented by a 2. A detailed description of the items observed is found in APPENDIX B.

Observable item C1 and C2 confirm that with regards to value stream analysis in the departments all the process steps for each process have been identified and all the waste has been identified. This proves that the departments understand the importance of mapping each process step of a process under study with the aim of eliminating unnecessary waste. Again, this confirms that any waste in the process can only be identified if each the process has been mapped step by step. Value stream principle aims at studying each step of a production process from beginning to end in purpose of eliminating any form of waste. Ideally, the analysis
of each process step, waste identification and elimination should improve the efficiency of the entire value chain therefore, achieving short lead times between order placement and order delivery (Borris, 2012).

Observable item C3 points out that all the departments have identified the product family of focus. This shows that the effectiveness of a value stream lies on a map that focuses on a certain product family. Through observable item C4 the research team finds that the current state of each product family process has been mapped. This data explains that all the departments fully understand the current handling of the product family.

It is evident from observable item C5 that in terms of having a future state map in place assembly reports a positive finding than the rest of the departments. This demonstrates that most of the value stream maps take a significant amount of time to translate into the future state map, if mapping of the future state happens at all. Again, this could be an indication that the rest of the departments do not have a strategic plan with regards to what the design of the processes could look like in the future. The research team learns that currently the logistics department is having challenges with the supply concepts of the parts. There is an evident gap with the current supply chain processes which lead to stock fluctuations in the warehouses and assembly line side presentation. The literature delineates that value stream mapping requires five core steps executed by the special team, being, identifying the product family, mapping the current state, mapping the future state, defining a work plan and executing the work plan (Cottyn, 2014). Focusing on developing the future value stream maps in all the departments could help the organisation have a better stream of flow of parts from the external supplier until the internal customer, being assembly.

It is apparent from observable item C6 that the organisation does not have a value stream manager assigned to drive the entire value stream exercise. This shows that the departments independently decide how to run and manage the value stream. The research team finds that the value stream exercise is driven by the VPS integrator from the main VPS steering department and the VPS integrator from each department. The research team realises that an exception is assembly department whereby the value stream is driven by the general manager with the support of the department’s VPS integrator. Rother and Shoock (1999) further explains that it is usually not common to have a person in an organisation with the in depth knowledge of the value stream; that is, a person who understands the entire flow of material and information for the product. This usually allows each department to handle a part according to its needs not from a value stream perspective. Rother and Shoock (1999) suggest the need of having an individual, a value stream manager that will mainly run with the responsibility of understanding a specific product family for the value stream and realising the
identified improvements. In order for the rest of the departments to realise progress on the value stream the organisation needs to make a careful selection of the individual with in depth knowledge of the plant’s different product families and operations thus, running with the identified improvements.

Observable item C7 and C8 reveals that in as much as there is no value stream manager to drive the value stream, even the VPS integrator from the main VPS steering department is not granted the opportunity to report to the plant leader on the value stream progress. This means that if the plant leader is not involved in the value stream there are slim chances of accomplishing the future state of the processes. The literature highlights that in order for the individual to have a better chance of executing the identified improvements from the future state map across the departments he or she must directly report to the organisation’s leader.

In turn the leader should lead and support the value stream team towards mapping and implementation of the future state value stream (Rother, 1999). If the organisation wants achieve better chances of making the value stream project a success having a value stream manager that reports directly to the plant leader and having a leader that fully supports the value stream leader is an imperative approach. This will mitigate the risk of running with incomplete value streams with efforts of few individuals.

Through observable item C9 and C10, the research confirms that the current state cycle time and uptime have been identified by the rest of the departments except for logistics. Cottyn (2014) outlines that the analysis of the current state map requires certain data in the form of cycle time at each process, change over time, uptime and number of operators available during analysis. Observable item C11 exhibits that the value stream team in logistics comprises of workers three levels lower in hierarchy and the VPS integrator from the main department. The lack of data for the value stream could be as the result of an insufficient team that has not been trained on value stream. Erikshammar (2017) explains that the value stream exercise requires a careful selection of the team and that the usual mistake is selecting irrelevant candidates for the exercise. The research reveals that the only data up to date within the value stream is the number of operators available for each operation. This means that identifying the number of operators available for each operation is the less demanding data to gather and most understood. The value stream is a tool for realising projects or continuous improvement topics; however, if the organisation wants to realise the improvements, formation of a team with in depth knowledge of the tool and understanding of the processes is crucial.

Observable item C12 and 13 indicate that the current value stream maps from all the departments have improvements identified in the form of kaizen bursts; however, there is no developed formal action plan for all the improvements following a PDCA cycle which translate
into a future state value stream map. This indicates that the entire organisation has to change
the approach towards the development of the value stream. The failure to identify the right
individuals to form teams and the absence of the value stream manager with immense
knowledge on the product family results to an unstructured approach for the exercise; thus,
having stagnant value streams. Cottyn (2014) explains that after the analysis of the current
state, a future plan and lean transformation plan is developed. The lean transformation plan
is suggested to comprise of improvement opportunities. These improvement opportunities are
made transparent on the future state map, represented by kaizen bursts and driven by
Deming’s cycle. This cycle follows a four stage methodology being; Plan, Do, Check, Act
(PDCA)

### 4.4. Problem solving analysis

This section of the research explores the standard and quality of problem solving in the
departments in relation to what the literature supports.

Table 10: Problem solving

<table>
<thead>
<tr>
<th>Item No</th>
<th>Logistics</th>
<th>Assembly</th>
<th>Paint shop</th>
<th>Body shop</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>D2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>D3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>D4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>D5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>D6</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>D7</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>D8</td>
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<td>2</td>
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<tr>
<td>D9</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>D10</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>D11</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>Total %</td>
<td>18%</td>
<td>55%</td>
<td>55%</td>
<td>55%</td>
<td>45%</td>
</tr>
</tbody>
</table>

Table 10 above presents the observation results of each observed item under the problem
solving theme. The results indicate that only 45% of the observable items prove to be positive.
It is worth noting that the extent to which assembly, paint shop and body shop applied problem
solving best practices on shop-floor is similar. The results reveal that these departments
record a positive contribution of 50% towards the effective problem solving approach in the
organisation; however, logistics records an 18% positive contribution. A detailed analysis of
each observed item is found in the section below.
Figure 11: Problem solving

Figure 11 represents the specific observable items in relation to problem solving. Table 10 represents the outcome of each observed item in each department. The outcome is either a yes or no, the yes being represented by a 1 and the no being represented by a 2. A detailed description of the items observed is found in APPENDIX B.

Observable item D1 reveals that the majority of the departments follow structured problem solving approach to solve problems; however, this is not the case with logistics department. This denotes that the organisation understands the importance of solving problems in a structured manner. Through observable item D2 the research team learns that during problem solving the departments solely rely on the knowledge of team leaders, engineers and experts to solve problems. The literature reveals that nowadays, experience is the normal approach of finding a solution to a problem as well as relying on executives who assume the role of experts instead of working on structured problem solving (Christiana, et al., 2015). Observable item D3 further reveals that the workers working with the process are not given a chance to take part in problem solving. In this regard the research team discovers that the line associates are full time on operations even during problem solving shop-floor time. This denotes that the organisation does not fully trust the capabilities of the line workers to solve problems. According to Arbos and Nadal (2006), the considerable amount of knowledge essential for solving problems is found amongst the line workers not the engineers; therefore, in this way
the line workers become knowledge workers; however, training and learning are necessary to enhance the skill. To improve the standard of problem solving and the skill of the line workers the organisation should perhaps consider involving the workers in problem solving meetings. Toyota’s culture from the shop-floor workers perspective reveals the culture of best work practices which suggests that when a defect has occurred the entire production line should be shut down and only when the source of the defect has been found will the line be operated again. This principle is referred to as Jidoka, it is the responsibility and right of the worker to apply it when necessary (Wilson, 2010).

Observable item D4 illustrates that although the line workers are not involved in structured problem solving the research finds that a team approach when solving problems is employed. The research team learns that in all the departments solving problems individually is not encouraged at least a team must be formed to solve problems in structured manner. Wojtaszak (2015) maintains that in attempt of resolving the problem, the resolution process requires a team approach and should start at the bottom of the hierarchy, the operator level to the level of engineers; however, simple problems can be entrusted in the hands of the operator.

Observable item D5 evidences that the problems are not classified according to categories of complexity. This shows that there is not significant correlation between the complexity of problems and the identification of the relevant individuals with the capability to solve the problems. The team leaders, engineers and experts are tasked with the responsibility of solving any kind of problem that arises. Interestingly, observable item D6 and D7 illustrate that although problems are not classified according to categories of complexity, most of the problems that arise always start with the process supporter having to solve the problem prior to escalating to the process leader then the process leader escalates to production engineer if the problem cannot be solved. If the problem is not solved by the team leader, he or she escalates it to the relevant person in hierarchy and the problem is tracked using the PDCA cycle; however, logistics does not follow this structured approach. This finding confirms that logistics department does not follow a structured problem solving approach when dealing with problems. It is noted in literature that in the problem solving process, problem complexity is an important factor to be looked into. The complexity is categorised into simple problems which can be solved by the operator, semi-complex problems which can be solved by team leader including the team as well as support functions and complex problem which need the attention of the managers (Christiana, et al., 2015). To instil the problem solving process the organisation should start classifying problems into categories of complexities. This will promote the involvement of line workers for simple problems in order to enhance their problem solving capabilities. In relation to this, adapting this practice will assist logistics with better
structuring of the current problem solving approach which overlooks the proper escalation process by not involving the process leader. Kaizen remains the most influential approach in lean manufacturing (Glover, Farris, & Van Aken, 2015). In a case whereby escalation of problems doesn’t prove to be sufficient, the kaizen approach facilitates a platform in the form of kaizen events whereby all the relevant people regarding the problem are brought together (Glover, et al., 2015). The main goal of kaizen events is to determine problems, brainstorm possible solutions and deploy resources accordingly (Martin, 2014).

Observable item D8 proves that most of the departments except for logistics believe in the application of the five whys analysis to get to the root cause of the problem. A striking finding through observable item D9 unveils that a tool such as the pareto analysis is not used to prioritise problems. This implies that even though the five why analysis is used to give attention to the root cause of the problem, problems are not tackled according to severity. Liker (2004) advocates that thorough understanding requires going to the actual place where the problem is occurring; that is, going Gemba with the possibility of using a pareto analysis for prioritising the number of transpiring problems according to severity, frequency and source of occurrence. For better justification on which problems should be solved first, the organisation should consider prioritisation of problems according to severity.

Observable item D10 brings to light that in all the departments the problem solving process does not apply 20% of tools and 80% mindset. A possible explanation for this result can be attributed to lack of adequate practical training on shop-floor post the induction training in order to gain an understanding of the logical approach of solving problems. The research team realises that the departments have mastered the theoretical use of tools when solving problems without thoroughly understanding the scope and complexity of the problem.

From the observable item D11 stems that a form such as the A3 has been adapted for all the departments. The form can be seen in figure 12 below. This form is used to facilitate a structured approach to solve problems; however, it is evident that logistics does not practise the application of this form. An implication of this is the possibility that logistics needs more training on the use of problem solving tools. Again, this could imply that the adapted A3 tool does not support the logistics environment.
4.5. Shop-floor coaching analysis

This section of the research explores the standard and quality of coaching on shop-floor in the departments in relation to what the literature supports.

Table 11: Shop-floor coaching

<table>
<thead>
<tr>
<th>Item No</th>
<th>Logistics</th>
<th>Assembly</th>
<th>Paint shop</th>
<th>Body shop</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>E2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>E4</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>E5</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>E6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>E7</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>E8</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>E9</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3</strong></td>
<td><strong>7</strong></td>
<td><strong>7</strong></td>
<td><strong>2</strong></td>
<td><strong>19</strong></td>
</tr>
<tr>
<td><strong>Total %</strong></td>
<td><strong>33%</strong></td>
<td><strong>78%</strong></td>
<td><strong>78%</strong></td>
<td><strong>22%</strong></td>
<td><strong>53%</strong></td>
</tr>
</tbody>
</table>
Table 11 above presents the observation results of each observed item under shop-floor coaching theme. The results indicate that only 53% of the observable items prove to be positive. Paint shop and assembly reveal a coleration in the manner with which coaching is practised on shop-floor. 78% of the time the departments practice the proposed coaching methodology during engagements, body shop practises 22% of the proposed approach and logistics 33%. A detailed analysis of each observed item is found in the section below.

**Figure 13: Shop-floor coaching**

Figure 13 represents the specific observable items in relation to shop-floor coaching. Table 12 represents the outcome of each observed item in each department. The outcome is either a yes or no, the yes being represented by a 1 and the no being represented by a 2. A detailed description of the items observed is found in APPENDIX B.

Observable item E1 indicates that the entire organisation does encourage the employees to take control of the improvements. The aim of coaching is to stimulate the employees’ capabilities by encouraging them to take control of any situation thus achieving desirable results (Trenkner, 2016). It is the mandate of the leaders to transfer the cultural beliefs and values of an organisation, they should encourage and stimulate the culture of learning and sharing knowledge (Mann, 2005) referenced in (Poksinska, et al., 2013). The research team finds that in each and every department there are transparency boards with CIP sheets used to encourage the employees to record any improvement ideas that will benefit the team. An example of the CIP sheet for capturing ideas from the team is seen in figure 14 below.
Figure 14: CIP sheet

Observable item E2 reveals that although the employees are encouraged to take control of improvements; however, continuous improvement does not follow an eight step process. This could mean that even though the employees are encouraged to come up with their own improvements this does not follow an in depth structured approach other than the CIP document and the CIP ideas are implemented haphazardly. Ehni and Kersten (2015) make claims that the third and the fourth level of the 4P model focus on people’s skills such as cooperation between operator and leaders. This cooperation forms a foundation for continuous improvement at shop-floor level and has been overlooked in western lean manufacturing approaches. In purpose of feeling this gap, Ehni and Kersten (2015) make reference to a study done made by Liker and Franz (2009); Rother (2009) which aimed at understanding the structure of improvement processes at Toyota and how these processes could be integrated into the daily routine on shop-floor. The improvements are recorded taking into account the ideal target state and the progress is monitored using the PDCA methodology.

Observable item E3 proves that two out of the four departments; being, assembly and paint shop use coaching approach to challenge employees to solve their own problems. This denotes that logistics and body shop employees are not entirely behind their own problem solving. The literature points out that coaching is the best approach to challenge the employees to come up with solutions for the actual problem. The well-established method in industry is Toyota Kata. This method provides an appropriate structure for coaching and improving the; therefore, establishing daily routines which result into a sustainable continuous improvement of processes (Rother, 2010) cited in (Dombrowski & Mielke, 2013).
It is noted from observable item E4 that assembly and paint shop department apply Toyota kata to coach the employees and establish daily routines which lead to improvements. Observable item E5 reports that the two departments ask a set of structured questions to establish step by step small improvements which contribute towards the bigger improvement or topic being tackled. A coaching card which provides a set of guideline questions during coaching is used. This card can be seen in figure 15 below. The literature brings to light that an improvement kata card can be used to facilitate the improvement and learning process. The first set of three questions on the card focuses on understanding the target condition and these questions are known as framing questions. The second set of two questions; the next experiment focuses on rapid experiments in pursuit of solving the topic under consideration. The last question focuses on reflecting on the outcome attained in relation to the explored measures from the experiment (Soltero, 2012).

![Coaching-kata card](image)

**Figure 15: Coaching kata card**

Observable item E6 reveals that time has been dedicated towards training top management, middle management and workers on Toyota kata. Through observations and interaction with the participants, the research team learns that the general managers, line managers, engineers and the majority of team leaders in all the departments were taken through Toyota kata training.

Observable item E7 demonstrates that with regards to coaching assembly and paint shop department do define the current and target condition for a problem understudy; however, the research team observes that logistics and body department do not practise this element of
coaching. A possible explanation for this finding could be that the two departments have not integrated coaching into the daily activities. On the other hand this does not hold true for assembly and paint shop department. A significant result worth noting between the two departments is that assembly department describes the current condition and target condition; and make it transparent for the entire team to see. Interestingly, the research team evidences that in paint shop coaching starts and ends on a verbal agreement note only. The current and target condition is not made transparent for the entire team to see. In a case study conducted by Carvalho and others (2013) in a certain organisation it was evidenced that the organisation integrated Toyota kata through training the employees in the methodology, defining starting condition, workers and coach defining the target condition for lead times and conducting daily meetings between the team and coach to check progress following the PDCA cycle.

Through observable item E9 the research reveals an interesting finding that assembly and paint shop departments have special designated areas where the coaching sessions take place. The assembly department makes use of white boards for making the current and target condition transparent and for tracking progress of each coaching topic. This finding could be an indication that the organisation has to work towards establishing coaching as a culture across all the departments. This significant discrepancy could be attributed to the fact that it has only been two years since the managers and leaders of the organisation have been taken through kata coaching training and no practical follow up was conducted to integrate this principle. The training on improvement kata and coaching kata took four hours and involved both top; and middle management and some of the workers. The literature outlines that the aim of visually managing progress a board should be made available next to production (Carvalho, et al., 2013). All the departments need to have areas specially for visualising progress on improvement topics.

Observable item E8 reports that in paint shop department the VPS integrator has the responsibility to coach both the process supporter and process leader on the daily main functions of responsibility. The assembly department has a coach that oversees the coaching sessions on small improvement topics which contribute towards a bigger problem for the process supporter and process leader. In assembly the process leader has the responsibility to coach the process supporter and the production engineer has the responsibility to coach the process leader. The coaching takes place in smaller time cycles until the problem is closed following the PDCA logic. If the rest of the departments track the improvement topics using the PDCA methodology, this will help the departments establish a structured way of managing the improvements through the different phases.
4.6. Conclusion

The purpose of this chapter is to present the outcome of the research observations on the main selected research themes. This is done with the aim of indicating the research questions stand point. The result of each observable item under each theme of interest is interpreted and discussed with the purpose of proposing possible recommendations towards improving the organisation at large. The results indicate aspects which need attention in the different departments as well as the entire organisation. The results indicate that the organisation needs to improve on the standard of shop-floor meetings, training and problem solving.
Chapter 5: Recommendations and Conclusion

5. Introduction

This section of the research provides a brief summary on the main aspects of the research and presents recommendations with regards to the gaps exhibited by research findings. The research team persuaded the research in purpose of studying contributors hindering sustainability of lean manufacturing principles in a manufacturing environment. The research is ordered around the following research question:

- What are the main aspects which contribute towards the sustainability of lean manufacturing principles in a manufacturing environment?
- How should manufacturing organisations incorporate lean in the daily business to achieve sustainable results?

A literature review regarding the research was conducted with the aim of learning what other researchers advocate as best practices on lean manufacturing. The literature reveals significant approaches practised by organisations such as Toyota to successfully sustain the implemented lean principles. The learning from the literature study was then used to focus on main aspects of observation to study the manner with which the organisation under study practises lean principles in relation to what is recommended in literature.

A structured observation sheet was compiled comprising of the main aspects of observation. The observations were conducted in four departments; logistics, assembly, body shop and paint shop taking into consideration the main themes being; qualification training, shop-floor meetings, value streams, problem solving and coaching.

The research reports that of all the observed themes with different observable items, the main themes which need attention are shop-floor meetings, training and problem solving. The research further reveals that out of the four departments logistics is the major concern in terms of practising lean principles however, assembly is the only department which has put most of the best lean practices in place. The section below discusses the proposals with regards to what needs further attention as revealed by research findings.

5.1. Shop-floor meetings

Observation A2 reveals that the managers in the organisation need to work on their coaching skills when on shop-floor. Currently during shop-floor meetings the managers do not interact with the workers through coaching with the purpose of improving the skills of the workers on the job; therefore, mitigating the occurrence of problems. Usually the focus is strictly on the problem and how to solve the problem. Research indicates that assembly is the only
department whereby managers coach their associates on solving the problems during Gemba meetings. Liker (2004) cited in Thorhallsdottir (2016) explains that there are notable methods of partaking in Gemba however, those who actually take part in Gemba walks should be mindful at all times by seeking the essential information such as asking why, observing and offering the necessary support. The idea behind the Gemba should be to observe how is work performed, pose open-ended questions, be open minded and coach the workers on the simpler methods of performing the work.

**Cross functional learning:** A hypothetical solution to this finding could be cross functional learning for the managers. Each manager in the respective departments needs to rotate to another area to learn better ways of engaging during shop-floor meetings specifically focusing on coaching. At the moment the benchmark department in this regard is assembly. This means that all the managers from the rest of the departments should learn from assembly.

Observation A4 and A4 designate that during Gemba time managers do not take time out to observe the process with problems and understand through hands on experience. The application of the Gemba principle takes into consideration the Ohno circle in the form of an imaginary or real circle. The leader steps into the circle with the aim of observing the process with failures (Dombrowski & Mielke, 2013). The observation of the process could possibly take some hours until the process with failures is understood therefore, the decision on possible improvements will be influenced by apparent facts. The logic behind the Ohno circle suggests that leaders should go on the shop-floor and get their hands dirty to improve the process.

**Standard meeting agenda:** Currently the Gemba walks are scheduled for 30 minutes to an hour at maximum and these meetings are usually discussion meetings amongst the managers with regards to the problem instead of observing the process and be hands on to gather facts on the problem. Structuring the shop-floor meetings into different section could bring direction to the meeting. This could be done by introducing a standard agenda for the meeting. The first part could be on general discussion towards understanding the problem, the second part could on actual observation of the processes and the third part could be hands on experience.

### 5.2. Training

The examination of the findings from observation B1 substantiated by findings from four other observations establishes that there is absence of adequate training in the organisation. Findings based on observation B4 highlight that new managers and leaders do not spend a day working on the line. Findings based on observation B5 proves that there is no designated coach especially for promoted managers and new workers side by side to teach them. Observation B7 indicates that office employees do not take part in induction training for at least five days. Observation B9 reveals the result that upon conducting induction training on
the principles there is not practical done to reinforce learning. Piatkowski (2004) outlines that all the newly appointed leaders and managers are expected to spend a day working on the line. If there is a new employee or promoted manager, the expectation is to have an experienced mentor side by side to teach the individual on TPS. This approach has proved to be authentic as everyone gets the same message and teaching with regards to the Toyota Production System philosophy. Again, he explains that all new employees including office employees have to go through an orientation training for five days. The training comprises of classroom training and practical exercises on basic Toyota Production System principles.

**VPS principles integration:** In purpose of improving the sufficiency of the training, the organisation should consider integrating induction training on VPS principles for everyone in the organisation, from the managers to the worker on the line. The current induction training targets the line workers and is not seen as the mandate of the organisation to ensure that everyone goes through the training from both the indirect and direct areas. To achieve consistency throughout the organisation all the associates in the different departments should go through the VPS induction training. This should be made a mandatory requirement for everyone. In addition to this, the induction training should be structured into two parts. The first part should only focus on theory on VPS principles and the second part should aim at reinforcing the practical application of these principles; therefore, reinforcing learning in all the parts of the organisation. Currently the expectation is for the line workers to have a certain level of knowledge whereas the office workers are not held to any form of expectation. This approach towards learning will break the silo mentality which is currently in place between the indirect areas and direct areas. Again, this will ensure consistent transfer of knowledge throughout the organisation and will improve the quality of coaching during shop-floor meetings as well as skills necessary in problem solving.

**Leaders conducting training:** To instil the importance of training in the organisation, the departments should work on capacitating the leaders with regards to training the people on VPS principles on shop-floor instead of permanently relying on the VPS integrators to conduct training in each department. This will boost the credibility of the leaders towards the people and substantiate why certain routine and principles should be applied when working.

Through observable item B1, it can be seen that none of the departments conduct training on the shop-floor. This finding demonstrates that most of the training is done in a classroom engagement and could be the reason why the organisation is struggling to sustain lean through consistent application of the principles in the daily business. The literature highlights that qualification is not strictly confined to classroom training but rather should take place on shop-floor on a daily basis. Conveniently coaching is the best approach to challenge the
employees to come up with solutions for the actual problem (Liker & Convis, 2011). To mitigate this finding, the organisation should consider the development of a learning factory whereby the lean principles can be practised right after the classroom without disturbing line operations.

5.3. Problem Solving

Observation D2 and D3 show proof that the knowledge of line workers is overlooked during problem solving and that the workers are not involved in the problem solving process. These findings substantiate the findings confirmed by observation D5 which indicate that the problem solving process in the organisation is flawed as problems are not classified according to categories of complexity. The departments deal with ongoing problems haphazardly and aim at solving each problem with the application of a specific tool.

According to Arbos and Nadal (2006), the considerable amount of knowledge essential for solving problems is found amongst the line workers not the engineers; therefore, in this way the line workers become knowledge workers; however, training and learning are necessary to enhance the skill. Furthermore, Wojtaszak (2015) highlights that the involvement of the workers working with the process is a basic principle in problem solving methodology.

**Problem landscape:** If the organisation considers to put in place a platform for categorising problems into categories of complexity this will strengthen the involvement of line workers in the problem solving process as the first category will be assigned to them. This could be achieved through the development of a problem landscape depicting the type of problems each level in hierarchy should attempt solving prior to escalating the problem. In pursuit of enhancing the problem escalation process, the organisation could consider introducing kaizen events to promote the workers’ involvement in problem solving.

**Kaizen events:** In a case whereby the problem escalation process does not prove to be sufficient, the organisation can consider establishing sessions strictly focusing on continuous improvement. The session will ignite the interest of the individuals across the organisation in purpose of improving processes; therefore, encouraging participation. In a case whereby escalation of problems doesn’t prove to be sufficient, the kaizen approach facilitates a platform in the form of kaizen events whereby all the relevant people regarding the problem are brought together (Glover, et al., 2015).

5.4. Coaching

**Departmental lean coach:** To enhance the application of the coaching language on shop-floor the organisation should consider nominating lean coaches in each department. The individual should have the capability to take the lead during coaching sessions on shop-floor and use the correct language to develop the workers thus helping the rest of the team to learn the correct coaching language. This role does not have to be assigned to an additional
candidate. The different departments could nominate an individual at management level with a good coaching capability. The role of a lean coach is not an easy one as people see lean as another additional task and suggest that this role should be cared in the hands of the line management rather than the staff members (Liker & Meier, 2006).

Observable item E9 reveals that in logistics, paint shop and body shop departments there are no coaching boards available next to production to make improvement topics transparent. Visual controls provide the essential information on the issues in the workplace such as root cause analysis to problems. The information on visual control should be updated on a daily basis (Williams, 2012).

5.5. Conclusion

The research reveals the major contributors pertaining to failure of manufacturing organisations to sustain the application of lean manufacturing principles in an organisation. The identified gap ranges from the manner with which the organisation conducts the qualification process; and knowledge transfer to the workers to the manner with which shop-floor engagement between leaders and workers takes place. Directing focus to the respective departments, the research reveals that the logistics department is lacking on several aspects; however, assembly department is currently in the lead. In addition to the recommendations provided, the organisation could use learnings from assembly to achieve equal knowledge transfer across the organisation.

5.5.1. Study limitations

✓ The learning acquired from the research findings is strictly for the company under study since the research was not extended to other automotive companies.

✓ This research only focuses on internal factors which influence the application of lean principles in a production system.

✓ The sampling procedure in this research is non-probability sampling; therefore, conclusion with regards to findings cannot be generalised.

5.5.2. Future research

In light of closing the gap in lack of sustainability of lean manufacturing principles in manufacturing organisations, future research could focus on incentive schemes to promote the engagement of employees in lean initiatives. Research reveals that the majority of lean adopters employ certain improvements and tools prescribed by the quality specialist to deal with projects, however this follows a top-down approach. He suggests that this approach overlooks the essential factors pertaining to Toyota’s positive lean results in the form of a workplace culture driven by knowledgeable employees, with well-defined structures which
facilitate consistent practice of desired behaviours and incentive schemes to promote engagement amongst the employees at all levels (Zarbo, 2012).

As previously mentioned in the previous section, this research focuses on internal factors which influence the application of lean principles in a production system, future research could focus on the role and impact of external factors in lean practising organisations.
6. References


Carvalho, J. D. et al., 2013. *Performance Enhancing in the Manufacturing Industry: An Improvement KATA*, s.l.: s.n.


Rathilall, R., 2011. _Improving Quality and Productivity Through Lean Manufacturing at an Automotive Manufacturing Organisation in Durban_, Durban: Durban University of Tehnology.


# Appendix A: Observable items check list

## Table 1: Category A: Shop-floor meetings

<table>
<thead>
<tr>
<th>Extracted literature for the observed item</th>
<th>Section</th>
<th>Reference</th>
<th>Observed item</th>
<th>Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genchi gembutsu namely Gemba is one of the main tools in lean. This tool is by means of encouraging managers to go and see the clear state of what is happening in purpose of getting a better understanding.</td>
<td>Section 2.7.1.8</td>
<td>(Thorhallsdottir, 2016)</td>
<td>Managers take part in Gemba meetings.</td>
<td>A1</td>
</tr>
<tr>
<td>The idea behind the Gemba walk should be to observe how is the work performed, pose open-ended questions, be open minded and coach the workers on the simpler methods of performing the work</td>
<td>Section 2.7.1.8</td>
<td>Liker (2004) cited in Thorhallsdottir (2016)</td>
<td>During this time managers coach the workers.</td>
<td>A2</td>
</tr>
<tr>
<td>This approach works best as it involves going to the actual place to source credible information than using the traditional methods which involves holding meetings in the offices and discuss opinions.</td>
<td>Section 2.7.1.8</td>
<td>(Ndou, 2009)</td>
<td>The Gemba meetings take place where the problem occurred.</td>
<td>A3</td>
</tr>
<tr>
<td>The application of this principle takes into consideration the Ohno circle in the form of an imaginary or real circle. The leader steps into the circle with the aim of observing the process with failures (Dombrowski &amp; Mielke, 2013). The observation of the process could possibly take some hours until the process with problems is understood.</td>
<td>Section 2.7.1.8</td>
<td>(Dombrowski &amp; Mielke, 2013).</td>
<td>Managers dedicate special hours to observe the process with problems</td>
<td>A4</td>
</tr>
<tr>
<td>The logic behind the Ohno circle suggests that leaders should go on</td>
<td>(Dombrowski &amp; Mielke, 2013)</td>
<td>During Gemba time managers take an</td>
<td>A5</td>
<td></td>
</tr>
<tr>
<td>the shop-floor and get their hands dirty to improve the process. This concept also suggests that the leaders should have their offices located close to shop-floor in appreciation of the shop-floor operations in the organisation</td>
<td>opportunity to be hands on to improve the process</td>
<td>A6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gemba is the time which leaders can use to practically develop their employees through their daily work routine on the shop-floor instead of using artificial examples for training</td>
<td>Section 2.7.1.8</td>
<td>(Dombrowski &amp; Mielke, 2013)</td>
<td>Leaders use Gemba time to develop their employees through their daily work.</td>
<td>A7</td>
</tr>
<tr>
<td>Simulated areas for learning close to the actual process should be used to develop the employees.</td>
<td></td>
<td></td>
<td>Simulated areas are available to train workers on the job.</td>
<td>A8</td>
</tr>
<tr>
<td>Normally when a team leader is unable to solve a problem due to complexity, the team leader uses an opportunity in the shop floor meeting to present the problem to other departments involved.</td>
<td>Section 2.8</td>
<td>(Christiana, et al., 2015).</td>
<td>Team leaders use the meetings to present and escalate problems he or she could not solve.</td>
<td>A9</td>
</tr>
<tr>
<td>This form is then presented to top management for final decision making strictly within the proposed agenda time. The advantage of using an A3 report is in data presentation format and structured approach to solving problems thus resulting to efficient meetings (Liker, 2004).</td>
<td>Section 2.8</td>
<td>(Liker, 2004)</td>
<td>Shop-floor meetings are used to have standard time to present to managers problems in an A3 format.</td>
<td>A10</td>
</tr>
<tr>
<td>Extracted literature for the observed item</td>
<td>Section</td>
<td>Reference</td>
<td>Observed item</td>
<td>Item No.</td>
</tr>
<tr>
<td>------------------------------------------</td>
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<td>---------</td>
</tr>
<tr>
<td>Qualification is not strictly confined to classroom training but rather should take place on shop-floor on a daily basis.</td>
<td>Section 2.7.1.8</td>
<td>(Liker &amp; Convis, 2011)</td>
<td>Training is conducted on shop-floor a daily basis.</td>
<td>B1</td>
</tr>
<tr>
<td>There is close to little written about Toyota Production System in the form of books or operating manuals however, brochures and handouts are the only form of script available. This is because Toyota advocates the importance of a spoken word to transfer knowledge from one generation to the next.</td>
<td>Section 2.7.1.8</td>
<td>(Piatkowski, 2004)</td>
<td>Learning is facilitated through brochures and spoken word.</td>
<td>B2</td>
</tr>
<tr>
<td>Toyota works on the development of in-house trainers from the experienced employees such as the team leaders, managers, engineers and senior executives.</td>
<td>Section 2.7.1.8</td>
<td>(Piatkowski, 2004)</td>
<td>People responsible for training are experienced managers, engineers and team leaders</td>
<td>B3</td>
</tr>
<tr>
<td>All the newly appointed leaders and managers are expected to spend a day working on the line. If there is a new employee or promoted manager, the expectation is to have an experienced mentor side by side to teach the individual on TPS (VPS).</td>
<td>Section 2.7.1.8</td>
<td>(Piatkowski, 2004)</td>
<td>Newly appointed leaders and managers spend a day working on the line. Promoted managers and new employees have side by side experienced mentors teaching them on TPS (VPS).</td>
<td>B4 B5</td>
</tr>
<tr>
<td>All new employees including office employees have to go through an orientation training for five days.</td>
<td>Section 2.7.1.8</td>
<td>(Piatkowski, 2004)</td>
<td>New employees and office employees go through an induction</td>
<td>B6</td>
</tr>
</tbody>
</table>
The training comprises of classroom training and practical exercises on basic Toyota Production System principles.

This is in turn followed by on the job training for about six to eight weeks, this is not strictly on the job content alone but it also covers how the employees should work according to Toyota Production System rules. Ultimately, when the employees have completed the training, they have the elementary knowledge on the basic Toyota Production System principles such as single piece flow, pull, Kanban, takt time, types of waste, kaizen and; identifying and solving problems.

<table>
<thead>
<tr>
<th>Section 2.7.1.8</th>
<th>Training for at least five days.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The induction training is in the form of classroom training and practical exercise.</td>
<td></td>
</tr>
</tbody>
</table>

Section 2.7.1.8 (Piatkowski, 2004; Arbós & Nadal, 2006)

The second part of the training is on the job training for not less than six weeks.

The training provides learning on principles such as single piece flow, pull, Kanban, takt time, types of waste, kaizen and; identifying and solving problems.
<table>
<thead>
<tr>
<th>Extracted literature for the observed item</th>
<th>Section</th>
<th>Reference</th>
<th>Observed item</th>
<th>Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>This principles aims at studying each step of a production process from beginning to end in purpose of eliminating any form of waste.</td>
<td>Section 2.4</td>
<td>(Borris, 2012)</td>
<td>Each process step of the process has been identified from beginning to end</td>
<td>C1</td>
</tr>
<tr>
<td>This approach is helps to separate value adding steps from non-value adding steps therefore, eliminating apparent waste.</td>
<td>Section 2.4</td>
<td>(Cottyn, 2014)</td>
<td>Waste has been identified and eliminated from the process</td>
<td>C2</td>
</tr>
<tr>
<td>The value stream mapping requires five core steps executed by the special team being; identifying the product family, mapping the current state, mapping the future state, defining a work plan and executing the work plan.</td>
<td>Section 2.4</td>
<td>(Cottyn, 2014)</td>
<td>The product family has been identified. The current state has been mapped. The future state has been mapped</td>
<td>C3 C4 C5</td>
</tr>
<tr>
<td>There is a need of having an individual, a value stream manager that will mainly run with the responsibility of understanding a specific product family for the value stream and realising the identified improvements.</td>
<td>Section 2.4</td>
<td>(Rother &amp; Shook, 1999)</td>
<td>A value stream manager has been assigned</td>
<td>C6</td>
</tr>
<tr>
<td>In order for the individual to have a better chance of realising the identified improvements from the future state map across the departments he or she must directly report to the organisation’s leader.</td>
<td>Section 2.4</td>
<td>(Rother &amp; Shook, 1999)</td>
<td>The value stream manager reports to the plant leader.</td>
<td>C7</td>
</tr>
<tr>
<td>In return the leader should lead and support the value stream team towards the mapping and implementation of the future state value stream (Rother, 1999).</td>
<td>Section 2.4</td>
<td>(Rother, 1999)</td>
<td>The plant leader supports the value stream towards the realisation of the future state.</td>
<td>C8</td>
</tr>
<tr>
<td>The analysis of the current state map requires certain data in the form of cycle time at each process, change over time, uptime and number of operators available during analysis.</td>
<td>Section 2.4</td>
<td>(Cottyn, 2014)</td>
<td>Current state cycle time has been identified.</td>
<td>C9</td>
</tr>
<tr>
<td>After the analysis of the current state, a future plan and lean transformation plan is developed.</td>
<td>Section 2.4</td>
<td>(Cottyn, 2014)</td>
<td>The plan for improvements for the future state is developed.</td>
<td>C12</td>
</tr>
<tr>
<td>The lean transformation plan is suggested to comprise of improvement opportunities. These improvement opportunities are made transparent on the future state map, represented by kaizen bursts and driven by Deming’s cycle. This cycle follows a four stage methodology being; Pan, Do, Check, Act (PDCA). Devin (2012) explains that the value stream satisfies three significant management</td>
<td>Section 2.4</td>
<td>(Cottyn, 2014)</td>
<td>The improvement opportunities are made transparent in the form of kaizen burst on the future state map and follow the PDCA cycle.</td>
<td>C13</td>
</tr>
</tbody>
</table>
### Table 4: Category D: Problem solving

<table>
<thead>
<tr>
<th>Extracted literature for the observed item</th>
<th>Section</th>
<th>Reference</th>
<th>Observed item</th>
<th>Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nowadays, experience is the normal approach of finding a solution to a problem as well as relying on executives who assume the role of experts instead of working on structured problem solving.</td>
<td>Section 2.8</td>
<td>(Christiana, et al., 2015)</td>
<td>Structured problem solving is followed when solving problems</td>
<td>D1</td>
</tr>
<tr>
<td>The considerable amount of knowledge essential for solving problems is found amongst the line workers not the engineers therefore, in this way the line workers become knowledge workers however, training and learning are necessary to enhance the skill. The involvement of the workers working with the process is a basic principle in problem solving methodology</td>
<td>Section 2.8</td>
<td>(Arbós &amp; Nadal, 2006)</td>
<td>The knowledge of workers is utilised to solve problems</td>
<td>D2</td>
</tr>
<tr>
<td>In attempt of resolving the problem, the resolution process requires a team approach and should start at the bottom of the hierarchy, the operator level to the level of engineers however, simple problems can be entrusted in the hands of the operator.</td>
<td>Section 2.8</td>
<td>(Wojtaszak, 2015)</td>
<td>Problem solving is a team approach.</td>
<td>D5</td>
</tr>
<tr>
<td>The higher is the complexity of the problem the higher escalated in the hierarchy therefore, it is important to classify the problems according to categories of complexity for problem solving and escalation purposes</td>
<td>Section 2.8</td>
<td>(Christiana, et al., 2015)</td>
<td>Problems are classified according to categories of complexity.</td>
<td>D6</td>
</tr>
<tr>
<td>During this time the problem is escalated to the relevant people who in turn will be responsible for solving the problem thus following the PDCA cycle until the problem is closed.</td>
<td>Section 2.8</td>
<td>(Christiana, et al., 2015).</td>
<td>The team leader escalates unsolved problems to the relevant people.</td>
<td>D7</td>
</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td>The five why analysis compels individuals to search deep about the root cause of the problem without having to settle for temporary solutions to the problem.</td>
<td>Section 2.8</td>
<td>(Wojtaszak, 2015).</td>
<td>The five why analysis is used to find the root cause.</td>
<td>D9</td>
</tr>
<tr>
<td>Thereafter possibly using the pareto analysis for prioritising the number of transpiring problems according to the severity, frequency and source of occurrence. This nature of classification helps with understanding which problems need the most attention in terms of problem solving.</td>
<td>Section 2.8</td>
<td>(Liker, 2004)</td>
<td>The pareto analysis is used to prioritise the urgent problems.</td>
<td>D10</td>
</tr>
<tr>
<td>It is suggested that the entire problem solving process comprises of 20% tools and 80% mind application however, in the traditional companies this notion is vice versa</td>
<td>Section 2.8</td>
<td>(Liker, 2004)</td>
<td>The problem solving process is 20% tools and 80% mind-set.</td>
<td>D11</td>
</tr>
<tr>
<td>The problem solving process is presented in the form of an A3 report which follows the PDCA cycle to track progress. The A3 form usually contains the necessary information and visuals about the problem. The application of the form begins during the observation of the</td>
<td>Section 2.8</td>
<td>(Liker, 2004)</td>
<td>A form such as the A3 report is used to document problems and follows a PDCA cycle.</td>
<td>D12</td>
</tr>
<tr>
<td>current situation in pursuit of understanding the real problem</td>
<td>Section 2.8</td>
<td>(Wojtaszak, 2015)</td>
<td>A form like an A3 report has been adopted to suit business need.</td>
<td>D13</td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
<td>-------------</td>
<td>-------------------</td>
<td>-----------------------------------------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>Although there is a standard format of the A3 report, it is however, flexible enough to allow organisation which have adopted the use of the A3 report tweak it to suit the intended use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5: Category E: Shop-floor coaching

<table>
<thead>
<tr>
<th>Extracted literature for the observed item</th>
<th>Section</th>
<th>Reference</th>
<th>Observed item</th>
<th>Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The aim of this stage is to stimulate the employees' capabilities by encouraging them to take control of any situation thus achieving desirable results.</td>
<td>Section 2.7.1.4</td>
<td>(Trenkner, 2016)</td>
<td>Employees are encouraged to take control of improvements.</td>
<td>E1</td>
</tr>
</tbody>
</table>
| The Toyota Business Practices approach for continuous improvement. This method follows 8 steps and a PDCA approach:  
  - Define the ideal state with regards to the problem (plan)  
  - Analyse the current state (plan)  
  - Do a root cause analysis (plan)  
  - Define the target state (plan)  
  - Plan a suitable approach (plan)  
  - Conduct experiment (do)  
  - Study results (check)  
  - Standardise, adapt and transfer knowledge of the solution (act). | Section 2.7.1.4 | (Ehni & Kersten, 2015) | Continuous improvement is an eight step process: Define the ideal state, analyse the current state, do a root cause analysis, define the target state, plan a suitable approach, conduct experiment, study results, standardise, adapt | E2 |
| Conveniently coaching is the best approach to challenge the employees to come up with solutions for the actual problem. The well-established method in industry is Toyota Kata. This method provides an appropriate structure for coaching and improving the therefore, establishing daily routines | Section 2.7.1.4 | (Rother, 2010) cited in (Dombrowski & Mielke, 2013) | Coaching is sued to challenge employees to solve their own problems. | E3 |
| | Section 2.7.1.4 | (Rother, 2010) cited in (Dombrowski & Mielke, 2013) | Toyota kata is used to establish daily routines leading to improvement ideas | E4 |
which result into a sustainable continuous improvement of processes.

<table>
<thead>
<tr>
<th>An improvement kata card can be used to facilitate the improvement and learning process. The first three questions on the card focus on the target conditions and are known as framing questions</th>
<th>(Soltero, 2012). An improvement kata card is used to ask a certain set of questions</th>
<th>E5</th>
</tr>
</thead>
<tbody>
<tr>
<td>It was evidenced that the organisation integrated Toyota kata through training the employees on the methodology, defining starting condition, workers and coach defining the target condition for lead times and conducting daily meetings between the team and coach to check progress following the PDCA cycle. The training on improvement kata and coaching kata took four hours and involved both top and middle management; and some of the workers.</td>
<td>Time has been dedicated towards training top management, middle management and workers on Toyota kata.</td>
<td>E6</td>
</tr>
<tr>
<td>The current condition and target condition has been defined for current problems.</td>
<td>E7</td>
<td></td>
</tr>
<tr>
<td>Daily meetings take place between the team and coach to check progress using the PDCA method.</td>
<td>E8</td>
<td></td>
</tr>
<tr>
<td>With the aim of visually managing progress a board was made available next to production and with</td>
<td>Coaching boards are available next to production.</td>
<td>E9</td>
</tr>
</tbody>
</table>
the help of the coach the maximum lead was identified as a performance indicator to tack improvement.
### Appendix B: Observation check list

#### Category A: shop-floor meetings

<table>
<thead>
<tr>
<th>No</th>
<th>Observable item</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Managers take part in Gemba meetings.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>During this time managers coach the workers.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>The Gemba meetings take place where the problem occurred.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>Managers dedicate special hours to observe the process with problems.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>During Gemba time managers take an opportunity to be hands on to improve the process</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A6</td>
<td>The offices of the managers are located close to shop-floor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A7</td>
<td>Leaders use Gemba time to develop their employees through their daily work.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A8</td>
<td>Simulated areas are available to train workers on the job.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A9</td>
<td>Team leaders use the meetings to present and escalate problems</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
he or she could not solve.

A10 Shop-floor meetings are used to have standard time to present to managers problems in an A3 format.

**Category B: Qualification training**

<table>
<thead>
<tr>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No</strong></td>
</tr>
<tr>
<td>B1</td>
</tr>
<tr>
<td>B2</td>
</tr>
<tr>
<td>B3</td>
</tr>
<tr>
<td>B4</td>
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<tr>
<td>B5</td>
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<td></td>
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<tr>
<td>B7</td>
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<tr>
<td>B8</td>
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<tr>
<td>B9</td>
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<tr>
<td>B10</td>
</tr>
</tbody>
</table>
## Category C: Value streams

<table>
<thead>
<tr>
<th>No</th>
<th>Observable item</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Each process step of the process has been identified from beginning to end</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>Waste has been identified and eliminated from the process</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>The product family has been identified.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>The current state has been mapped.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>The future state has been mapped.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td>A value stream manager has been assigned</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C7</td>
<td>The value stream manager reports to the plant leader.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C8</td>
<td>The plant leader supports the value stream towards the realisation of the future state.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C9</td>
<td>Current state cycle time has been identified.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10</td>
<td>Current state uptime has been identified.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C11 The number of operators available have been identified.

C12 The plan for improvements for the future state is developed.

C13 The improvement opportunities are made transparent in the form of kaizen burst on the future state map and follow the PDCA cycle.

Category D: Problem Solving

<table>
<thead>
<tr>
<th>No</th>
<th>Observable item</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Structured problem solving is followed when solving problems</td>
<td></td>
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</tr>
<tr>
<td>D2</td>
<td>The knowledge of workers is utilised to solve problems</td>
<td></td>
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<tr>
<td>D3</td>
<td>Workers working with the process are involving in the problem solving process</td>
<td></td>
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<tr>
<td>D4</td>
<td>Problem solving is a team approach.</td>
<td></td>
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</tr>
<tr>
<td>D5</td>
<td>Problems are classified according to categories of complexity.</td>
<td></td>
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</tr>
<tr>
<td>D6</td>
<td>The problem follows the PDCA cycle until it is closed</td>
<td></td>
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</tbody>
</table>
The five why analysis is used to find the root cause.

The pareto analysis is used to prioritise the urgent problems.

The problem solving process is 20% tools and 80% mindset.

A form such as the A3 report is used to document problems and follows a PDCA cycle.

A form like an A3 report has been adopted to suite business need.

### Category E: Coaching

<table>
<thead>
<tr>
<th>Application</th>
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<tr>
<td><strong>No</strong></td>
</tr>
<tr>
<td>E1</td>
</tr>
<tr>
<td>E2</td>
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<tr>
<td>E3</td>
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<td>E4</td>
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<td>E5</td>
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<td>E6</td>
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<td>E7</td>
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<tr>
<td>E8</td>
</tr>
<tr>
<td>E9</td>
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</table>
Appendix C: Data presentation

<table>
<thead>
<tr>
<th>No</th>
<th>Observable item</th>
<th>Logistics</th>
<th>Assembly</th>
<th>Paint Shop</th>
<th>Body shop</th>
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</thead>
<tbody>
<tr>
<td>A1</td>
<td>Managers take part in Gemba meetings.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>A2</td>
<td>During this time managers coach the workers.</td>
<td>2</td>
<td>1</td>
<td>2</td>
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<tr>
<td>A3</td>
<td>The Gemba meetings take place where the problem occurred.</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>A4</td>
<td>Managers dedicate special hours to observe the process with problems</td>
<td>2</td>
<td>2</td>
<td>2</td>
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</tr>
<tr>
<td>A5</td>
<td>During Gemba time managers take an opportunity to be hands on to improve the process</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>A6</td>
<td>The offices of the managers are located close to shop-floor</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>A7</td>
<td>Leaders use Gemba time to develop their employees through their daily work.</td>
<td>2</td>
<td>2</td>
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</tr>
<tr>
<td>A8</td>
<td>Simulated areas are available to train workers on the job.</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>A9</td>
<td>Team leaders use the meetings to present and escalate problems he or she could not solve</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>A10</td>
<td>Shop-floor meetings are used to have standard time to present to managers problems in an A3 format</td>
<td>2</td>
<td>1</td>
<td>2</td>
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<tr>
<td>B1</td>
<td>Training is conducted on shop-floor a daily basis.</td>
<td>2</td>
<td>2</td>
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<tr>
<td>B2</td>
<td>Learning is facilitated through brochures and spoken word.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>B3</td>
<td>People responsible for training are experienced managers, engineers and team leaders</td>
<td>2</td>
<td>1</td>
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</tr>
<tr>
<td>B4</td>
<td>Newly appointed leaders and managers spend a day working on the line.</td>
<td>2</td>
<td>2</td>
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<td>2</td>
</tr>
<tr>
<td>B5</td>
<td>Promoted managers and new employees have side by side experienced mentors teaching them on TPS (VPS).</td>
<td>2</td>
<td>2</td>
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</tr>
<tr>
<td>B6</td>
<td>New employees go through an induction training for at least five days.</td>
<td>1</td>
<td>1</td>
<td>2</td>
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</tr>
<tr>
<td>B7</td>
<td>Office employees go through an induction training for at least five days.</td>
<td>2</td>
<td>2</td>
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</tr>
<tr>
<td>B8</td>
<td>The induction training is in the form of classroom training and practical exercise.</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>B9</td>
<td>The second part of the training is on the job training for not less than six weeks.</td>
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<tr>
<td>B10</td>
<td>The training provides learning on principles such as single piece flow, pull, Kanban, takt time, types of waste, kaizen and; identifying and solving problems.</td>
<td>1</td>
<td>1</td>
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<tr>
<td>C1</td>
<td>Each process step of the process has been identified from beginning to end</td>
<td>1</td>
<td>1</td>
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<tr>
<td>C2</td>
<td>Waste has been identified and eliminated from the process</td>
<td>1</td>
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<tr>
<td>C3</td>
<td>The product family has been identified.</td>
<td>1</td>
<td>1</td>
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<tr>
<td>C4</td>
<td>The current state has been mapped.</td>
<td>1</td>
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<tr>
<td>C5</td>
<td>The future state has been mapped</td>
<td>2</td>
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<tr>
<td></td>
<td>Description</td>
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<td>---------------------------------------------------------------------------------------------------</td>
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<tr>
<td>C6</td>
<td>A value stream manager has been assigned</td>
<td>2</td>
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<tr>
<td>C7</td>
<td>The value stream manager reports to the plant leader.</td>
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<tr>
<td>C8</td>
<td>The plant leader supports the value stream towards the realisation of the future state.</td>
<td>2</td>
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<tr>
<td>C9</td>
<td>Current state cycle time has been identified.</td>
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<tr>
<td>C12</td>
<td>Current state uptime has been identified.</td>
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<tr>
<td>C11</td>
<td>The number of operators available have been identified.</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>C12</td>
<td>The plan for improvements for the future state is developed.</td>
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<tr>
<td>C13</td>
<td>The improvement opportunities are made transparent in the form of kaizen burst on the future state map and follow the PDCA cycle.</td>
<td>2</td>
<td>2</td>
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<tr>
<td>D1</td>
<td>Structured problem solving is followed when solving problems</td>
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<tr>
<td>D2</td>
<td>The knowledge of workers is utilised to solve problems</td>
<td>2</td>
<td>2</td>
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<tr>
<td>D3</td>
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<td>2</td>
<td>2</td>
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<td>D4</td>
<td>Problem solving is a team approach.</td>
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<tr>
<td>D5</td>
<td>Problems are classified according to categories of complexity.</td>
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<td>2</td>
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<tr>
<td>D6</td>
<td>The problem follows the PDCA cycle until it is closed</td>
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<tr>
<td>D7</td>
<td>The five why analysis is used to find the root cause</td>
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<tr>
<td>D8</td>
<td>The pareto analysis is used to prioritise the urgent problems.</td>
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<tr>
<td></td>
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<td>D9</td>
<td>The problem solving process is 20% tools and 80% mindset.</td>
<td>2</td>
<td>2</td>
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<tr>
<td>D10</td>
<td>A form such as the A3 report is used to document problems and follows a PDCA cycle.</td>
<td>2</td>
<td>1</td>
<td>1</td>
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<tr>
<td>D11</td>
<td>A form like an A3 report has been adopted to suite business need.</td>
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<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>E1</td>
<td>Employees are encouraged to take control of improvements.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>E2</td>
<td>Continuous improvement is an eight step process: Define the ideal state, analyse the current state, do a root cause analysis, define the target state, plan a suitable approach, conduct experiment, study results, standardise, adapt</td>
<td>2</td>
<td>2</td>
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<tr>
<td>E3</td>
<td>Coaching is sued to challenge employees to solve their own problems.</td>
<td>2</td>
<td>1</td>
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<tr>
<td>E4</td>
<td>Toyota kata is used to establish daily routines leading to improvement ideas</td>
<td>2</td>
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<tr>
<td>E5</td>
<td>An improvement kata card is used to ask a certain set of questions</td>
<td>2</td>
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<td>1</td>
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<tr>
<td>E6</td>
<td>Time has been dedicated towards training top management, middle management and workers on Toyota kata.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>E7</td>
<td>The current condition and target condition has been defined for current problems.</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>E8</td>
<td>Daily meetings take place between the team and coach to check progress using the PDCA method.</td>
<td>2</td>
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Coaching boards are available next to production.

<table>
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</table>

The data below represent the response turn out for each principle per department.

The graph above portrays the quality of shop-floor meetings in the different departments as suggested in literature. The quality of the meetings is subject to the extent to which the observable items are evidenced during the meetings. The observations delineate that 92% of the time the quality of shop-floor meetings taking place in logistics does not reflect what is suggested in literature; however, in other respects 1% of the time the meetings follow a good structure. In assembly, 32% of the time the quality of meetings reflects negative practices while 72% of the time shows positive practices. In paint shop, 62% of the time the quality of meetings shows negative practices while 42% of the time shows positive practices. In body shop 52% of the time the quality of meetings shows negative practices while 52% of the time shows positive practices.
The graph above portrays the quality of training in the different departments as suggested in literature. The quality of training is subject to the extent to which the observable items are evidenced by the research team during the training sessions. The observations delineate that 62% of the time the quality of training taking place in logistics does not reflect what is suggested in literature; however, in other respects 42% of the time the training focuses on providing essential knowledge. In assembly, 52% of the time the quality of training shows negative practices while 52% of the time shows positive practices. In paint shop, 72% of the time the quality of training shows negative practices while 32% of the time shows positive practices. In body shop, 72% of the time the quality of training shows negative practices while 32% of the time focuses on providing essential knowledge.
The graph above portrays the quality of values streams in the different departments as suggested in literature. The quality of values streams is subject to the extent to which the observable items are evidenced by the research team during mapping. The observations delineate that 62% of the time the quality of values streams mapped in logistics do not reflect what is suggested in literature; however, in other respects 38% of the time the quality of the values streams reveals the strength of the logistics processes. In assembly, 38% of the time the quality of values streams shows negative practices with regards to the processes while 62% of the time shows positive practices. In paint shop, 46% of the time the quality of values streams shows improvement opportunity on the processes while 54% of the time shows positive practices. In body shop, 46% of the time the quality of values streams shows negative practices while 54% of the time shows positive practices.

The graph above portrays the contribution of each department towards problem solving in the entire organisation. The quality of problem solving is subject to the extent to which the observable items are evidenced during problem solving sessions. The observations delineate that 82% of the time the quality of problem solving sessions taking place in logistics does not reflect what is suggested in literature; however, in other respects only 18% of the time the quality of problem solving indicates good problem solving practices. In assembly, 45% of the time the quality of problem solving shows negative practices while 55% of the time shows positive practices. In paint shop, 45% of the time problem solving shows negative practices while 55% of the time shows positive practices. In body shop 45% of the time the manner with which problem solving is conducted reveals weaknesses in the problem solving process while 55% of the time reveals positive practices.
The graph above portrays the contribution of each department towards coaching in the entire organisation. The quality of shop-floor coaching is subject to the extent to which the observable items is evidenced during Gemba meetings. The observations delineate that 71 % of the time the quality of shop-floor coaching taking place in logistics does not reflect what is suggested in literature; however, in other respects 29 % of the time the quality of the shop-floor coaching is effective. In assembly, 14 % of the time the quality of coaching shows lack in the application of the method while 86 % of the time shows positive practices. In paint shop 14 % of the time the quality of shop-floor coaching shows a flawed approach in coaching while 86 % of the time shows the best application of the coaching language. In body shop, 71 % of the time the quality of shop-floor coaching shows lack in the application of the method while 29 % of the time shows positive practices.