Developing a Lean Value Chain for Botswana's Grain Milling Industry – A Case Study Of a Wheat Milling Company

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Abstract

The past years have revealed increased participation of individual companies in Lean Manufacturing (LM) tools and principles across different industries around the world. Grain milling industry, being one of Botswana's greatest source of food, is not excluded from developing constructive processes to improve the productivity of grain value chain. Shifting this industry from traditional production setups to meet the lean manufacturing principles is a catalyst for the country to be self-sufficient in grain products. This work present a case study of a wheat milling company and applications of some lean manufacturing tools to enhance performance in the grain milling industry. The discussion is based on the results obtained from the implementation of Lean Manufacturing tools in the production system of the case study company. Significant achievements have been observed in the company's supply chain, with a clear view of continuous process improvement art, improved product and service quality and flexibility in the production process.

Keywords
Lean manufacturing, value chain, supply chain, value stream mapping, Grain Milling

Introduction

Digitalization is a necessity for all sectors of the economy and one of the sectors influenced much by this digital transformation is the grain milling industry (PARLAK, 2020). Real time information management systems work best in milling industries to make information available to the whole supply chain anytime everywhere. SAGE job system is entirely more effective for allocation of different jobs across the shop floor especially for the maintenance and production departments.

Appropriate lean measures need to be taken into consideration to develop intelligent processes throughout the grain supply chain to enhance productivity in this sector. Innovation plays a very important role in the milling industry to increase efficiency in the production process, increase product quality, reduce wastage, and brings transparent communication throughout the value chain (Rui Borges Lopes, 2015).

Companies that do not align to the new developed standards of production are more likely to be slow in the market and may revert to their traditional ways of production (Davenport, 1993). Botswana grain industry have to forsake traditional processes and adopt lean manufacturing strategies to serve the milling industry with high quality raw materials. In return the industry also has to devise concepts and procedures that help them to process grains efficiently to serve its end customers. Lean manufacturing therefore aim to add value to the grain supply chain by reducing production waste, human effort, inventory, time to market, and manufacturing environment to become sensitive to customer demand, while delivering quality products efficiently (Womack *et al.*, 1990). The Botswana's milling industry is often treated as a dirty work and there are beliefs that it's almost impossible to achieve maximum level of productivity. Therefore, the purpose of this paper is to develop lean concepts and tools suitable to be used by the Botswana's milling industry to improve productivity in the production process.

Aims, Objectives and Value of the Study

This study aims to report on the existing lean manufacturing tools and principles that are of a significant importance to the grain milling industry in Botswana using a wheat mill company case study, furthermore the study recommends other tools that can be used to increase productivity of the whole grain supply chain up till the end consumers.

Literature Review

Lean manufacturing (LM) concept was first introduced based on the concept of waste (muda) by the Toyota production system (Shingo, 1981). The definition of waste means every non-value adding activity along the production process. It refers to anything that does not improve the product in anyway in the eyes of the consumer (Hines and Taylor, 2000).

Lean methodology is mainly aimed at reducing 7 types of wastes namely: Motion, Waiting, Overproduction, Rework, Transportation, Inventory and Work In Process (Monden Y, 1983). The milling industry encounter such kind of waste in their day to day operations but the traditional culture have made it seem almost impossible to eliminate these discrepancies. The following literature will look directly into individual lean concepts and tools applicable in the milling industry. Lean manufacturing is based on the 5 principles as show in Table 1.

Based on studies on the rate of Lean Manufacturing application in Botswana companies, the major drawback was seen to be lack of skilled personnel in the successful implementation of lean manufacturing in Botswana (Mapfaira et al, 2018). Kojima and Kaplinsky (2004) made a study in the performance of Lean manufacturing in manufacturing companies using Lean Production Index (LPI). It focuses on the aspect of quality, continuous process and process flexibility (Kojima S, 2004). The results have proven that LPI depends on factors such as ownership, access to international technology and human resource development.

Table 1: Basic Lean Principles (Furlan A et Al, 2011)

Value Creation	LM is aimed at creating value for the customers through the expenditure of resources. Customers are willing to pay for the quality that satisfy their needs. Companies need to seek how customers perceive to be successful.
Value stream identification	This involves the identification of company's processes raw materials, information, machinery, production and services. Manufacturers must aim at eliminating all non-value adding activities.
Uninterrupted Flow	The flow of resources within the production system must be well managed to reduce waiting times, reduce movement costs along the production process. A steady flow of resources is often desired.
Pull	The production process must start based on the demand for the product or services. This reduces the return rates of unsatisfactory products.
Perfection	The main aim of LM is to attain perfection through continuously analyzing and improving the processes. Continuous improvement is an unending process in manufacturing industry.

Milling Process Design

Milling process design is the engineering activity of specifying a coherent assembly of equipment with the objective of conducting a sequence of operations on grains in order to convert them into human or animal foods (Clark, 2005).
Every process is designed to add a level of significant value to the product. Due to differences in types of processes used in the milling industry, different results are often obtained. Improvement is an endless process and for the company to align to industry standards, it must adopt a culture of lean process optimization. Lean design and optimization deals with consistent application of lean principles to eliminate waste and other non-value adding processes in the manufacturing and design of processing plant or equipment (Koskela and Huovila, 1997).

Conceptualizing the design process as a flow of information lends itself to reducing waste by minimizing the amount of time before the raw material get used, the time spent inspecting products for conformance to requirements, the time spent reworking rejects to achieve conformance, and the time spent moving the product from one design contributor to the next (Ballard and Koskela, 1998). In a milling company the process begin from the suppliers of grains until the end consumers of finished products. The effectiveness of the process depend on the strategy that was used to design the same process, the communication strategies used and the collaboration between individual departments. Figure 1 below shows the typical flour milling process:

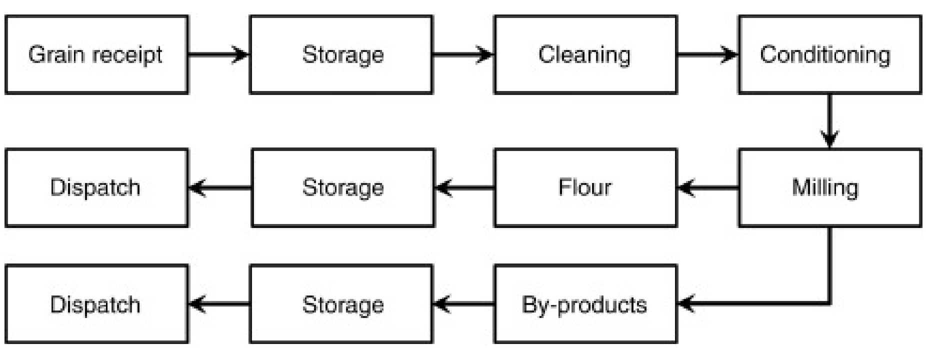


Figure 1: Flour Milling process (Alldrick, 2017)

Constant process improvement is essential to reduce waste in a milling company. Milling industries are known to have a lot of waste and high level of uncleanliness due to the nature of products being produced. Reworks in the milling industry are considered normal because there is a belief that there is a lot of cross contamination along the production process (Javier Freire1, 2002). Lean process improvement methodology seek to eliminate these beliefs and create milling processes with low rejects quantities and zero chances of cross contamination. The lean process improvement methodology is shown in Figure 2 below:

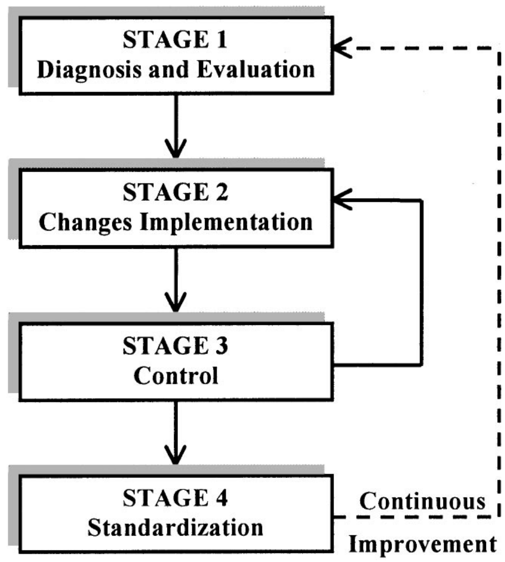


Figure 2: Improvement methodology (Javier Freire1, 2002)

Kaizen 5S, 6S, and 7S Methodologies

During the Second World War, the production capabilities of Europe and Asia were destroyed. That was the time United States (US) was working on expanding their production to focus on quality not just quantity. US quality control expert Dr W Edwards Deming started working with the Japanese and many tools were developed (Deepak Dhounchak, 2017).

One of the best technique developed by the Japanese was the 5S methodology. It was developed by Hiroyuki Hirano and was first used by Toyota in 1970 (Deepak Dhounchak, 2017; Joshi, 2015). Later the 5S methodology was then developed to include the "Safety" aspect and it was called 6S. Recently another S (Spirit/Support) was added to the 6S framework and this formed the latest 7S methodology. The 7th S, Spirit/Support, seeks to enhance team consistent cohesion, motivation, and cooperation from top down and up top in the Organizational hierarchy (Joshi, 2015; Mahlaha, et al., 2020).

The Table 2 below shows the 7S methodology words and meaning.

Table 2: 6S Word and Definitions.

7S WORD	MEANING
SORT	Dispose all useless and waste materials from the workplace
SET IN ORDER	Put everything in the appropriate places for quick access.
SHINE	Make sure that the workplace is clean and tidy at all times.
STANDARDISATION	Make a habit out of keeping order in the workplace at all times.
SUSTAIN	Practice 6S daily without ceasing.

SAFETY	Use all appropriate safety equipment and adhere to all safety requirements.
SPIRIT/SUPPORT	Willingness to cooperate as part of a team. An additional piece to make explicit the reliance on the people factor and the need to continually keep it in mind as other steps are undertaken.

7S methodology is very helpful in organizations and it is very easy to implement, understand and comprehend. The methodology enables all employees' engagement in process capability of the organization (Sukdeo, 2017). The aims of 5S, 6S, and 7S methodologies are:

- Reduce costs
- Improve product quality
- Minimize workplace accidents
- Keeping the workplace neat and tidy at all times
- Eliminate waste in the process
- Increase production rate
- Reduce inventory handling costs
- Improve workplace safety. (Sukdeo, 2017)

Research Methodology

The lean value chain methodologies implementation case study of a wheat milling company is described in this section. The study has taken into account the main objectives of the company, its major processes, management structure and was conducted following qualitative approach. The case studies include Botswana Company whose name will be held for confidentiality reasons and was conducted between April and September 2020.

The company under study is a wheat milling company which has about 30 years' experience in wheat milling. It supplies the wholesalers and largest chain stores in Botswana with its products, as well as individual local bakeries and general dealers. They have a very long supply chain network which range from supplier consultants to end customers which consume both main products and by-products for extended processing or for distribution. There is a well-established transport and logistics wing in the company that make sure that goods are delivered to their distribution centers and to customers in the right quantities at the right time to avoid warehouse spillages and compromised reputation. The company launched a process review strategy in the year 2014 and its intensions were to eliminate waste in the supply chain by adopting a continuous process culture in the workplace which triggered the need to implement lean tools and concepts.

Understanding the milling supply chain is an important aspect to analyze the impact of lean process implementation. The study is underpinning the current process all over the milling supply chain as an understanding of the manufacturing process of a flour commodity. Figure 3 illustrates the process mapping of the milling supply chain in Botswana.

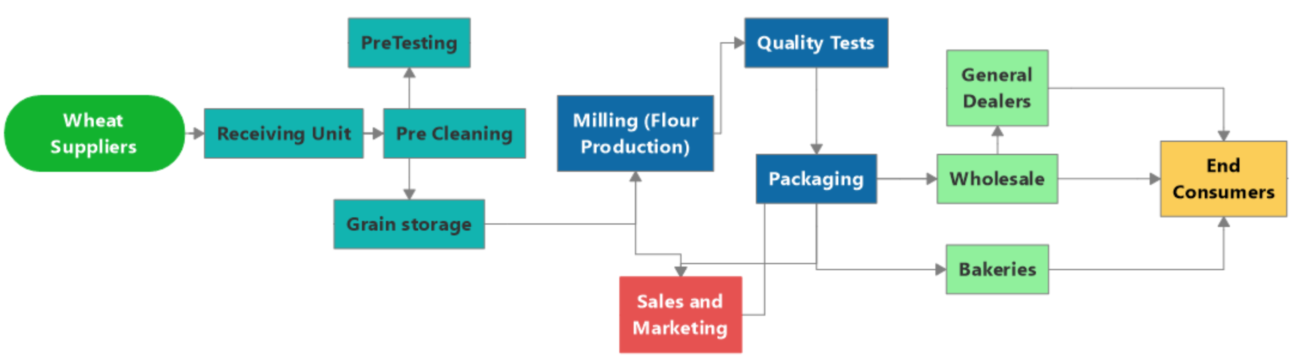
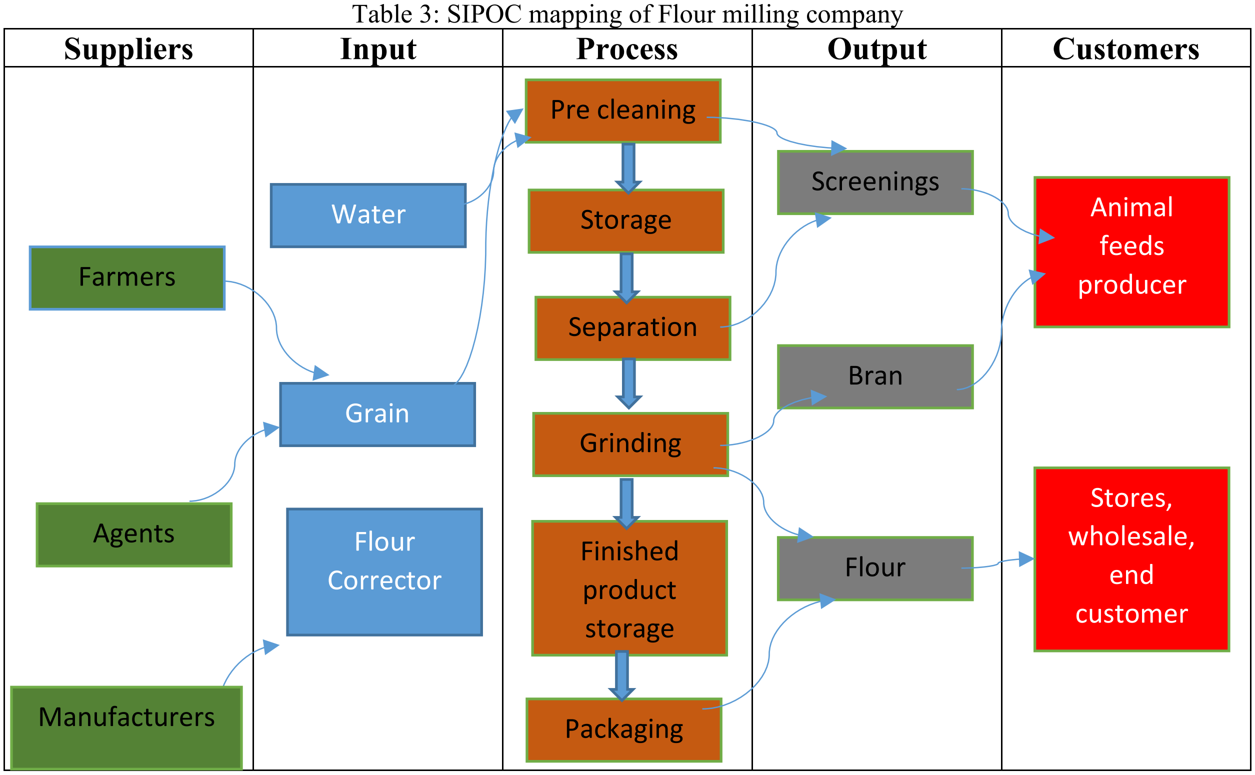


Figure 3: Process mapping of milling supply chain

Wheat grains in Botswana are sourced from Pandamatenga farms, South African farms, Germany, Poland and Brazil through the Durban port in South Africa. More than 90% of wheat in Botswana is imported. Upon arrival, the receiving department performs pre quality tests for compliance before storage in silos. The wheat is then drawn from silos into the milling plant for processing before taken to the packaging department. According to the orders placed through the sales and marketing department, the packed finished products will be transported to wholesalers and chain stores, and finally to end consumers. The process need to be optimized for maximum productivity.

Table 3 illustrates the current situation of flour production flow. The SIPOC mapping consists of the supplier (means actors entire wheat supply chain), input, process (starting from procurement until Distribution), output and customers (means shop or market). Suppliers consist of farmers and intermediaries. Meanwhile, local government acts as a policymaker and does several support for the production process. The output of this supply chain is flour that is divided into White bread flour, cake flour and brown bread flour.

Table 3: SIPOC mapping of Flour milling company



Application of 6S Kaizen Methodology

The methodology was introduced to the company in the year 2014 and was mainly aimed at eliminating waste, increasing the employee awareness of the company's production process, and engaging them in the culture of process continuous improvement.

After its launch the managers from every department were trained to spearhead the implementation and supervise junior staff members for proper compliance. These included Operations Manager, Production Manager, Shift Millers, Finance Manager, Maintenance Foreman, Supply Chain Manager and Human Resource Manager. The leaders then trained their junior staff and introduced them to the new way of doing business.

After the culture was fully known, a Kaizen 6S consultancy company was contracted to fully implement the methodology in the premises. They engaged everyone in the company during their operations because training sessions were already made to sensitize employees. The following are the main changes that were done in the company when the methodology was introduced:

- Implementation of red tag areas,
- Introduction of labels in the workplace,
- Introduction of color coding,
- Standardization of storage facilities,
- Production machines re-arrangements,
- Tool storage techniques,
- Operational manuals,
- Standardization of company forms according to department,
- Introduction of a Management Information System (MIS).

Staff Engagement

Junior staff were given the responsibility to be key leaders in the workspaces every time and to be Kaizen 6S conscious at all times during their working periods. They were given the opportunity to be able to make kaizen related decisions and make sure that their workstations comply with the rules and regulations set by the Kaizen 6S compliance team. These gave them the confidence to stand out and be the best version of themselves in the workplace, being able to suggest areas of improvements to make their everyday work easier and more efficient.

Health and Safety Module (6S)

Health and Safety measures were implemented before but were not that affective due to lack of a base methodology to rely upon. After sometime, the implementation of the last "S" of the 6S was fully taken into consideration. The junior staff were chosen randomly from every department and were trained as Fire Marshalls, First Aiders and Safety Compliance Leaders. Safety measures were put into place and points of critical safety were identified such as food handling, high speed moving objects, high sound level points, heights, and lifting equipment.

The compliance department deployed the implementation of this module and printed all safety signs and displayed them in appropriate places to warn the employees at real time.

The company management introduced the **Health and Safety Management System** (ISO 18001) principle to guide them in occupational health and safety implementation. The aim being to reduce health hazards in the workplace by sensitizing employees and ensure compliance to all safety regulations. Below are the examples of such safety regulations:

- Health hazards,
- Hand Sanitizing,
- Wearing of masks,
- Use of Protective clothing,
- Proper material handling.

The aspect of food safety was introduce and implemented through the use of **Food Safety Management System** (ISO 22000. The company manufactures food and to reduce cross contamination along the production process, the company must have food safety regulations in place. The main aim of this module was to:

- Eliminate contamination,
- To encourage cleanliness,
- Personal hygiene,
- Prepare for the next step in the production process.

As time went by, the **Environment Management System** (ISO 14000) was also introduced in the company to make sure that the production process comply with the Botswana environmental management act. The following were the main aims:

- Avoid environmental contamination,
- Ensure proper handling of chemicals,
- Reduce electricity consumption,
- Reduce emissions.

Impact of Kaizen 6S Methodology

- All the plant machinery was labelled for easy identification and placed apart to create a working space between them. This made it easier for the maintenance personnel to be able to understand the processing plant better and easily identify faults and be able to attend to them quicker. The SAGE job card system was updated with current machine labels and it made it easy to identify the machines which have high numbers of breakdowns and easier to identify more efficient machines. The maintenance data was easily generated with machine labels in place. It also made it easier for the quality personnel to easily identify product sampling points without struggle and improved quality testing productivity. New milling staff training became more simplified with the labeling in place, which shortened the time they take to know all plant machinery.

- The plant cleanliness improved, which eliminated cross contamination along the production process. Infestation consultants were contracted to deal with pest issues in the production plant.

- The junior staff were-empowered to become the best version of themselves by owning process improvement in their workstations. Employees developed high self-esteem, had confidence in their workplaces which lead to improved results.

- Tools, cleaning equipment and files arrangement was successful, all labels were in place and it was easier to identify what is needed in a short space of time. This helped the maintenance personnel by reducing idling time while looking for tools to use.

- Managers and junior staff relationships improved as juniors were transparent to suggest improvement points that make their work easier.

- Product quality improved as there were no more delays in the production process. Millers were able to easily identify problems and assign maintenance personnel without any unnecessary delay.

- The plant condition improved due to improved cleanliness, quick problem identification, quick maintenance personnel engagement and improved operating procedures.

- The accidents in the production process were minimized because employees were more sensitive to health and safety measures

Upon successful implementation of the Lean 6S methodology an audit was made at regular intervals to determine the adherence to the set standards in the company per department in the shop floor. Table 4 shows the audit results from September 2018 to August 2019. In early 2020, the company was Kaizen 6S certified basing on the above results.

Table 4: 6S Implementation Health Status Audits Results -SHOP-FLOOR

Audited Areas	**September 2018 Results**	**November 2018 Results**	**March 2019 Results**	**August 2019 Results**
Receiving	68,18%	77,78%	66.67%	74.07%
Production	72,73%	74,07%	66.67%	77,14%
Packaging	68,18%	74,07%	74.07%	77.14%
Rework	72,73%	70,37%	66.67%	70.37%
Production Warehouse	63,64%	74,07%	66.67%	74.07%
Quality Lab	81.82%	84.20%	84.20%	84.20%
Engineering	63,64%	68,18%	63.64%	70.37%
Site	61,11%	70,37%	63.16%	70.37%
Material Store	64,56%	73,68%	73.68%	77.14%
Main Kitchen	61,11%	68,0%	60.00%	81.48%

Conclusion

Successful Lean Manufacturing in milling industries brings significant improvements and lead to the adaptation of continuous process improvement culture. Less wastes are encountered during the production process and employees become more result oriented rather than being deskbound and working only with instructions. With employees being the key role players in improvement process the company have succeeded in creating a productive environment with strict measures to help align to the main objectives. It has also helped to device a working model which respects expert knowledge and create fecund process improvement teams.

Implementation of 6S in a milling company brought a leaner process and has helped to separate processes and single them out to easily identify loopholes and attend to them more efficiently. The company began to reach high production targets, reduce reworks and rejects, deploy an efficient Management Information System (MIS), redefine its hierarchical employee structure and reduce wastes around the shop floor by a significant amounts. A milestone was reached in creating a wing department called the "Compliance department" to ensure that the company adhere to the set Lean Manufacturing standards. The department has been working hand in hand with managers and the rest of the employees and their results have been noticed across the shop floor including accelerating implementation of the discussed process improvement tools.

Lean manufacturing cannot be entirely linked to the human resource improvement but also the equipment used play a major role in the process therefore a detailed assessment must be considered. Placing the responsibility upon the human resource and neglecting the unavoidable contributions of machines in the production process can bring the whole process improvement process to a halt. The future research in the milling industry can be seeking to devise technological developments in the milling plant to effectively make high tech, leaner and smart milling plants.

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Biography

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