“Developing a lean and green manufacturing plan for the newspaper printing industry - considering the Rising Sun Printers”

A dissertation submitted in partial fulfillment of the requirements for the degree of

MASTERS IN BUSINESS ADMINISTRATION Of RHODES UNIVERSITY

By

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ABSTRACT

This research is focused on lean and green manufacturing using a printing company in South Africa as a case study focusing on their printing division. The reason for addressing the printing division of the company was to develop a lean and green manufacturing plan to address the concerns of resource utilisation and waste disposal in the printing division. The research looked at the concept of lean and green individually as well as together and by analysing the relationship between the two concepts. The outcome was that environmental "green" waste is embedded in the seven types of lean waste which is overproduction, waiting, transport, inappropriate processing, unnecessary inventory, unnecessary motion and waste due to defects (Moreira, Alves and Sousa, 2010 cited in Pampanelli, Found and Bernardes, 2014). It was found that the company under consideration had not been familiar with these concepts but learnt and understood the value it could bring to the company. The research concludes with the plan using the 5S tool to reduce the seven types of waste linked to lean and green manufacturing.

DECLARATION

I, Avish Maharaj, hereby declare that this dissertation is my own work and that sources of information that have been utilized in this study were acknowledged. This dissertation has not been submitted for the purpose of assessment to any other university.

SIGNED BY:

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Avish Maharaj

DATE: 30 October 2015

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Chapter 1: Introduction

1.1 Background

This research will focus on lean and green manufacturing using a printing company in South Africa as a case study. The company being considered is the Rising Sun Printers which is situated in Durban, Kwa-Zulu-Natal and Johannesburg, Gauteng. Established in 1999, the company's focus is on cold set web printing which involves the printing of newspapers (Rising Sun, 2014). The company offers services such as printing, publishing and distribution (Rising Sun, 2014). For the purpose of this research this paper will be addressing the printing division of the company.

The reason for addressing the printing division of the company is to develop a lean and green manufacturing plan to address the concern of resource utilisation and how waste is disposed of in the printing division. The printing division of the company has the capacity to print 24 hours a day seven days a week (Rising Sun, 2014). There are five machines that are capable of printing up to 780 000 copies of newspapers at the rate of 32500 copies per hour for 24 hours (Rising Sun, 2014).

1.1.2 Scope

I. This dissertation aims to develop a lean and green manufacturing plan to utilise resources responsibly, reduce waste and environmental impacts within the printing division.
II. Lean and green in this dissertation is defined as reducing lean and environmental "green" waste and inefficiencies.
III. A short section on the drivers of sustainability will be presented.
IV. Data will be collected through interviews, non-participant observation and document analysis.

1.2 The concept

This research defines lean manufacturing as, an idea that has its main focus on delivering the highest quality product to customers on-time and at the lowest cost and green manufacturing as the focus on the environment and reduction of waste (Pampanelli, Found and Bernardes, 2013; Kumar and Kumar, 2015).

Research was conducted to analyse the relationship between the two concepts and the outcome was that environmental "green" waste is embedded in the seven types of lean waste which is overproduction, waiting, transport, inappropriate processing, unnecessary inventory, unnecessary motion and waste due to defects (Moreira *et al*, 2010). The study by Moreira *et al.* (2010) supports the idea that there is environmental impact reduction to a business when considering the seven types of lean waste (Pampanelli *et al*, 2014). This supports the claim that lean manufacturing improves a company's environmental performance because it focuses on eliminating non-value added activities (Yang, Modi and Hong, 2011). Value in this research is another key aspect and has been identified to be producing services or products that meet and exceed customer needs and expectations (Bodolay, 2010). In principle, it is something that the customer is willing to pay for. It becomes obvious that if a process does not create value it becomes a non-value added process, which means it adds cost or time therefore resulting in waste (Pampanelli *et al.* 2013). By the reduction of overproduction waste, waiting waste, transport waste, inappropriate processing waste, unnecessary inventory, unnecessary motion and waste due to defects, an organisation can expect environmental benefits such as less energy use and a reduction in solid and hazardous waste (Yang *et al.* 2011).

1.3 Aim of the research

The aim of this research is to understand the printing, processes and to develop a lean and green manufacturing plan to utilise resources responsibly, reduce waste and environmental impacts within the printing division (Yang *et al.*, 2011; McMahon 2011; Womack and Jones, 2003; Singhal, 2005).

1.4 Research objectives

The objectives are as follows:

I. Identify and describe the activities associated within the printing process.
II. Identify opportunities for lean and green practices to be implemented within the Rising Sun Printers manufacturing process.
III. Develop a lean and green manufacturing plan for the company under consideration.

This research paper will examine lean and green manufacturing by defining the concepts individually as well as together. The research goes onto showing the relationship between lean and green. By understanding the lean and green concept there were seven types of waste that was highlight by literature that needed to be explored. The need for them to be explored was to get an in-depth understanding of how to identify them in manufacturing. Understanding lean wastes lead to the relationship made between green. The relationship was that green waste is embedded in the seven types of lean waste. Therefore not only does lean help a company to become more efficient and effective economically and socially but also factors in identifying green waste which sees to the environment, this lead developing a lean and green manufacturing plan. The research uses an array of literature taken from several resources (e.g. Bergmiller, 2006; Bodolay, 2010; Engum 2009; Fabrizio and Tapping, 2006; Moreira *et al.,* 2010; Pampanelli *et al.,* 2013) to gain a holistic view of the research topic and to achieve the objectives set out. It was found that the company under consideration had not been familiar with these concepts but learnt and understood the value it could bring to the company. The research concludes with the plan using the 5S tool to reduce the seven types of waste linked to lean and green manufacturing.

Chapter 2: Literature review

2.1 Chapter overview

This section of the paper explores sustainability and the interaction between lean and green manufacturing. Two studies by Engum (2009) and Bodolay (2010) highlight the implementation and impact of lean and green manufacturing in a newspaper industry. This section of the paper focuses on developing a lean and green manufacturing plan to reduce the seven types of waste linked to lean and green manufacturing. By doing so in theory, the outcome is reduced energy consumption, minimizing the amount of waste produced during manufacturing and improved utilisation of resources therefore it could lead to financial cost saving and reduction of environment impacts. From this, we see that the three pillars of sustainability, social, economical and environmental are being adhered to (Pampanelli, Found and Bernardes, 2011).

2.2 Sustainability

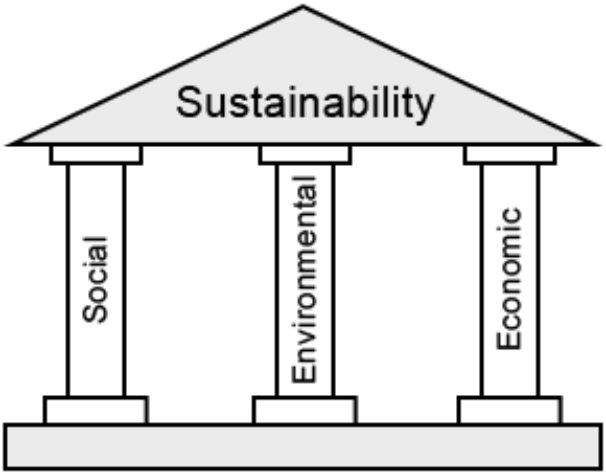


Figure 1: Three pillars of sustainability (source: Weybrecht, 2013)

According to Weybrecht (2013), the theme around sustainable development examines the balance and interaction between social equity, environmental protection and economic development as shown in figure 1. The term was first used by the Brundtland Commission and according to World Commission on Environment and Development (1987, cited in Fisch, 2014) sustainability is 'the ability to achieve simultaneous performance in environmental, social and economic dimensions in the present time, without compromising the ability to maintain this performance in the future'. What does it mean from a national or South African perspective? According to the National

Environmental Management Act (NEMA, act 107 of 1998), it explains that sustainability is the integration between the three dimensions of sustainability and the core managerial functions of planning, decision-making and implementation to make sure that the development will be beneficial for present and future generations (National Environmental Management Act, 1998).

The common thread lies in the three main components that make up sustainability, which are, the environment, the economy and social dimensions (Weybrecht, 2013). Firstly, environmental sustainability requires that natural capital remains intact meaning that wherever the resources are being sourced and disposed of, the area must not be degraded. Therefore, there must be a balance between how many natural resources are being extracted and the rate that they are renewed as well as the amount of waste being disposed (Gilbert, Stevenson, Girardet, and Stren 1996). Secondly, social sustainability, involves the society collaborating and working towards one common goal (Gilbert *et al.* 1996). The needs of people such as education, shelter, health care and culture should be met (Gilbert *et al.* 1996). Lastly economic sustainability is the dimension that looks at the financial feasibility of development (Gilbert *et al.* 1996).

The term sustainability in business has become a buzzword over the past decade, meaning corporates are using the word for enhancing their firm's image but it sometimes comes across as green washing to its consumers (Gordon, Carrigan & Hastings, 2011; Weybrecht, 2013). This must be corrected because sustainability in business according to Visser & Sunter (2002) is a new way of understanding business and its purpose, methods and impacts. Visser & Sunter (2002) state that if a company is able to adopt, adapt and understand the concept quickly and intelligently, there will be an opportunity for capturing new markets and profits to be made. For those companies that do not fully understand the concept of sustainability and what it stands for, it will become a threat to their corporate survival (Visser & Sunter, 2002).

The consensus view seems to be that from the definitions of sustainability, it is seen there is much focus on the well-being of present and future generations (Cohen and Robbins, 2011; Hart, 1997).

2.3 Sustainable manufacturing

This section of the literature explores what sustainable manufacturing is with regards to the lean and green manufacturing and the printing industry. It is important to understand what sustainable manufacturing is due to the nature of this research.

2.3.1 What is sustainable manufacturing?

Ferrer, (2008) looks at what sustainability means for an operations manager. He states that it is the mission of the operations manager to operationalise strategy for the company, (Ferrer, 2008). Therefore, the only way to achieve sustainability is through a continuous improvement philosophy with performance objectives, (Ferrer, 2008). In order to operationalise the three dimensions of sustainability, economy, society and the environment, the operations manager must combine the initiatives as one, into total quality of products and processes, environmental protection and total process safety (Ferrer, 2008).

On the other hand Wilkinson, Hill and Gollan (2001) state that sustainable manufacturing addresses two challengers: Firstly, the commercial pressures due to the environmental demands and secondly, internal pressures related to social sustainability that looks at minimizing the increasing staff turnover, declining staff loyalty and increasing work hours and stress levels (Wilkinson *et al.* 2001).

According to Gavronski (2012) there is a great impact that manufacturing has on the environment globally. In operations management, there is a lack of focus in the sustainability issues of it. Therefore, it is important to have a sustainable operations framework. According to Gavronski, (2012: 3) there are five dimensions that an operations manager can use to address sustainable manufacturing. They are: external context, competitive dimensions, strategic decisions, operations value chain activities, and organisational learning and knowledge.

Examining the dimensions by Gavronski (2012), there is an external context of sustainable operations that is defined as the forces acting externally to the firm which influence the decisions of operation managers (Gavronski, 2012: 3). These are divided into the following categories of sustainable operations strategies; they include

stakeholders, consumers, suppliers, investors, employees, governments, political groups, business associations, and communities **(**Gavronski, 2012).

Competitive dimensions in sustainable manufacturing, is simply the performance characteristics that customers or clients of the organisation rate the vendor, (Gavronski, 2012: 6). These performance measures should be a benchmark for the industry to follow and to compare themselves with their competitors. There are two performance characteristics by Gavronski (2012). They are: a) the dimensions of performance that should be within the operations function, and b) that should provide a competitive advantage to the company (Gavronski, 2012:6). When consumers are buying a particular product from a firm they take into consideration, the attribute of the product or production process that has been linked to sustainability, this characteristic is known as a competitive scale in operations. This dimension, in essence looks at the sustainable competitive advantage a process or product has, that is visible to its consumers and adds value to the product or process (Gavronski, 2012:6).

Strategic decisions in sustainable manufacturing, is defined as the standards the operations manager should encourage, in order to manage the performance objectives they have set for the competitive dimensions of operations (Gavronski, 2012: 9). In order to attain a competitive advantage, environmental competences in operations are put into the following groups: pollution controls and pollution prevention (Gavronski, 2012: 10). The pollution control technologies are focused at the treatment of waste and emissions from the production process and the pollution control technologies are those designed to treat waste and emissions from the production. Pollution prevention on the other hand is focused on avoiding the emissions and waste from the product altogether (Gavronski, 2012: 10).

Operations value chain is a set of activities, which entail fundamental activities in operations namely research, and development and distribution and services (De Toni, Filippini, & Forza, 1992). In order to understand the sustainability of the operations value chain, there needs to be an understanding of the social and environmental aspects of outsourcing or in-housing value chains, (Gavronski, 2012:11).

Lastly, organisational learning is defined as the know-how and information of an organisation, and knowledge, which is the ongoing learning of organisational

knowledge (Gavronski, 2012). According to Gavronski (2012), organisational learning determines the bond among sustainable practices with suppliers and performance, (Gavronski, 2012: 15).

In contrast, a paper by Kleindorfer, Singhal and Van Wassenhove (2005), shows dimensions in sustainable manufacturing that are vital to follow. If sustainable manufacturing is addressed in the proper manner, it may become a key competitive advantage in an organisation's production process. From this paper a discussion by Kleindorfer *et al.* (2005) highlighted ways of improving sustainable manufacturing.

According to Kleindorfer *et al.* (2005) sustainable manufacturing "is defined as the set of skills and concepts that allow companies to structure and manage their business processes to obtain competitive returns on its capital assets. This is without sacrificing the legitimate needs of internal and external stakeholders and impact of its operations on people and the environment." According to Kleindorfer *et al.* (2005: 485), sustainable manufacturing has three clear areas that integrate profit, people and planet, they are; green product and process development, lean and green operations management and lastly, remanufacturing and closed-loop supply chains.

The component of, lean and green operations management from Kleindorfer *et al.* (2005) will be explored individually as well as together. The reason for choosing to focus on this component is because the aim of this study is to explore the printing sector pertaining to inputs, processes and outputs and develop ways in which, to utilise resources responsibly, reduce waste and environmental impacts within the printing sector by introducing lean and green manufacturing (Yang *et al.* 2011; McMahon, 2011; Pampanelli *et al.*, 2013). Therefore it corresponds to the aims of this paper and due to the nature of a dissertation it will not be possible to focus on all components.

2.4 Lean and green manufacturing

In this section of the paper both lean and green manufacturing will be defined accordingly and discussed critically.

2.4.1 What is lean?

The concept of lean thinking comes from the Japanese word for continuous improvement "Kaizen" (Pampanelli *et al.* 2014). According to Pampanelli *et al.* (2014), the concept of lean manufacturing leads to higher production efficiencies and is the best way of running a manufacturing company. This concept is related to the Toyota Production System (TPS), which is a world-class example of lean manufacturing (Johansson and Sundin, 2014; Yang *et al.*, 2011) and it explains how Toyota was able to decrease waste and identify customer needs to create value within the firm (Bergmiller 2006; Engum, 2009).

Womack and Jones (1998 cited in Pampanelli *et al.* 2013) define lean according to five principles around value. There are specific values looking at the how the customer perceives value, identifying value streams and eliminating waste, making value flow, satisfying customer wants and pursuing perfection by continually finding ways to reduce waste in the production process (Womack and Jones, 1998). It is important to understand that one of the key factors in lean manufacturing is simplification (Pampanelli *et al.* 2013)

Leon and Farris (2011) define lean as "the cross-functional design practices (techniques and tools) that are governed by the philosophical underpinnings of lean thinking value, value stream, flow, pull, and perfection and can be used (but are not limited) to maximise value and eliminate waste in product development," this definition is the same as Womack and Jones (1998)

Yang *et al.* (2011) also mentions that lean manufacturing stems from TPS (Johansson and Sundin, 2014; Yang *et al.*, 2011) and the conception of the assembly line. According to Yang *et al.* (2011), lean manufacturing has its main focus on the elimination of waste (Pampanelli *et al.*, 2013; Kleindorfer *et al.*, 2005; Womack and Jones, 1998). Lean manufacturing is defined as a set of practices focused on the reduction of waste and non-value added activities from firms operations, (Yang *et al.*, 2011; Pampanelli *et al.*, 2013; Kleindorfer *et al.*, 2005; Womack and Jones, 1998; Leon and Farris, 2011).

The common body of knowledge that is discussed by these authors is all around reducing waste. They look at elimination of waste in areas of the production process

such as customer, product design, supplier networks, production flow, maintenance, engineering, quality assurance and factory management, (Engum, 2009; Cost & Rothenberg, 2004; Jasiulewicz-Kaczmarek, 2013; Johansson and Sundin, 2014; Pampanelli *et al.*, 2014; Yang *et al.*, 2011).

2.4.2 Waste

Why is it waste reduction that we are dealing with? Bergmiller (2006) states that companies that strive to be lean, need to forget about competitors and compete against perfection, through detecting all activities that are waste and eliminating them (Bergmiller, 2006). Waste in lean manufacturing can be defined as the elimination of non-value-added activities, which are all activities that do not directly increase the value of a service or product (Porter and van der Linde, 1998; Hart, 1997; Cobert and Klassen, 2006; Pampanelli *et al.*, 2014). Value in lean manufacturing is defined as producing services or products that meet and exceed customer needs and expectations (Bodolay, 2010). There are seven types of waste that need to be detected; waste of overproduction, waste of waiting, waste of transport, waste from inappropriate processing, waste due to unnecessary inventory, waste due to unnecessary motion; and waste due to defects and this is joint understanding between the following authors (Bergmiller, 2006; Bodolay, 2010; Engum, 2009; Jasiulewicz-Kaczmarek, 2013; Johansson and Sundin, 2014; Pampanelli *et al.*, 2014).

2.4.3 What is Green?

Green and sustainability are both taken as been doing things that are environmentally friendly. As discussed, a sustainable method of completing tasks is by doing it with aspects on the economic side, the social side and the environmental side (Elkington, 1996).

Green manufacturing has its main focus on the environment and reduction of waste elimination (Atlas and Florida, 1997; Pampanelli *et al.*, 2014; Jasiulewicz-Kaczmarek, 2013; Yang *et al.*, 2011). It looks at the amount of natural resources used and how it is being disposed of to eliminate the possibilities of air, water or land pollution as well as the harm it causes to human health (Pampanelli *et al.* 2013). The objective of green manufacturing is to reduce energy consumption by introducing new technology,

transform pollutants and waste to create byproducts and introduce systems to maximise production with minimum waste (Pal, 2002).

Manufacturers should take advantage of the fact that they are practicing in a time where they can be part of an environmental solution rather than a problem (Bergmiller, 2006). By adopting cleaner processes and being resourceful with water and energy consumption will benefit the manufacturers and it makes good business sense. What this means for business is that by the reduction of waste there is a cost saving component and it lowers the risk of doing business.

It is important to note that green manufacturing must be merged with existing business processes but it must not change the process severely meaning it should not affect the outcome of production (Johansson and Sundin, 2014). Green waste occurs when consumers use and dispose products, and also when company's dispose of their used unnecessary resources (Pampanelli *et al.* 2014).

2.5 Lean and green manufacturing

A small number of scholarly studies have investigated the relationship between lean and green manufacturing (Florida, 1996; King and Lenox, 2001; Moreira *et al.*, 2010; Rothenberg, Pil, and Maxwell 2001). These studies show that there is a positive relation between lean and green manufacturing. The study by Rothenberg *et al.* (2001), is an example of how non-lean companies have no control over waste issues where as lean companies have a better understanding of environmental performance and embrace environmental waste minimisation (Bergmiller, 2006). In the study by Florida (1996) the common best practices between lean and green management systems where identified; examples of these systems are new process technology, teams and innovative product design.

The lean and green concept measure companies' processes and helps add value by making an overall evaluation of the company's practices (Kleindorfer *et al.* 2005). However, the findings by King and Lenox (2001) and Rothenberg *et al.* (2001) was that there is a link between lean manufacturing and green manufacturing however harvesting the interaction of the two is not simple. Numerous authors have written about

whether the lean and green concept is evident in practice, the benefits and how it is achieved and they are discussed below, (Kleindorfer *et al.* 2005).

Yang *et al.* (2011) states that both lean and green operations has its main focus on reducing waste and inefficiencies therefore this agrees with the view of Kleindorfer *et al.* (2005). Green operations with regard to improving environmental and social performance is said to undermine the economic sustainability of a company and that it is not cost effective (Florida, 1996). In contrary many authors have shown that by increasing environmental performance there has been significant increases in company revenue (Porte and van der Linde, 1995, Hart, 1995, Cobert and Klassen, 2006; Pampanelli *et al.,* 2013). According to Pampanelli *et al.* (2013) if the amount of waste is minimised, energy consumption is reduced and efficient use of recourses can result in financial cost saving and the final outcome may also be the protection and enhancement of the environment. Therefore this statement shows that by using lean and green manufacturing for waste elimination it will have potential benefits for social, environmental and economic sustainability (Pampanelli *et al.* 2013).

Research was conducted to analyse the relationship between the lean and green concept and the outcome was that environmental "green" waste is embedded in the seven types of lean waste mentioned above (Moreira *et al.* 2010). The study by Moreira *et al.* (2010) supports the idea that there is environmental impact reduction to a business when considering the seven types of lean waste (Pampanelli *et al.* 2014). Meaning lean manufacturing improves a company's environmental "green" performance because it focuses on eliminating non-value added activities (Yang *et al.,* 2011; Wikoff, 2009). By the reducing of overproduction, waiting, transport, inappropriate processing, unnecessary inventory, unnecessary motion and waste due to defects, it will lead to environmental "green" benefits such as less energy use and a reduction in solid and hazardous waste will be gained (Florida, 1996; King and Lenox, 2001; Moreira *et al.*, 2010 ; Rothenberg *et al.* 2001; Yang *et al.*, 2011).

2.5.1 Identifying the seven types of waste

This section will now pay further attention to explaining what waste is and describing the sevens types of waste. What is waste? As discussed in this research waste can be

defined as the elimination of non-value-added activities, which are all activities that do not directly increase the value of a service or product (Porter and van der Linde, 1998; Hart, 1997; Pampanelli *et al.*, 2014). So in essence waste can take form in the unnecessary processes in manufacturing, materials, machinery, labour hours and anything thing that does not create value.

2.5.1.1 Overproduction waste

This is the greatest type of waste according to Bergmiller (2006). It is simply when output goes beyond the amount required by the customer or faster than required (Bergmiller, 2006; Yang *et al.*, 2011). It is a concern because it becomes scrap and unwanted meaning it leads to becoming solid waste and could be additional hazardous waste (Bergmiller, 2006). Domingo (2003) states that the cause for over-production could be due to poor production planning and scheduling or high capacity machinery, etc. which leads to excess inventory as shown in figure 2.

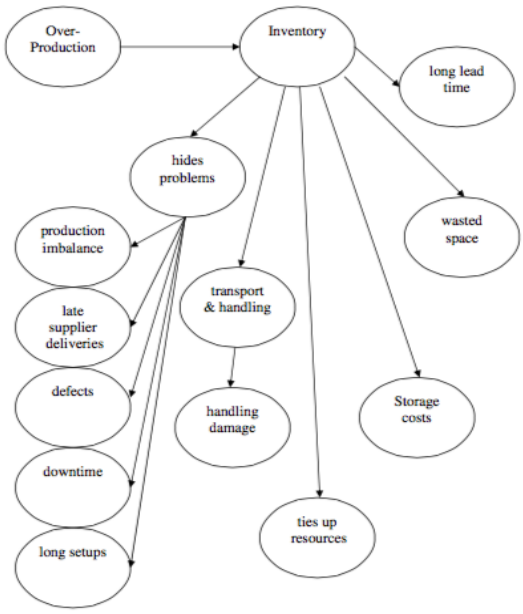


Figure 2: Over-Production Generates All Other Lean Wastes (source: Bergmiller, 2006)

The excess inventory has to be transported therefore it requires excess motion. This requires an increase amount of energy use then it leads to higher generation of green-house gases (Bergmiller, 2006). To address this type waste the just-in-time (JIT) system may be used. JIT is a system used that allows goods to move via a system as soon as

they are required. It was initially only used for production but now it has been integrated to lean operations (Pampanelli *et al.* 2011). The objective of JIT is to eliminate disruption, be flexible and eliminate waste such as excess inventory. This system allows a company to carry less stock therefore not tying up financial capital (Pampanelli *et al.* 2011).

2.5.1.2 Waiting waste

This is a common occurrence when there is no balance between the processes (Bergmiller, 2006). An example is if the operation managers are waiting for the preceding process to deliver materials, they are not producing value (Bergmiller, 2006). Meaning there is downtime on machines hence no value is created. The machines will be running, waiting on preceding processes hence it may be using energy, water and could generate hazardous and green house emissions (Bergmiller, 2006). This type of waste is caused because of shortages with the labour force or materials, unsynchronised schedules for machine downtime, over staffing with no controlled management of staff (Domingo, 2008). Therefore all processes that lead to the final product must work congruently for effective production.

2.5.1.3 Transport and handling waste

Transportation and handling waste: for a company to be lean it is ideal for all its processes and manufacturing processes to be in close proximity (Bergmiller, 2006). Transportation is in forms of conveyor systems, forklifts, pallet jacks or vehicles (Yang *et al.* 2011). Transport is inefficient because it is non-value added (Bergmiller, 2006) meaning there is just additional cost involved with transporting products between processes. This could lead to damaged products, injuries; increase use of energy and green house emissions (Bergmiller, 2006). Examples of this can be transporting the incorrect parts, sending the wrong types of raw materials and not sending the correct documents, etc. (Domingo, 2003). With regards to this research transportation will be defined as the handling of products between processes within the printing sector. The idea here is to move departments that need one another in close proximity for example, raw material and tools department may be relocated closer to the factory for ease of use (Domingo, 2003).

2.5.1.4 Defect waste

These are items that do not meet the customer's standard or specified requirements; therefore it will require reworking (Bergmiller, 2006). The defects will then cause additional waste in production times, causing delays excess resources and labour being used and added power consumption (Bergmiller, 2006). Defect waste happens mainly because of lack of control in processes, imprecise customer requirements, an unskilled labour force and inconsistent quality control (Domingo, 2003). There must be consistent quality controls set in stone from start to ensure the task being done is done right. If quality becomes an ongoing problem from a company it tends to damage the company image and creates additional costs. To ensure customer satisfaction and reduce defect waste continuous quality control measures must be adhered to (Domingo, 2003). If the product becomes scrapped completely it turns out to be solid waste, which may be hazardous waste (Bergmiller, 2006).

2.5.1.5 Processing waste

Sometimes the operation manager may derive a system that he/she thinks will work better to produce a product for the customer however it may lead to defects. This is due to unclear requirements by the customer, work instructions or too many adjustments being made to quality control. The idea is to reduce this type of waste and remove all complex systems, replace them with simply to use efficient systems and keep to the customers' requirements (Bergmiller, 2006 ;Yang *et al.,* 2011). To help prevent this case one must be able to identify value-adding activities and eliminate the non-value adding activities, this can be achieved through value stream mapping. Value stream mapping is used to show the flow and integration between processes and how raw materials are utilised in the production process (Bodolay, 2010).

2.5.1.6 Inventory waste

Is having more than minimum stock that is required (Bergmiller, 2006). Bergmiller (2006) made an analogy to describe inventory waste in lean and green manufacturing as shown in figure 3. He compares inventory to water, in this analogy water/inventory

hides, like rocks under the water, manufacturing problems such as machine breakdowns, over-production, high rework rate, imbalances production line or lack of planning. With regard to this hiding, the problems will just lead to more issues and making it a lot harder to find the root cause (Bergmiller, 2006). Therefore the solution is to have a continuous flow to customers so no products sit on the factory floor. If inventory is idle it leads to wasted resources through costs of storage and maintenance (Bergmiller, 2006).

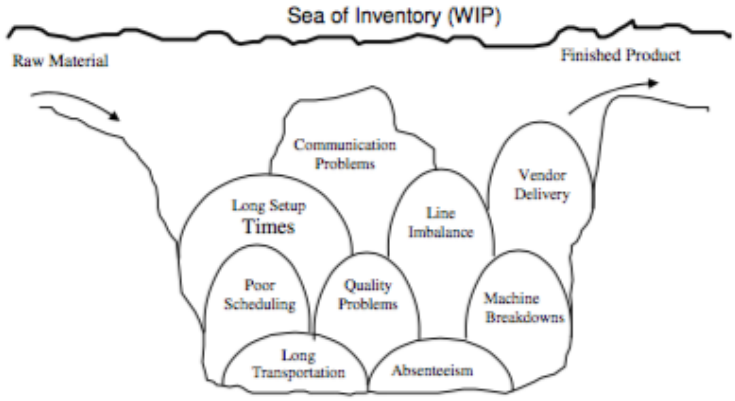


Figure 3: Analogy of inventory to water (source: Bergmiller, 2006)

2.5.1.7 Motion waste

In lean terms it is any unnecessary human movement (Bergmiller, 2006). The reason, behind this waste is due to an unconstructive layout and housekeeping, imprecise work instructions and a disorganised and cluttered workplace (Domingo, 2003). Motion is linked to the structure of the workplace i.e. ergonomics and is seen in all instances of bending, stretching, walking, lifting, and reaching (Yang *et al.* 2011). Meaning if there is poor ergonomics within the workplace it may lead to injury, fatigue, illness and could increase the amount of defect products and (Bergmiller, 2006). The solution needed in this regard is to have a formal layout of the workflow process to guide the employee towards reaching targets and objectives in a skillful manner (Domingo, 2003).

2.6 The newspaper industry

Whilst conducting the research on lean and green manufacturing, there are two studies by Engum (2009) and Bodolay (2010) that highlighted the implementation and impact of lean and green manufacturing.

2.6.1 Implementing lean manufacturing into a newspaper manufacturing business

This paper addresses the concept of lean manufacturing in the printing industry, which includes waste elimination, whilst increasing profits and reducing cost.

As we have learnt above the seven types of waste in lean manufacturing also incorporates a green manufacturing (Yang *et al.* 2011). The implementation of lean manufacturing printing in companies has an array of opportunities attached to it for example, saving time, lowers overall cost, reduce inventory, increased innovations and most important sustainability (Profectus, 2008 cited in Engum, 2009). Through lean manufacturing large organisations and printers have seen increased performance with regards to reduction of waste, etc. within their organisations (Cost & Rothenberg, 2004; Cooper, Keith, & Macro, 2007).

The reason this study was conducted was to identify the general knowledge of lean manufacturing within the newspaper industry and areas where newspaper printers can reduce or eliminate waste by implementing the principles of lean manufacturing. Lastly, explore the best approaches for implementation of lean manufacturing principles at a newspaper printer.

The methodology used in this research was qualitative, to get a better understanding of the process of lean implementation in newspaper printers, (Engum, 2009:29). Qualitative data collection was appropriate in this instance seeing that it was dealing with lean manufacturing, (Engum, 2009:29).

This study was able to analyse the common literature of lean manufacturing, in the newspaper printing industry. It outlines the most important aspects of the critical concepts of lean manufacturing principles, that helps increase profit margins and transformation companies to make use of their resources more efficiently, (Engum, 2009:100).

In this industry, the focus must be on utilization, (Engum, 2009:100). When lean manufacturing is adopted within a firm, it enables the strengthening of competitiveness (Engum, 2009). This concept needs to be weaved into the company's core strategy and training needs must be enforced, for optimal competitive advantage, (Engum,

2009:101). With this, newspaper printers will reduce changeovers, allowing them more time for planned maintenance, resulting in fewer breakdowns, (Engum, 2009:101). Therefore, there will be increase-starting times after web breaks and in essence increase delivery times.

When a printing company can operate using their resources skillfully they will be able to do more at an efficient rate, (Engum, 2009:101). By enforcing this concept of lean and green manufacturing and increase productivity, the overall culture will be improved, therefore results in successful implementation if change management and culture empowerment, (Engum, 2009:101; Yang *et al.* 2011).

In the study Engum (2009) mentions, another benefit of newspaper printers applying lean manufacturing is waste reduction, (Engum, 2009:90). This is mainly in the areas of paper waste, change over times, wasted labour resources and downtime, (Engum, 2009:90). This then relates to literature on lean and green manufacturing, seeing that waste of inappropriate processing, motion and time was adhered to (Bergmiller, 2006; Bodolay, 2010; Engum, 2009; Jasiulewicz-Kaczmarek, 2013; Johansson and Sundin, 2014; Pampanelli *et al.,* 2014).

2.6.2 Impact of lean practices on printing companies

This paper entails the discussion of understanding lean management and sustainable practices within the printing industry and the reason for them being popular and efficient, (Bodolay, 2010:1). These two aspects are a focus in industry due to its ways of managing resources skillfully, (Bodolay, 2010:1). They both have the same end goal as lean and green manufacturing (Yang *et al.* 2011) and that is to minimise the effects of waste, while being highly productive in the printing process.

The study refers to lean management as, all that takes part in the company that conforms productivity and energy, (Bodolay, 2010). Lean focuses on the company's products and services. The sustainable practices are what businesses want to buy into, seeing that consumers are becoming more familiar with the importance of it on a regular basis. "This environmental movement was first popular in the 1970's and is now gaining recognition once again," (Kessler, 1999).

The purpose of this paper was to answer the question, "what lean and sustainable methods are most productive in making a printing company run to its highest efficiency," (Bodolay, 2010:2). Looking at what lean tools could be used.

2.6.2.1 Lean tools

Research conducted by Domingo (2003) explains in five steps how waste can be effectively eliminated. Step 1: make waste visible, step 2: be conscious of the waste, step 3: be accountable for the waste step 4: measure the waste and eliminate and lastly step 5: reduce the waste.

Which means, before developing ways to eliminate waste, one must be able to see it, understand what kind of waste it is, pinpoint the activity responsible and lastly measure the waste, if it is not measure one will not be able to find enough ground to be motivated to stop it (Domingo, 2003).

This method of waste elimination is just an overview on how waste can be eliminated however a more theoretical manner to do this is by using tools in lean manufacturing (Bodolay, 2010). There are a number of lean tools for example (JIT) Just in time and inventory, kaizen, value stream mapping, Total productive maintenance (TPM) and 5S tool (Bodolay, 2010).

2.6.2.1.1 JIT and inventory

JIT is a system used that allows goods to move via a system as soon as they are required. It was initially only used for production but now it has been integrated to lean operations (Bodolay, 2010). The objective of JIT is to eliminate disruption, be flexible and eliminate waste such was excess inventory. This system allows a company to carry less stock therefore not tying up financial capital (Bodolay, 2010).

2.6.2.1.2 Kaizen

Kaizen is a Japanese word for continuous improvement, (Pampanelli *et al.* 2011: 7). It focuses on developing a problem solving culture and people involvement (Pampanelli *et al.* 2011: 7). One of the basis for a plant to become lean is focusing on the element of kaizen. In kaizen events, there are teams allocated to identify problems causing waste and create ways in which it may be avoided. If kaizen methods are well performed it

will assist in have less quality issues, improve performance consistency and improve safety in the workplace

2.6.2.1.3 Value stream mapping

This principle consists of all the activities linked to getting the product out for the customer. Relating it to the printing an example of this can be the time a plate sits before it gets onto the press. By mapping activities the observation of waste will become easier to see over the entire operation therefore it allows for improvement (Bodolay, 2010).

2.6.2.1.4 Total productive maintenance (TPM)

This tool strives to achieve the least amount of machine downtime and makes maintenance a part of everyone's job at the company (Bodolay, 2010). If this tool is well organised it will be beneficial to the company because it will be possible to plan the number of breakdowns by assessing a daily report on downtime and the causes for it (Bodolay, 2010). A cross-functional effort is required by the TPM and it gives a great responsible to machine operators, (Bodolay, 2010).

2.6.2.1.5 5S tool

This study made use of the 5S tool. The reason for using the 5S tool was to create a visual workplace where all that is needed in the manufacturing process is easily identified, therefore reducing the risk of poor product quality, unnecessary use of resources and waste. The 5S's are namely sort, set in order, shine, standardize, and sustain. With these in practice an idea is brought about that there is a specific place for everything and ways it could be efficiently utilized, (Bodolay, 2010). This approach also helps with the dealing of risks such as operator fatigue that may result in quality issues or raw material wastage, (Bodolay, 2010:5). According to Engum (2009) this tool is a good starting point for elimination of the seven wastes. For a lean organisation 5S is vital because it deals with continuous improvements, reduction of costs and safety in workplace (Engum, 2009).

Another lean key factor is that it makes use of sustainable resources in the printing process. A big issue in a print company is the waste of paper, (Bodolay, 2010:7). "Paper can either be virgin pulp or recycled," (Bodolay, 2010:7). Virgin pulp meaning it comes directly from a tree and affects the natural environment all the time and has a high-

energy cost attached to it, (Bodolay, 2010:7). Or it may use recycled paper which saves water, electricity and energy, (Bodolay, 2010:8).

There are also a number of efforts that can be adopted to reduce the effects that chemicals have to the environment internally and externally, (Bodolay, 2010). The chemicals that are inks, press chemicals, and fountain solutions, and plate burning processes, however when used are in printing production process they are seen to be volatile organic compounds, (VOCs), (Bodolay, 2010:8). This means that they are harmful to the atmosphere and have been proven to be a health hazard as well, (Bodolay, 2010:8).

The method that was used to research this paper was qualitative, with use of case studies, surveys, trend analysis, documentary analysis and developmental studies, (Bodolay, 2010:13).

The analysis of the survey results showed that lean management needs to be coordinated full time to add value to the company.

The conclusion from the research shows that there is a positive outcome on lean management and sustainable operations, (Bodolay, 2010:27). It allows a firm to become more flexible and make efficient use of their resources as well as their machinery. It reduces overheads, therefore increases the competitive advantage the firm has in the market, (Bodolay, 2010:30). There needs to be a drive from management among the entire operation in order for these two concepts to be successful.

The two studies by Bodolay (2010) and Engum (2009) define lean and green operations as elimination of non-value-added activities, which are all activities that do not directly increase the value of a service or product, the same way as it has been discussed by (Porter and van der Linde, 1995, Hart, 1995, Cobert and Klassen, 2006; Pampanelli *et al.*, 2013). Lean is seen as a way of reducing time of producing products and implementing ways of increase operational efficiencies. According to George (2002 cited in Bodolay, 2010), the focus of lean is doing the right things, at the right place and the right time at every stage of production. At the center of lean and green manufacturing is the elimination of any type of waste; this can be done by, turning any waste into value for a company, (Womack & Jones, 2003).

2.7 Conclusion

The aim of this research is to understand the printing, processes and to develop a lean and green manufacturing plan. Therefore lean and green manufacturing has been chosen to be the focus of this paper. In order for a company to implement lean and green manufacturing it is of vital importance that managers must be involved and move away from the traditional top down approach of making all the decisions, to managers allowing information to come from all directions (Bodolay, 2010). It is important for managers to empower employees and work towards a common purpose (Bodolay, 2010).

It is clear that there is a relation between lean and green manufacturing (Florida, 1996; King, Lenox, 2001; Moreira *et al.*, 2010; Rothenberg *et al.*, 2001). The common thread found from all the literature being discussed is the focus on, waste elimination. There is the traditional approach to waste reduction which is reducing inputs and managing outputs and the lean approach to waste reduction and becoming green, is reducing overproduction, waiting, transport, inappropriate processing, unnecessary inventory, unnecessary motion and waste due to defects (Cooper, Keith, & Macro, 2007; Bodolay, 2010).

Chapter 3: Methodology

The research methodology aids in addressing the main objectives of this dissertation, which is to:

I. Identify and describe the activities associated within the printing process.
II. Identify opportunities for lean and green practices to be implemented within the Rising Sun Printers manufacturing process.
III. Develop a lean and green manufacturing plan for the company under consideration.

This section of the paper will discuss the research strategy, data collection methods and data analysis.

3.1 Research approach

This section defines the research approach

3.1.1 Qualitative research

Engum, (2009) and Yang *et al.* (2011) suggest qualitative data collection is appropriate in this instance seeing that this research is dealing with lean and green manufacturing. Hence methodology utilised for this research will be qualitative rather than quantitative to become more experienced with the lean and green concepts. Qualitative research is also preferred because quantitative research focuses on measurements and quantities and the answer 'how', where as former answers 'why' (Pezic, 2012).

Qualitative research is "development of *concepts* which help us to understand social phenomena in natural (rather than experimental) settings, giving due emphasis to the meanings, experiences and views of the participants" (Nigatu, 2009). Qualitative data works within a social context and is related to opinions, values and behaviours of people (Nigatu, 2009). Types of qualitative include structured and unstructured interviews, focus groups, analysis of documents and audio and video recordings (Nigatu, 2009).

3.2 Data Collection

The method chosen for gathering data for this particular research will be through interviews, visual observation, and documentary analysis.

Interviews require asking an array of questions and recording or listening to answers from the interviewee or group and it may be semi-structured or in-depth depending (Nigatu, 2009). This depends on what sort of information is required from the research paper (Nigatu, 2009). With regard to visual observation, the researcher may or may not participate in the study but gets as close as possible (Nigatu, 2009). This is so that he/she can understand for themselves what people actually do and whether they really do it (Nigatu, 2009). Documents that were analysed were internal and came from the firm under consideration and for ethical considerations they are not attached to the research.

3.2.1 Interviews and Observations (Appendix 1)

This research focused on obtaining data through interviews with the general manager of the Rising Sun Printers and staff, and non-participant observations. An in-depth interview was conducted with the general manager to get a thorough understanding of what the processes are and how the company works. Semi-structured interviews were used to interview the staff, seeing that it allowed the interviewer to perform the interview with planned questions while giving the interviewee room to add other information they find appropriate that the interviewer may not have incorporated (Harrell and Bradley, 2009). This data collection method was used because it is flexible in terms of obtaining information from the interviewee hence it assisted in gaining a thorough understanding of the activities associated with the printing process, challenges and opportunities relating it to a lean and green manufacturing. Non-participant observation was used to gather information on how processes flow within the printing division to measure waste of waiting and transport.

3.2.2 Population and Sampling

This research will be analysing documents such as, production records to monitor overproduction and inventory schedules, relevant to the Rising Sun Printers, printing division.

The company under consideration has a labour force is twenty-five employees. Due to the firm having a limited amount of employees, three senior members and five

employees of the Rising Sun Printers were interviewed for a more in-depth understanding of the activities associated with the printing process, challenges and opportunities relating to introducing a lean and green manufacturing plan.

3.3 Data Analysis

Qualitative data analysis is transforming the qualitative data that has been collected through a series of processes into some form of interpretation or understanding of data being researched (Nigatu, 2009).

The results from the interviews were used to understand the current manufacturing environment and the activities involved in the printing process. Documentation analysis offered insight on the process and wastage. Data results from documents contributed to the development of the lean and green manufacturing plan, which made use of the 5S tool. Results from observations helped in gaining an understanding of how processes flow and what issues arise in-between processes.

3..3.1 Using the 5S tool

This paper made use of the 5S tool to create the lean and green manufacturing plan. The 5S tool begins each step with improvement. It focuses on creating a harmonious work environment that is well organised, clean, highly effective and efficient (Maharjn: 2011). The 5S's are: sort, set in order, shine, standardize, and sustain. Sort assists with process improvements and organising cluttered workspaces (Michalska and Szewieczek: 2007). Set looks more at the efficiency and effectiveness of safety process improvements (Michalska and Szewieczek: 2007). Shine helps increase the machine efficiency and improves the work environment (Michalska and Szewieczek: 2007). Standardise aids in creating procedures to reduce the amount of industry pollution and systems (Michalska and Szewieczek: 2007). Lastly sustain, assists with increasing the awareness and morale in the company (Michalska and Szewieczek: 2007). From the brief overview of the 5S tool it is clear to see that this lean tool takes into consideration not only economic and social sustainability of a company but also the environmental aspects to, by looking at reducing harm to the internal and external environment of a company. The company under consideration has no understanding about lean and green manufacturing. Therefore the reason for using the 5S tool in this paper is because it is one of the first steps a company can take to bringing about a lean and green culture

(Maharjn: 2011). It also helps identify the seven types of waste, processes and systems that take up time and add no value to the company (Maharjn: 2011). This coincides with the definition of lean and green manufacturing established in this research of, lean manufacturing improving a company's environmental "green" performance because it focuses on eliminating non-value added activities (Yang *et al.*, 2011; Wikoff, 2009).

3.4 Conclusion

This chapter explained the methods used to the information required for the research defined in chapter two. It goes one to explain the research approach and the reasoning behind using the 5S tool for the lean and green manufacturing plan. Data collection steps were explained in detail was summarised and will be described in detail in chapter four.

Chapter 4: Findings and Discussion

4.1 Introduction

This chapter will present the findings and discussion from the data obtained from documents, observations and the semi-structured interviews conducted. The first part of this chapter simply reports on the findings. The second part of this chapter deals with linking the results from the findings with literature.

4.2 Findings: The printing process

The results in this section are examined in the discussion.

4.2.1 Document analysis

Through document analysis and non-participant observation the findings are as follows: the Rising Sun Printers are equipped with state of the art pre-press equipment. The company makes use of four Computer to Plate Machines (CTP) in their operation. It has a total of five printing machines that are all functional and purpose built for the printing of newspapers. All the printing machines have the capacity to print between a 4 to 24 pager, in one run, at a maximum speed of 35,000 copies per hour. The number of copies that can be printed within 24 hours at an average speed of 32 500 copies per hour is 780 000 copies on each machine provided that there is continuous printing. The inking systems for the machines are housed in flow bins, which are then pumped directly into the ink ducts of the printing machines. The conveyor allows for the printed copies to be moved to automatic stackers where the copies are stacked into neat bundles according to customer specifications. Each printing press is equipped with a shrink-wrap tunnel as well; this is to package the bundles of paper neatly.

4.2.2 Interviews

From the interviews pertaining to this research the following information surfaced. This section presents the gathered data during the conducted interviews.

4.2.2.1 General manager

The results from the interview with the general manager show the following, in terms of the organisational structure of the Rising Sun Printers is made up of the following

people: Vijay Maharaj, the sole member of the company. His approach to the business is hands on and he plays an active role in the day-to-day functioning of the business.

Beverley Naidoo, is the general manager of the company. Her tasks among others include scheduling of print work for day and night shift. She oversees each department and ensures that they are operating efficiently.

Mannie Moodley, is the pre-press manager. He manages an important step of the printing process and is responsible for taking an image, created either by a client or graphic designer, and preparing it electronically to run on the press. He also interacts with customers; making sure the page layout is correct before they go to the press.

Factory managers are Keith Govender and Elvis Moodley. They monitor the stock of materials such as paper, ink, and metal in order to maintain supplies. They are tasked to make certain that the print quality is to perfection and staff is taking the necessary steps to ensure optimum customer satisfaction when printing every job. They coordinate printing activities of the workers who set up, clean, and feed machines. They are also tasked to examine job orders to determine details such as quantities to be printed, production times, stock specifications, colours, and colour sequences.

Electrical and mechanical engineer is Ali Khan he is responsible for making certain that all machinery and equipment operates efficiently by performing maintenance daily, weekly, monthly and an annual service to all machinery and equipment. He is on call 24 hours a day for electrical, mechanical and technical support.

According to the general manager, the printing process involves checking of pages. This process requires that the client sends through their pages via the drop box or emails them in an Adobe format. The pages are then checked by the computer to plate technician to ensure that the colour is correct, the size of each page is according to the specifications and that all content is clear. The computer to plate technician then reports back to the client explaining if there are any errors with regards to their layout so that it can be corrected. Once corrections are made the client then sends through an email stating that the computer to plate technician can go ahead with sending through the pages through the computer to plate machine (CTP). The computer to plate technician then inserts the plates into the computer to plate machine, and through advanced

technology the images of the newspaper get imprinted on the plates. After the plates come of the processor, the plates need to be punched on the plate punch and bent on the plate bender. The plates will have to be arranged to go onto the different towers according to pagination and the colour for the printing press. Once that is complete the towers are all set up, the printing press is ready to print.

Once the lean and green manufacturing concept was explained to the general manager, the importance of it with regards to ease of practice and waste reduction was understood. The general manager explained that the major bottlenecks in newspaper production come from meeting deadlines and staff not cooperating. She went on to explain there is no need for large amounts of inventory to be stored because there is an adequate supply of paper from the suppliers and they work around the first in first out method. The first-in, first-out method is simply a system used by businesses to monitor inventory. This method monitors that inventory that comes into the company first must be used first (Pampanelli *et al.* 2011). Quality control is maintained by the floor managers and printing operators. With regard to the health and safety of the employees, all the employees are given a package with the necessary safety gear and the floor managers on a day-to-day basis check this. The lack of staff loyalty and staff cooperation is a challenge that needs to be solved.

Employees are continuously motivated to reduce the waste of paper, ink and other consumables. Employees are rewarded with incentives on a monthly basis, which motivates them to reduce waste. The wastage target is set at 5% or less per month. Employees are given incentives on three of the most frequently printed jobs.

4.2.2.2 Employees

The results from the interviews with the employees were combined and show they following: The time taken to set up the machine before printing a job depends on the pagination of the print publication. The smaller the pagination, the lesser time it takes to set up the machine. Setting up the machine is done by filling the inks into the ink ducts and plating up by getting the plates ready for the job. The time taken to prepare the machine is anything between 15 minutes to half an hour. All employees should be hands on and fully cooperating in the work that needs to be done. Inkers and reel stand operators should be able to assist on the press since there may be web breaks, wraps,

jamming on units and rollers, folder jams etc. therefore employees need to be multi-skilled.

According to the employees, preceding processes do have set backs. Sometimes there can be a delay in the client's confirmation to go ahead in the printing of a job. Every print job that is received goes through a checking and refining process, during that process they identify if there are any discrepancies in the artwork, and advise the client to make the necessary changes. At times, the amendment to the artwork is prolonged and could result in a delay.

To maintain a successive result in printing the ink keys should be preset before the job, water and ink controls to be preset, quick setting of ink colours should minimise waste. Also basic maintenance should be carried out such as checking of rollers, cleaning, and wear and tear on rollers and bearings, which causes little or no contact on rollers transferring ink and water. Reel stands to be serviced and cleaned daily. Sensors need to be wiped on a daily basis. Washing and reporting of damaged blankets are of utmost importance.

Materials needed in the factory are all in close proximity; inks are delivered via an ink pump system to the units/ towers. By having all products in close proximity it avoids delays in production and there is ease of access for efficient productivity.

The minimum amount of over production / waste should be 400 to 800 copies per job, maximum a 1000 copies. All the print jobs must meet the customer's requirements be it quality or deadlines. The employees say that there is room for improving the work environment with regard to cleanliness, staff especially in the factory should be more careful when using tools and equipment, they must make sure they leave it in the designated places once used. Monitoring employees to follow instructions could be improved so that there is more cohesiveness between the employees.

4.2.2.3 Machine operators

The machine operators where asked an array of questions to acquire a better in-depth understanding of what happens in the process of newspaper printing. According to the machine operators, the activities associated within the printing process are as follows; once the plates come of the processor they are punched then go onto the bender. Plates

need to, then be arranged per colour as follows: cyan, magenta, yellow and black. If plates are mixed up the job will not print the correct colours. Once all plates are on and the paper is fed through the machine the printing may commence.

To achieve a high quality of printing a time cannot be given seeing that every job is different and tailored accordingly. However, on average it takes between 800-1000 copies to get the perfect quality out.

The necessary precaution required by the employees working with the machine is that every employee needs to understand what a stop button is and what it's used for. There are two types of stop buttons on the machine one is global stop and one is safe stop. Safe stop is for sections of the machine, to stop and global stop is for the entire press to shut down. Employees should not tamper with electrical components of the machine. Employees need to be alert for buzzer sounds. No loose clothing and headphones near the machine and playing around with cellphones is not allowed. Machine operators need to be vigilant in checking that the machine workers are all wearing there necessary safety gear "safety boots, ear plugs, dust masks, gloves for chemicals" and that they are all within reasonable distance from the machine during the process.

To reduce over production the machine operators have noticed that getting the inking correct in the process is a determining factor. Machine inkers need to be taught and clued up with all the necessary skills required to keep the inking at a set standard. They need to know, what pages they working with, how much ink to put, and what towers they are working with. Ink and water control is a major issue and needs to be addressed with importance, meaning if the water is to high you are going to waste the ink and if the ink is too high you going to run up your water. If not controlled the outcome will be an over inked and watered product.

The machine operators feel that the preceding process of printing plate development affects their time in production. From the interviews they explain that they have the machine set and they wait for production of printing plates. Time is wasted therefore delays are caused. On the other hand unskilled employees working on the printing machine also results in set backs, due to the unskilled employees not having the knowledge to set up the machine for printing.

4.2.3 Observations

Non-participant observation was used to gather information on how processes flow within the printing division to measure waste of waiting and transport. The Ergonomics how people move between processes was monitored and any unnecessary movement of goods etc.

In the office there was a lot of movement between the employees offices. Walking to the printing and fax machine because it was situated away from the computer. Employees were called out to do work not their activity span therefore their work at days end was not completed, this lead to employees having additional work going forth the next day. On the factory floor employees where not at there designated stations doing what was required of them. This meant having the machine operators coming in and showing them how things are supposed to be done, which mean time was being wasted. Some employees where also not used constructively meaning they were sent on errands for the machine operators but they could have been doing set up work to benefit the printing process. The lack of basic tools needed in the printing process was also another issue recognised in the observation, employees share too many tools this results in waiting on employees each time a task has to be done therefore creating idle employees.

In terms of transportation and handling within the office environment and the factory there was no unnecessary movement of paperwork or printing plates in the office. In the factory, the inventory used for the production of the paper is in close proximity and a one employee is dedicated on a daily basis to replenish stocks needed. From starting the machine to the final product all the processes are synchronised. Meaning that there is no double of triple handling of the product. The reason for synchronisation and minimal handling of the product is so to reduce the chance of the newspaper coming into contact with too many people and getting damaged. Through observation of waste disposal, it is seen that waste is disposed by re-selling bundles of waste paper to various companies who reuse this paper. Companies who purchase these bundles are bottles stores, shoe factories and religious organisations. The end reels of paper are also sold after it reaches its maximum usage on the press. This encourages the recycling of paper.

From the observation of the printing process the outcome establish is as follows; the reason for the company having four Computer to Plate Machines is that in the event of a technical glitch, their clients can be assured, they will continue with their pre-press work. The inking system reduces unnecessary spilling and excessive ink from lying around the print plant, which lowers the risk of, untidy print jobs and print quality variation, which can result in the poor quality of print jobs. The conveyor allows for the printed copies to be conveyed to automatic stackers where the copies are counted for the second time. The copy counter scale then counts the bundles of newspaper as they come off the compensating stacker. The copies are checked for the third time during this process and neatly bundled as per clients packaging requirements. The reason behind checking the copies for the third time is to ensure there is no room for errors. Shrink-wrapping machines then ensures the product is kept neat and weatherproof and also easy to handle when distributing. In the event of a power failure the company is equipped with generators to power up our print operation. The generators also ensure that they don't suffer any down time in the production process. In the event of a shortage in the supply of water, the company has water tanks that have sufficient supply of water so that printing process continues without any delays.

4.2.4 The printing process

From the findings there are three stages of the printing process highlight, pre-press, print production and finishing. The pre-press process is as follows, firstly the company receives the job request from the client. This is usually via the drop box or he/she emails them in an Adobe format to the company. Once the company are receives the job request the client is to confirm that this is his/her final submission, colours and texts are checked and the process continues. Once the pages have been finalized they are sent to the computer to plate technician. The computer to plate technician then inserts the plates into the computer to plate machine, and through advanced technology the images of the newspaper get imprinted on the printing plates. For the print production, the plates are inserted onto the different towers of the printing press, according to the pagination and the colour. Once that is complete the towers are all set up, the paper is fed through the machine, ink and water supply is checked and the printing may commence. Lastly the finishing process, the conveyor allows for the printed copies to be conveyed to automatic stackers where the copies are counted. The copies are checked and neatly bundled as per clients packaging requirements.

4.3 Discussion: Integration of lean and green manufacturing

The understanding thus far of lean manufacturing is that its main focus on delivering the highest quality product to customers on-time and at the lowest cost (Kumar and Kumar, 2015) and green manufacturing as the relentless identification of waste in the working environment and reduction of this waste (Pampanelli *et al.* 2013).

Integration of lean and green manufacturing allows for the improvement of resource management, communication, company image and its ability to achieve goals. It provides the organisation with the tactics and methods it requires to improve lean results and environmental performance (Jasiulewicz-Kaczmarek, 2014).

The common understanding between the interviews and the non-participant observation is that there is room for improvement meaning there is opportunities for lean and green practices to be implemented within the Rising Sun Printers, manufacturing process and a lean and green manufacturing plan is required for further improvement. This is due to their lack of understanding of the concept of lean and green manufacturing.

The company unaware of the benefits that is available through the implementation of this concept. Throughout the interviews it was evident that staff related issues are a major trend and this was a commonality in the operation as well. According to Jasiulewicz-Kaczmarek (2014) one of the methods is increasing productivity of employees through the elimination of environmental hazards and provision of a safe, hazard-free working environment. The elimination of environmental hazards reduces the risk of employee fatality (Jasiulewicz-Kaczmarek, 2014). One of the goals of this lean and green manufacturing is to be able to harmonise all the procedures and processes of the organisation in such a way that they achieve organisational goals in a way that is not only effective but efficient too. It is fundamental that information and resources are shared between various departments (Jasiulewicz-Kaczmarek, 2014).

4.3.1 In relation to the seven types of waste

Recognising waste is extremely essential to ensure the eradication of non-value adding processes (Pampanelli *et al.* 2011).

Waste gets weaved into the production process overtime by default (Bergmiller, 2006). It becomes a process norm therefore we oversee it (Bergmiller, 2006). However if an issue arises a 'band aid' approach is taken-meaning the root cause of the issue in the production process is not dealt with (Bergmiller, 2006). How can these wastes discussed throughout this paper be found? Firstly the value added processes must be identified (Pampanelli *et al.* 2013). Thereafter, operators must ask questions around why they do things the way they do, what the operation is about and is it necessary to follow this specific process to gain a holistic understanding of what they are working with (Jasiulewicz-Kaczmarek, 2013; Johansson and Pampanelli *et al.* 2014; Sundin, 2014).

4.3.1.1 Over production

Overproduction, the company does not fall short when it comes to overproduction waste. They work with strict instructions with regard to how much to printing to do for every client. However there are times were overproduction is an issue and unlike other manufacturing operations, the overproduction in this case becomes waste, reason being every client has different job therefore there is no use for it if overproduced. This is a concern because it becomes scrap and unwanted meaning it leads to becoming solid waste and is additional hazardous waste (Bergmiller, 2006). What needs to be done in this case is production planning and scheduling which leads to excess inventory (Domingo, 2003).

4.3.1.2 Waiting waste

From the results of the interviews the issue waiting on preceding processes is evident. The reason being is that there is not enough training being done to help with the systems and processes that are in place. If additional training is arranged it will help benefit the overall process. By waiting on preceding processes the company suffers from downtime (Domingo, 2003). Time wasted waiting between processes is common in most manufacturing operations (Moreira *et al.* 2010). However there is a way of minimising this. According to the machine operators it can be through printing plate removal, which should be sped up due to it being down time, solution to get all the plates out at once. Operators need to be vigilant to see that when they start up the press the paper must not run loose and cause web breaks because once the web cuts there is downtime. With regard to management of staff, there are five people running the machine at one

time, inkers need to be inline and have urgency to maintain the colours. As an operator, he/she should be involved in changing plates, getting the press started for the next job, there should be minimal time used to plate up and remove plates.

4.3.1.3 Transportation and handling waste

This is the unnecessary movement of goods or employees moving for no given reason. From non-participant observation data that was gathered showed that within the office and factory environment there was no unnecessary movement of sort. All office and factory processes are all in same area and according to Bergmiller, (2006) this is ideal for a company that is on it way to reducing waste and become lean and green. All the departments that contribute to the printing sector are in close proximity therefore there is no value lost.

4.3.1.4 Defect waste

This is minimal seeing that the machine operators are thorough when it comes to managing the quality of product they are tasked to produce. There are however times when quality control is an issue however the highlighted issue of unskilled employees causes this. By having unskilled labour the company is putting themselves at risk of having increased defects which will then cause additional waste in production times, causing delays, excess resources and labour being used and added power consumption (Bergmiller, 2006).

4.3.1.5 Processing waste

Is usually an issue if there aren't any procedures to follow when it comes to quality control or if there are too many complex systems to follow in the manufacturing process (Bergmiller, 2006; Yang *et al.*, 2011). From the interviews it is apparent that there aren't complex systems to follow, additional is needed training to make the operation run a lot more efficiently. Additional training will assist the issue of waiting on preceding processes mainly dealing with plating up the machine. Whilst conducting the interviews with the machine operators it was found if machine parts are changed in pairs there are no discrepancies and this avoids unnecessary machine breakdowns. All rollers on the machine have to be checked weekly and paper quality needs to be monitored to avoid decrease in quality. To avoid folder jams, rollers and cutting sticks need to be checked once the edge on the paper is uneven it needs be checked. When the

product is coming into the stacker it must be straight and not bent on any way. If the product is not straight it tends to cause stacker jams, which leads to waste in time and materials. Shrink-wrap machine must be given sufficient time to warm up and come to the correct temperature for use. These factors contribute in assisting decrease-processing waste.

4.3.1.6 Inventory waste

The inventory system adopted by this company works well for them, as the general manager says they keep a sufficient amount of inventory on hand and there is never a shortage. As research shows it is not required to be have more than the minimum stock needed for production (Bergmiller, 2006). Once there isn't a continuous flow in the manufacturing process, problems start to surface.

4.3.1.7 Motion waste

From observing the factory and the office staff there were a few issues found in motion waste. Motion waste in theory is defined as any unnecessary human movement (Bergmiller, 2006). The reason for this could be unconstructive layout and housekeeping, imprecise work instructions and a disorganised and cluttered workplace (Domingo, 2003). With regard to this company within the offices there isn't routine established meaning the employees are not given set responsibilities therefore they are interrupted time after time hence they are not able to finish tasks for the day. In the factory the employees are not monitored if a proper manner therefore there is a lot of idle employees resulting in delays in the printing process. The solution needed in this regard is to have a formal layout of the workflow process to guide the employee towards reaching targets and objectives in a skillful manner (Domingo, 2003).

4.4 The lean and green manufacturing plan

If waste is reduced and finally eliminated, it will have an adverse effect on quality and cost will be lowered (Bodolay, 2010). Lean and green manufacturing is defined in this research as, an idea that has its main focus on delivering the highest quality product to customers on time and at the lowest with having its focus on the environment and reduction of waste (Kumar and Kumar, 2015; Pampanelli *et al.,* 2013). From the

discussion above it is clear that there is need for a guiding principle such as a plan for the Rising Sun Printers to follow. To create a lean and green manufacturing plan we have to look at how we are going to address the seven types of waste found in manufacturing.

4.4.1 Developing the lean and green manufacturing plan make us of the 5S tool

For the purpose of this research the 5S tool will be used in developing the lean and green manufacturing plan, to identify and eliminate the seven types of waste (Engum 2009). Small offices to large manufacturing companies use this tool and it helps reduce waste and increase productivity by creating a safe, clean, and well-organised workplace (Engum 2009; Pampanelli *et al.*, 2013).

From the findings it is seen that there is an issue with employees. Employees make this company function, and by not having them cooperating at their optimum level it becomes a waste to the printing process. Therefore working areas become crowded, equipment gets incorrectly used, machines are not operated correctly and this all leads to the end product being degraded. What the 5S tool sets out to do is, it standardises operations and provides the company a base on which to build on other lean and green developments. The 5S's are sort, straighten, shine, standardise, and sustain. According to Engum (2009) this tool is a good starting point for elimination of the seven wastes. For a lean organisation 5S is vital because it deals with continuous improvements, reduction of costs and safety in workplace (Engum, 2009).

4.4.2 The 5S tool

Figure 4: The basic 5s tool (source: Fabrizio and Tapping 2006)

The 5S tool visually communicates to workers via easy signals to give basic understanding information needed in operations (Bodolay, 2010).

Sort: This means needed items and unneeded items must be clearly identified and unneeded item are to be left out of the process (Engum 2009). The reason for this is to remove obstacles, which then frees up space to work, hence the orderliness process begins (Fabrizio and Tapping, 2006). "When in doubt, move it out" (Fabrizio and Tapping, 2006).

Set in order: after sorting all items should be arranged and clearly marked so that anyone will be able to find them. It will simplify the task out looking for tools therefore reducing time wasted to do so (Engum 2009). The fundamental idea of set in order, is to place all materials used for the process in the most ergonomic position, this is to reduce reaching, bending and turning (Fabrizio and Tapping, 2006). "A place for everything with everything in its place" (Fabrizio and Tapping, 2006).

Shine: after all the unnecessary tools and items are removed from the work place the idea of shine is to continually keep the working environment clean (Engum 2009). However it is not only about keeping the work environment neat and tidy, it goes onto inspecting damaged and broken machinery. The benefit of the stage is, it allows the

machine operators and employees to have a clear perspective of what is working and what is not therefore they are able to use the correct skill set to see to the problems. It standardizes processes, aiding in lesser machine breakdowns and increased efficiency (Fabrizio and Tapping, 2006). “Make it clean and keep it clean” (Fabrizio and Tapping, 2006).

Standardise: making all tasks understandable and with set procedure to follow (Engum 2009). This involves creating a specific set of guidelines for reducing pollution, keeping the internal and external environment organised, clean and conducive for efficient work (Fabrizio and Tapping, 2006). “If you cannot see, you don’t know and if you don’t know then you cannot control” (Fabrizio and Tapping, 2006).

Sustain: this is to make sure there are rosters and checklists to make sure the 5S it become part of the daily routine (Engum 2009). This is achieved my educating and communicating with the employees to ensure that they are following the 5S standards (Fabrizio and Tapping, 2006). “Maintain the gain and forget the blame” (Fabrizio and Tapping, 2006).

4.4.1.1 The benefit

The 5S tool reduces delays in manufacturing process, the visual management shows when products and tools are out of place meaning issues and problems are highlighted (Engum 2009; Pampanelli *et al.*, 2013). Its helps with the set up times increasing production efficiency, as discussed there is an issue with this at the company under consideration. The quality of work is improved due to the processes being standardised, there is less handling of the product minimising the chance of defect waste, and the right tools and equipment are made available (Engum 2009; Pampanelli *et al.*, 2013). Safety issues are also addressed making it a stress free working by enforcing measures to help the well-being of employees. This increases the morale and motivates the employees to make improvement and results in the operators having less stress (Engum 2009; Pampanelli *et al.*, 2013). If this tool is implemented correctly, it will drive products and processes continuously and fundamentally it creates a sense of ownership within the workspace (Engum, 2009).

4.5 Conclusion

This chapter reviewed the data and critically discussed the findings with literature from (Bergmiller, 2006; Bodolay, 2010; Engum 2009; Fabrizio and Tapping, 2006; Moreira *et al.*, 2010; Pampanelli *et al.*, 2013). The company under consideration did not have an awareness of lean and green manufacturing and the benefits that are attached to it. There were three stages of the printing process identify namely, pre-press, and print production and finishing.

When addressing the seven types of waste, the company does not fall short when it comes to overproduction waste. However waiting waste is evident when is comes to preceding process. For transportation and handling waste all the departments that contribute to the printing sector are in close proximity therefore there is no value lost. Defect waste on the other is minimal seeing that the machine operators are thorough when it comes to managing the quality of product they are tasked to produce. Processing waste, is a issue due to the employees not being skilled to work with systems and process in place. With regard to inventory, waste thre is no conern due to the system adopted by the company which works well for them. Lastly motion waste seems to be a problem due to the unconstructive layout and housekeeping, imprecise work instructions and a disorganised and cluttered workplace. Hence the discussion showed how each of the seven types of wastes lies within the company.

The 5S tool was propose as a tool to eliminate the seven types of waste. This tool according to Parrie (2007), “the 5S tool helps significantly in implementing and sustain improvements.” “5S is the foundation, for successful lean and green implementation and is an invaluable tool to begin, support, and sustain a journey to lean production,” (Parrie: 2007).

Chapter 5: Conclusion

5.1 Introduction

The following chapter will summarise the four objectives of this research by making use of the results. The first four chapters of described the type of industry under consideration, defined lean and green manufacturing in terms of the research, outlined the objectives of the research, explained what type of data collection methods would be suitable to such industry and provided a discussion on the findings.

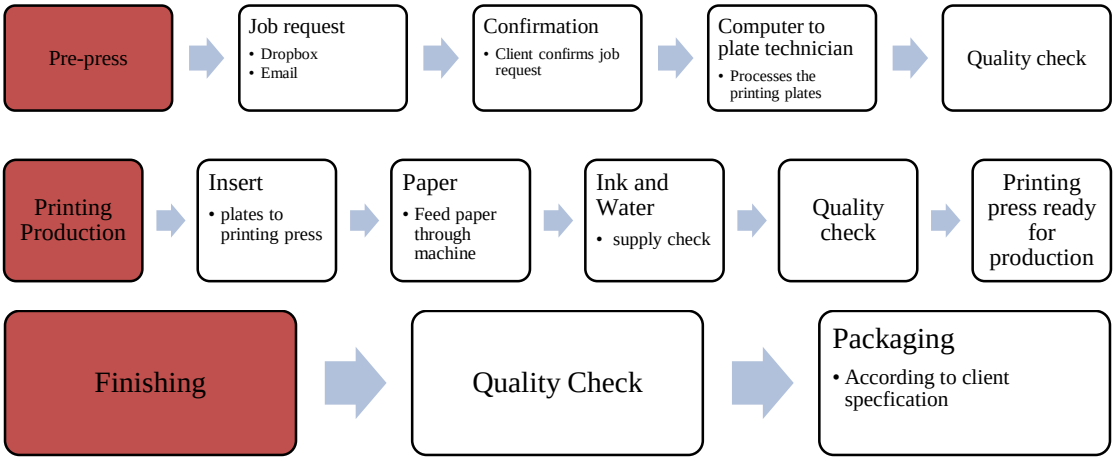
Through conducting this research it is evident that, by adopting lean and green manufacturing there is a reduction of barriers within the workspace, all employees are able to get involved thereby decreasing the amount of idle labourers. Hence there is increased quality in the product on time of completion and resources used are minimised however customer needs are still met (Pampanelli *et al.* 2013).

The research has examined lean and green manufacturing, focusing on eliminating the seven types of waste using the 5S tool to develop a lean and green manufacturing plan. The research method used was qualitative.

5.2 Summary of findings

I. Identify and describe the activities associated within the printing process.

The Rising Sun Printers is currently run with no lean and green manufacturing plan. This is an indirect cost to the company because they are not benefiting from advantages lean and green have to offer (Moreira *et al.* 2010). The Rising Sun Printers have an established organisational structure. Roles and responsibilities of employees are in place however there was room for improvement. The printing process is not simple; it is very labour intensive therefore leaving room for error. By applying theory on the seven types of waste to the Rising Sun Printers, the research shows that by taking into consideration the value added, the company can start its journey on becoming a lean and green manufacturing company. The diagram below outlines the printing process.
Diagram: The printing process at Rising Sun Printers



II. Identify opportunities for lean and green practices to be implemented within the Rising Sun Printers manufacturing process.

With lean and green manufacturing there is not one simple approached that can be taken. There are a number of tools that can be used. The reason for using the 5S tool for this research is because it is an exceptional tool to start the lean and green manufacturing process (Bodolay, 2010). It assists the company with identifying the seven types of wastes, standardising work processes and their optimising production efficiencies (Bodolay, 2010). What is important when using this tool is thoroughly identifying all the types of waste in order to reduce it. It is important to note that waste may not only be printing waste of but may come in forms waste of overproduction, waste of waiting, waste of transport, waste from inappropriate processing, waste due to unnecessary inventory, waste due to unnecessary motion; and waste due to defects (Moreira *et al.* 2010).

Literature shows that the lean and green manufacturing concept needs to be weaved into the company's core strategy and training needs must be enforced, for optimal competitive advantage, (Engum, 2009:101). With this in mind, newspaper printers will reduce changeovers, allowing them more time for planned maintenance, resulting in fewer breakdowns, therefore decreasing waste (Engum, 2009:101). Lean and green manufacturing has a positive affect on the company (Bodolay, 2010). There is a noteworthy impact on the company by making use of the tools provided by lean and green manufacturing for waste elimination (Bodolay, 2010). These tools help organise and add value to the work processes therefore creates ways to eliminate waste.

Sustainable practices such as ways of recycling paper, reducing energy consumption and dealing with employee related issues will increase the bottom line, social equity, environmental protection and economic development within the company (Bodolay, 2010; Weybrecht, 2013).

The opportunity for implementing lean and green manufacturing within the Rising Sun Printers manufacturing process can bring the cost of production lower by decreasing the amount of inventory, energy and human resources used. In the production process time will be saved, and mostly importantly the quality of work will be improved. This in turn will have a positive affect on the bottom line (Bodolay, 2010).

III. Develop a lean and green manufacturing plan for the company under consideration.

The lean and green manufacturing plan will make use of the 5S tool described in chapter 4. As mentioned, it is an ideal starting point for the elimination of the seven types of waste (Engum 2009; Pampanelli *et al.* 2013). How the tool responds to dealing with the seven types of waste.

Overproduction as discussed in the literature does not add value and the customer will not pay for it. The solution is to reduce the amount of over production (Fabrizio and Tapping, 2006). This can be done by changing the way processes are done, by monitoring the production records of the company on a weekly basis (Fabrizio and Tapping, 2006).

Waiting waste is the waiting on preceding processes, people, machinery or waiting on anything that affects the process of in that case printing, (Fabrizio and Tapping, 2006). The disruption caused by idle time hinders the production process. With regards to the printing process there is a lack of communication between the employees. How the 5S tool solves this type of waste is by allowing the company to creaste a holistic view of what the printing process is defined as therefore making it clear to see where time is being wasted (Fabrizio and Tapping, 2006).

In terms of transport and handling waste, all material required for the manufacturing process must be in close proximity to the company (Fabrizio and Tapping, 2006). The

5S tool set all areas on the company in order, this then makes it easy to see where the resources should be place so that there is no unnecessary waste in time, fuel, energy and labour to move material around (Fabrizio and Tapping, 2006).

Defect waste, is created by how work is performed (Fabrizio and Tapping, 2006). The 5S tool offers a solution that makes all processes a standard procedure that highlights all the possible areas that create defect waste, decreasing the amount of mistakes that could occur in the manufacturing process (Fabrizio and Tapping, 2006).

Processing waste, work should be done right from the start (Fabrizio and Tapping, 2006). The 5S tool reduces the amount of processing waste by offering standardised solutions to the manufacturing process thereby reducing environmental waste. This will reduce the expenditure of additional time, materials, energy and labour required (Fabrizio and Tapping, 2006).

Inventory waste, excess stock is a waste according to (Fabrizio and Tapping, 2006). The 5S tool helps devise a plan of how much inventory is needed by sorting out the amount of material needed for the manufacturing process from those that are not needed (Fabrizio and Tapping, 2006).

Motion waste, every hour of the day is crucial in manufacturing. If there is an hour that can be saved by doing a task in a different way it will add value to the company and reduce this type of waste. Poor layout of the work environment and poorly placed resources, creates this type of waste (Fabrizio and Tapping, 2006). From the 5S tool the second S- set in order helps address this type of waste.

5.3 Conclusion

This research has shown that there is a distinct relationship between lean and green manufacturing. It was found that environmental waste is embedded in the seven types of lean waste previously acknowledged (Moreira *et al.* 2010; Pampanelli *et al.*, 2014). It was also discovered that lean and green manufacturing improves a company's environmental performance through focusing on eliminating non-value adding activities (Wikoff, 2009; Yang *et al.*, 2011). From the exploration of the research into lean and green manufacturing it was possible to draw connections, firstly the 5S tool is a starting point for a company's journey to lean and green, secondly the 5S tool aids

with the identification of seven types of wastes and thirdly Rising Sun Printers manufacturing process can be improved by applying of the aforementioned 5S tool.

5.4 Suggestions for further studies

Firstly, the concept of lean and green manufacturing can be explored further by researching the challenges within a printing company with applying lean and green tools other than the 5S tool. Secondly, companies need to know the theories behind lean and green manufacturing but further research could be done one how the use of different types of production materials that could reduce the impact on waste. Lastly, implementation of lean and green manufacturing involves employee buy in therefore the challenges surfaced from this can be explore using other companies facing a similar problem.

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Appendix 1:

Interview questions

Interview questionnaire 1

Title of Project: "Developing a lean and green manufacturing plan for the newspaper printing industry - considering the Rising Sun Printers"

Name of Researcher: Avish Maharaj

About the Research:

The aim of this research is to understand the printing process pertaining to inputs, processes and outputs and develop a lean and green manufacturing plan to utilise resources responsibly, reduce waste and environmental impacts within the printing division (Yang, Modi, Hong, 2011; McMahon 2011; Womack & Jones, 2003; Singhal, 2005).

Thank you for willing to be part of this research that has its focus on "Developing a lean and green manufacturing plan for the firm under consideration.

The questions for the interview are listed below. Once the interview summary is written I will send it to you for clarification to ensure there are no misunderstandings.

1. What is the organisational structure?
2. In steps please identify and describe the activities associated with printing i.e. the inputs, process and outputs.
3. Are you familiar with the concept of lean and green manufacturing? If not explain.
4. Where do you think newspaper printers have their major bottlenecks in the production?
5. In terms of inventory, is there need for large quantities to be stored?

LEAN and GREEN

6. What types of wastes occur with the printing sector and how is it linked to the seven types of waste.
7. How does the production department work with elimination of non-value added work
    a. Overproduction waste
    b. Waiting waste
    c. Transport and handling
    d. Defect waste
    e. Processing waste
    f. Inventory waste
    g. Motion waste

Interview questionnaire 2

Title of Project: “Developing a lean and green manufacturing plan for the newspaper printing industry - considering the Rising Sun Printers”

Name of Researcher: Avish Maharaj

Thank you for willing to be part of this research that has its focus on “Developing a lean and green manufacturing plan for the firm under consideration.

The questions for the interview are listed below. Once the interview summary is written I will send it to you for clarification to ensure there are no misunderstandings.

1. How long does it take to setup the machine before a print job?
2. Is there an issue in waiting on preceding process? If so what are the issues?
3. When a particular job is started up how would you act to minimise waste on the machine
4. In order for the machine to run smoothly what are the necessary steps involved?
5. Are all material needed for production in close proximity? If yes/no why?
6. When producing newspaper what is the minimum amount of over-production?
7. Do all the print jobs meet the customer’s requirement?
    a. Is there a skilled labour force?
    b. Who checks on quality of products?
    c. Are there deadlines set? If so are they met?
8. Do you follow a system to complete a customer’s job?
    a. What is the system?
    b. And if you had to change them, will you?
9. Would you say there is room for improving the work environment with regard to
    a. Cleanliness
    b. Co-operating with work instruction
    c. Monitoring employees

8. Is there paper waste in the process?
    a. If so how much per a month?
    b. What is being done to reduce it?
    c. And how is it being disposed?

Interview questionnaire 3

Title of Project: “Developing a lean and green manufacturing plan for the newspaper printing industry - considering the Rising Sun Printers”

Name of Researcher: Avish Maharaj

Thank you for willing to be part of this research that has its focus on “Developing a lean and green manufacturing plan for the firm under consideration.

The questions for the interview are listed below. Once the interview summary is written I will send it to you for clarification to ensure there are no misunderstandings.

1. In steps please identify and describe the activities associated with printing i.e. the inputs, process and outputs.

2. What are the issues when operating that machinery
    a. Stacker
    b. Shrink wrap
    c. Plate bender
    d. Plate punch
    e. Forklift
    f. Web machine
3. How long does it take to achieve the quality required by the customers
4. What are the necessary precaution required of by the employees who are working with the machinery
5. How do you minimise overproduction waste?
6. Do you find the preceding processes affect the time taken to start production?
7. How long does it take to start the printing process?
8. How you as a machine operator manage the staff working on the floor.
    a. Are the controls and systems in place? If what are they