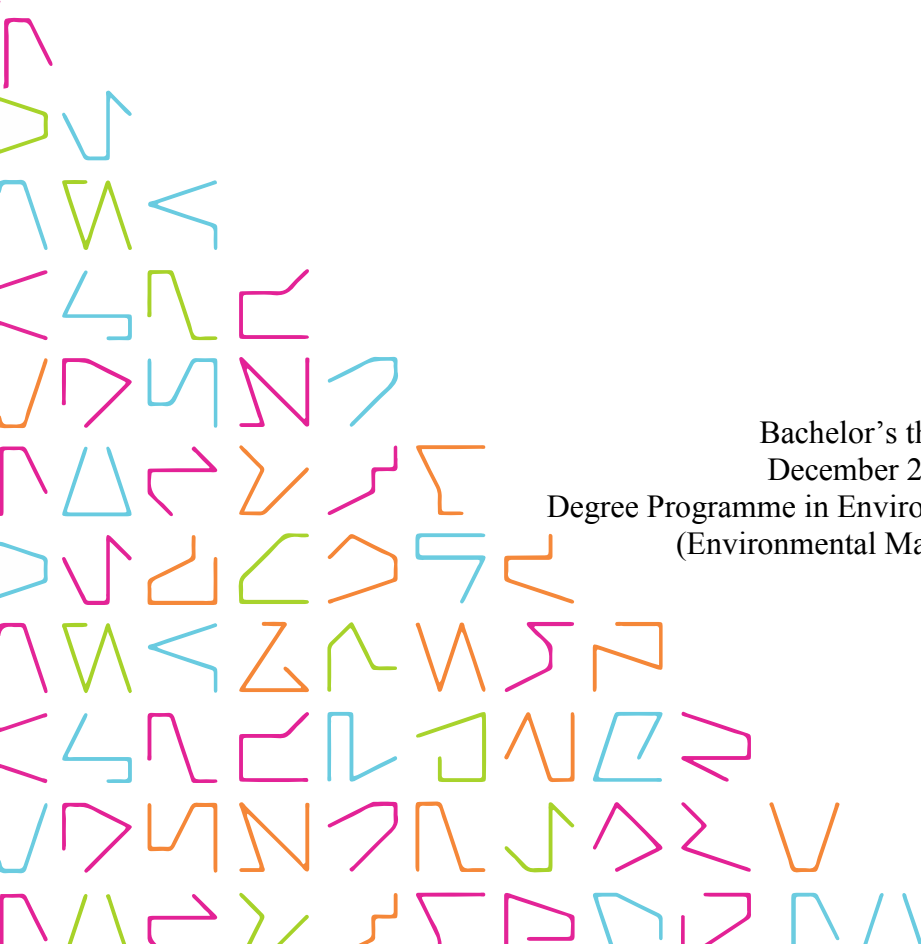


AN OPERATIONS MANAGEMENT PERSPECTIVE ON WASTE MANAGEMENT IN A FOOD PROCESSING FACTORY

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Bachelor's thesis
December 2015
Degree Programme in Environmental Engineering
(Environmental Management)



ABSTRACT

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In a Food Processing Factory

Bachelor's thesis 65 pages, appendices 15 pages
December 2015

The EU waste framework directive and several other adjoining laws have put a lot of financial responsibility on the manufacturing community including the food processing industry. The responsibility for managing production wastes makes the very idea rather unsavoury from the business point of view. This work proposes that waste management can be the basis for long term benefits when implemented under a different production philosophy.

The paper proposes Lean production and Six Sigma as two management philosophies that can transform the way waste management is understood and applied in a production environment. Since Lean focuses on waste reduction and Six Sigma on eliminating errors in production, the paper supports previously held and well documented views that both can effectively and beneficially complement each other when deployed side-by-side. With every previously documented successful implementation of Lean or Six-Sigma, deliberate and controlled cultural transformation has been critical to the outcome of the process. The paper therefore makes a proposal for a cultural transformation plan based on Kotter's 8-step model for leading change and Senge's mental model.

An actual production situation was used as a case study and the outcome discussed in detail. Both production philosophies are extensively dependent on the mental orientation of the entire workers from top to bottom, therefore a performance improvement survey was also used to ascertain workers disposition to the changes that will inevitably occur. By analyzing both case studies and referring to antecedents, the paper concludes that there is a vast potential for success of Lean and Six-Sigma in a food processing factory.

Key words: Lean, Six-Sigma, waste management, food processing industry, cultural transformation, Kotter, Senge

ACKNOWLEDGEMENTS

I did not undertake this journey alone. Along the way enjoyed uncommon help and many great privileges without which I may not have brought this work to a conclusion. My immense gratitude goes to my supervisor Eeva-Liisa Viskari for her unwavering support and patience.

To Liisa, Anna, management and staff of Company X, I say thank you for the opportunity to serve in your midst. It has been without doubt one of the most rewarding experiences of my life.

To Birgitte Chrintz and Lene Hultén, (NNZ Scandinavia ApS), thank you for the enlightenment.

To Leonard and Anna-Marja Ihekwazu, Imran Moshin, Professor Emma Agomuo (Univ. of Nigeria), Apostle Sunday Amadi (late) and family, Corinna Casi, Susanna Työppönen(lauttalab), Mirja Onduso and several others out there who helped silently, I say a hearty thank you.

To my wonderful wife Peace and my kids Chukwuma, Debbie and Osita; thank you for being such a great inspiration.

To my loving, heavenly father who permitted me to come to Finland and graciously deemed me worthy of all these privileges, I remain eternally humbled by your mercy. Thank you for bringing me this far.

December 2015

Chinedu Ohaegbunam.

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GLOSSARY

EU	The European Union
EC	The European Commission
WFD	Waste Framework Directive
TPS	Toyota Production System
JIT	Just In Time
SQC	Statistical Quality Control
MIT	Massachusetts Institute of Technology
GE	General Electric
DMAIC	Define-Measure-Analyze-Improve-Control
DMADV	Define-Measure-Analyze-Design-Verify
OPP	Oriented Polypropylene
PP	Polypropylene
AF/L	Anti fog & Laser perforated

1 INTRODUCTION

Communal waste management efforts and legislation aimed at protecting our environment began several centuries ago even though there is popular belief that it began with the publication of Rachel Carson's *Silent Springs* in 1967. Without any doubt, Rachel Carson played an eminent role in drawing the world's attention to the imminent threat posed by waste to humanity, however the very first public position taken against waste dates as far back as 1634 with the law in Boston prohibiting the improper disposal of fish and garbage (Roberts 2011) and also in 1657 with the law in Manhattan against dropping of waste on the streets (The Association of Science-Technology Centers Incorporated and the Smithsonian Institution Traveling Exhibition Service).

The 20th century awakening and the global initiative to curb the threat posed by accumulation and dumping of waste has drawn a huge participation in the European Union. Waste control legislation at the community and national levels have been so painstakingly drawn up and monitored, that the EU can be said to be playing a leadership role in the drive to limit the environmental impact of production activities around the globe. As a consequence, environmental laws have addressed waste not only as a problem, but also as a potential source of raw material as research efforts continue to yield valuable knowledge. By general consensus, waste management initiatives are fundamentally guided by the three waste management principles of reduce, reuse and recycle (Mohanty 2011). These principles commonly known as the three Rs are the guiding principles behind research efforts and waste management initiatives globally. When put into the perspective of sustainable development, these principles become all the more compelling and undeniably necessary for ensuring a habitable environment for the present and future generations. As a result, different ways of putting waste to further use have been emerging as research findings increase available knowledge and so-called eco-friendly materials are continuously being developed by scientists with a competitive fervor as consumer awareness continues to grow. Consumer and public behavior seem to have compelled and continue to compel a certain sense of responsibility and obligation on the part of producers, towards the environment. Hence waste can be said to have become a burgeoning industry all by itself in this century (Modak 2011).

1.1 Waste Management in the European Union

According to the 2008 European Union waste framework directive (Directive 2008/98/EC), “waste is anything for which we have no use; which we want to or are required to throw away” (European Commission 2008). With the progress made through research efforts, one would expect that the number of materials classified as waste would continue to decrease as new ways of reusing or recycling these materials are developed. Unfortunately this has not been the case. Even though EU waste framework directive approves that certain wastes can obtain the status of a product or a secondary raw material under the end-of-waste criteria, the legal obligations pertaining to the waste material remains binding on the producer until certain criteria are met. Specifically,

“ According to Article 6 (1) and (2) of the Waste Framework Directive 2008/98/EC, certain specified waste shall cease to be waste when it has undergone a recovery (including recycling) operation and complies with specific criteria to be developed in line with certain legal conditions, in particular:

- *the substance or object is commonly used for specific purposes;*
- *there is an existing market or demand for the substance or object;*
- *the use is lawful (substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products);*
- *the use will not lead to overall adverse environmental or human health impacts.*

Such criteria should be set for specific materials by the Commission using the procedure described in Article 39(2) of the Waste Framework Directive (so called "comitology"). A mandate to set end-of-waste criteria was introduced to provide a high level of environmental protection and an environmental and economic benefit. They aim to further encourage recycling in the EU by creating legal certainty and a level playing field as well as removing unnecessary administrative burden”.(European Commission 2008)

By implication, producers have to incur more cost in order to convert waste to raw material, assuming of course that there is a ready and willing market for the reuse of the waste product. In addition, the processes must be shown not to have any adverse impact on the environment. In many cases, the cost of reprocessing waste makes the venture economically unviable and often cheaper to just consign the waste to the landfill.

1.2 Wastes and the Food Processing Industry

In the food processing industry the waste situation is hardly different. Most of the waste generated in a food processing plant is bio-waste. In many European countries it was previously possible for food waste to be spread over land surfaces where they will undergo natural decomposition and eventually become components of the soil. By spreading food processing wastes over land the amount of bio-waste going into landfills is significantly reduced, thereby reducing the production of methane from such waste decomposing in landfills. Methane produced from landfills accounted for some 3% of total greenhouse gas emissions in the EU-15 in 1995 (European Commission). In addition to these benefits, turning organic matter back into soil enhances soil resilience, locks in carbon, reduces the energy needed for agriculture, reduces chemical use, enhances biodiversity and prevents harvesting of biologically valuable peat bog (Hontelez 2009). Today, such practices are not readily permissible due to concerns about the biochemical quality of these wastes and ground water vulnerability. The risks to groundwater and surface water quality are mainly influenced by the proximity of the ground water source and the chemical and microbiological content of the waste (Environmental Protection Agency, Ireland 2004). Waste from food processing industry is not limited to food wastes. A substantial part of these waste include packaging materials (wood, paper, plastics etc.), metals, batteries and wastewater. Handling and disposal of these wastes present increasingly significant challenges from a financial perspective. Anaerobic digestion for biogas generation and composting are being promoted as profitable and alternative applications for bio-waste handling (Kossmann & Pönitz), however compost from these processes has to meet certain specific requirements of suitability before it can be introduced into the soil or sold as compost. (Al Seadi & Lukehurst 2012) For production processes that generate several tons of waste on a daily basis, this presents a serious and undesirable distraction from the primary production activity. In general, these cost considerations and legal constraints make operators less amenable to abide by the provisions of these environmental laws even though they recognize their moral and ethical obligations to do so. On the other hand, industry trend, environmental and quality management standards have become essential requirements for operators that wish to remain in business in most parts of the world. Because consumers are curious to know if their food is produced in an eco-friendly manner, operators of food processing facilities must get certified for environmental and quality management (ISO 90001 and 14001 respectively), which

require them to put structures in place indicating their compliance with laws pertaining to waste handling and environmental protection.

1.3 Common types of wastes from the Food Processing Industry

Typically, a food-processing factory generates mostly bio-wastes and wastewater considering that raw materials are mainly from food crops and vegetables. Large amounts of water are used during production for the processing of products and also after production for the cleaning of floors and equipment. Several other materials are used during production process, from the handling of raw materials during storage to the final packaging and palletizing of finished products. My observation showed these materials are not all consumed during the production process, but show up as residues of the production process at the end of each production day. These materials include wooden crates, plastic bags, disposable gloves, paper, carton boxes, wooden pallets, dry cell batteries, metals components and chemical agents.

Table 1: Types of Wastes observed in a Food Processing Factory

	PROCESS	TYPE OF WASTE GENERATED
1	Raw material inspection and storage	Wooden pallets, paper, carton boxes, dry cell batteries, food wastes and plastic films
2	Unpacking and sorting	Wooden pallets, food wastes, paper, carton boxes and plastic films
3	Washing and storage	Carton boxes, paper, wooden pallets, food wastes and waste water
4	Processing	Raw material off-cuts, carton boxes, paper, wooden pallets, plastics and waste water
5	Quality check	Plastics and food wastes
6	Packing, labeling and boxing	Paper, plastics, dry cell batteries and carton boxes
7	Palletizing	Food wastes, paper, wooden pallets and plastic films
8	Cleaning and decontamination	Food wastes, raw material off-cuts, carton boxes, paper, wooden pallets, plastics and waste water

1.4 The Food processing Factory

It is a medium-sized company owned by a Finnish family and has been in existence since November 1993. It is located in the Varsinais-Suomi region of Finland. The company's only area of business has been in the fresh-cut sector where it has been competing mostly as an underdog with much bigger companies. In the early years of existence, the proprietor operated a greenhouse alongside the fresh-cut business presumably to grow most of the vegetables needed as raw materials for production. However as the company's clientele expanded, it presented a potential the nurturing of which required the undivided attention of the management. Today the green house is being operated by a new owner while the food processing factory now relies on growers from all around the world, but mostly from Spain, Holland, Sweden, Poland and Finland for the huge amount of raw materials needed for its daily operation.

1.4.1 Operations

The factory runs a very precise daily operation from the purchase of raw materials, processing, packaging and distribution to its 19 major retailers in 11 major cities of Finland. With a remarkably consistent lead-time of less than 12 hours, the management relies on the dedication of a highly motivated production team to process over 40 different types of vegetables into a daily output of approximately 18 tons of over 300 different products for over 40 different customers 6 days a week.

1.4.2 Process Flow

The production process which is structured to fulfill all requirements for production of safe and wholesome foods can be broken down into eight very distinct and essential processes.

- **Raw material inspection and storage:** This is the first point of quality check in the production line. Raw materials coming in from the supplier are checked by the purchasing team for defects before storage. If the raw material is found to be defective either in quality or in specification, the supplier is notified and reclamations are made. If the raw material is found to be in satisfactory condition, it is then sent into the storage area and assigned a unique set of numbers which are also used in tracking the raw material when it goes out for processing. The storage temperature ranges from 2 degrees Celsius to 4 degrees Celsius depending mostly on the frequency of human traffic.
- **Unpacking and sorting:** Raw material designated for processing are unpacked from their original packaging and transferred into special plastic boxes for washing. During this process, the raw material is examined to remove defective items that may have found their way into an otherwise good batch. Care is also taken to examine the raw material for signs of spoilage that could affect the quality and shelf life of the final product.
- **Washing and storage:** Raw materials are washed in the washing room and transferred into a cold storage area where it waits for processing. Washing is done in a special washing line at sufficient water pressure to ensure effectiveness.
- **Processing:** Washed raw materials are processed through different processing lines into various products by hand or machine. The tracking numbers for each raw material are entered into the database before they are moved out for processing.

- **Quality check:** Processed products are checked as they come out of the line for defects, homogeneity and packing temperature.
- **Packing, labeling and boxing:** the products are packed into several different packages, labeled and boxed appropriately. Labeling is consistent with the EU regulations on the labeling of food products.
- **Palletizing:** The packed products are deposited onto pallets in the product storage area and prepared for delivery to the customer.
- **Cleaning and decontamination:** At the end of each production day, the factory is cleaned by professional cleaners and all surfaces decontaminated and prepared for production.

1.4.3 The Workforce

A very unique attribute of the company is the diversity of its approximately 55-member work force. Whether by accident or by design, the management had managed to attract a culturally diverse collection of workers at a time when most Finnish employers were still very shy about employing foreigners. In the 22 odd years of its existence, the company has benefitted from the experience and expertise of workers from 15 different countries. Presently there are workers from 13 different countries in its workforce.

1.4.4 Waste Management and Handling in the factory.

Over the years, the management of waste in the factory has evolved from basic mixed waste collection to sorting of wastes and very recently to primary handling of wastes in situ. A waste management plan consistent with environmental obligations and EU laws was first proposed and implemented in the summer of 2011. The theme of the proposal was 'cleaner production' and the goal was to reduce the amount of waste generated during production by encouraging waste reduction at source rather than end-of-pipe solutions. The proposal amongst other things resulted in more emphasis being placed on the impact of generated waste on the environment and plans for long-term solutions to several waste management challenges. A wastewater management solution was also put in place to reduce the impact of production runoffs on the environment. Unhygienic practices like returning of spilled in-process material from the floor back to the processing line were strictly prohibited and the feeding of the processing line beyond its capacity was curtailed. Constant cleaning of floors during production was also advised resulting in a general improvement in the work environment.

As production increased over the years, waste began to present a huge challenge to the management. Bio-waste was particularly a pressing issue because it could not be stored for long periods without compromising the hygiene of the factory and possibly the comfort of neighbors due to the offensive odor of decaying organic matter. Previously, land spreading of food and agricultural wastes was permissible on privately owned fields, but with the implementation of the 'EU Nitrates Directive' and Water Framework Directive (WFD) the use of land for such purposes became unlawful, giving rise to a need for alternative long-term solutions. (European Commission 2010) Modern hydraulic presses are now in place for bio wastes, paper materials and mixed wastes respectively. Wooden crates, metals and batteries are each collected in separate containers. There is also a lot of reuse of materials, particularly carton boxes. There are considerable savings associated with this practice, in addition to the reduction in the amount of material that would have ended up as waste. Carton boxes that not reusable are sent to the carton press where they are compressed, bound and sent out for recycling. Wooden pallets that usually come in with the raw materials are put to use in the palletizing of finished products due to be supplied to customers. Unfortunately the inflow of wooden pallets into the factory exceeds the outflow significantly, to the end that a huge waste of wooden pallets is kept in storage in the factory. Wastewater was previously channeled to underground sewage tanks. The technical specification of the tanks is unclear and it becomes all the more worrisome when the increased amount of wastewater associated with increase in production is taken into consideration. There have been unverified concerns in the past that runoffs from the sewage tanks ended up in the stream that ran behind the factory. Thankfully such concerns have been put to rest with the connection of the waste water pipes to the municipal wastewater treatment grid. The continuous improvement policy adopted by the management and the implementation of quality assurance and management standards have ensured that the standards of waste management remain in a state of constant improvement in keeping with industry and EU standards.

1.5 Objectives and Scope of study

The purpose of this paper is to model a holistic and practicable waste management plan that attempts to redefine the concept of waste, thereby achieving waste reduction alongside improvement in quality, customer satisfaction and productivity. The Operations Management tools of LEAN and Six Sigma as-well-as traditional operations management principles will form the basis of this effort. All the analysis in this paper

will be based on data collected from observations of actual production processes in the factory and the work will be done in collaboration with the management and production personnel.

The study does not include in-depth analysis of the Lean or Six Sigma, but attempts to show how the fundamental components these tools can be applied in the case study under discussion to achieve optimum and calculable benefit from the operations management perspective. In the analysis of the production process, the biochemical mechanisms which are inevitable and significant factors upon which the process revolves will also not be part of this study, but may be referred to for clarification purposes.

2 MATERIALS AND METHODS

The method used in this study is based first on a performance improvement survey and secondly on a process improvement case study. Analysis of data from the case study will be quantitative, while analysis of the performance improvement survey will be both quantitative and qualitative. IBM's SPSS statistical tool will be used for this analysis and graphs will be generated using Microsoft excel.

The performance improvement survey was incidentally the first ever in the history of the company and was very significant in the sense that it was part of the company's program on its journey to acquiring the ISO 22000, 14001 and 9001 for food safety, environmental management and quality management respectively.(Company X) The survey was done using an anonymous questionnaire of 6 sections which included 58 questions, 6 of which were qualitative and the rest quantitative. Amongst other equally essential matters, the survey attempted to assess the workers' level of awareness on waste and its impact on production operations. It was also a medium for the management to determine the willingness of workers to voluntarily participate in these types of exercises in the future.

The process improvement case study was based on the processing of sliced onions and the data was from actual production figures. The study was done in conjunction with the management team and two experts from NNZ Scandinavia, Denmark, a packaging solutions company. They provided packaging materials, technical support and background information for this study.

In summary, the methods will involve;

- Sampling the opinion of the production personnel using a questionnaire to ascertain the level of awareness on the waste situation in the factory.
- Observation and participation in production processes to identify waste generation hot spots and inefficient production practices.
- Selecting and designating a production line as a model for sampling of opportunities.
- Observing and analyzing data on the processing of the designated model product.

- Consulting with the management on possible approaches and proffering systematic and practicable solutions.
- Deploying and implementation of the solution.
- Discussion and analysis of the outcome.
- Final reporting and recommendation.

3 LITERATURE REVIEW

This chapter discusses the theoretical basis for this study. The concepts and ideas put forward are not new and have been discussed extensively in various academic publications and research materials all of which have been duly acknowledged.

3.1 Operations Management Perspective on Waste

The different activities that make up the typical production operation generate large amounts of different kinds of waste in varying proportions depending on several factors. In many situations the volume of waste can be controlled by understanding and manipulating the underlying factors. Some of these factors are;

- Volume of production
- Quality of raw material
- Efficiency of production processes
- Competence of production personnel
- Handling and storage conditions of finished products

Because production is confronted daily with three pertinent questions; what to produce, when to produce and how much to produce, operations management tends to look at waste from a somewhat different perspective. The widely acclaimed bestseller, *The Goal: A process of On-going Improvement* theorized and concluded that the ultimate goal of every production operation is to make money.(Goldratt 1984) The processes involved in a production operation must be designed to be as efficient as possible in order to fulfill all expectations of profitability. To this end, emphasis is therefore given to the proper allocation and use of raw materials and resources during production. *In summary, “operations management is concerned with converting materials and labor into goods and services as efficiently as possible to maximize the profit of an organization”.*(Investopedia) Efficiency would simply mean the use of the least possible amount of raw materials and resources to achieve company production goals of making money. Any activity in the production operation that does not aid in achieving this objective is a considered to be a waste. Operations management therefore sees not just the unusable residues from production, but other intangible by-products in production process that translate into minor or considerable losses in revenue. In a more simplistic definition of waste, Robinson and Schroeder (1992), (cited by B.V.Cadambi, IBS, Pune, in the article, ‘Waste management, an operations and strategic performance

driver'), waste is anything that adds cost without adding value. (Cadambi 2011) This definition captures the thinking behind operations management most effectively because it takes into consideration not just the material wastes, but also other resources like time and labor to which we can assign some form of value.

With conventional waste management, waste is easily identifiable because it is comprised of physical substances which are observable, classifiable and measurable. With operations management, waste takes on a near abstract form and can mostly be identified by principles that are intrinsic to the idea of maximizing profit by improving the efficiency of production. If we think of the whole production process as a system, we can also consider all the activities and components of this system as one form of energy or the other. The efficiency of the system is the ratio of energy output to energy input, which according to the law of conservation of energy can never be greater than 100 percent. Taking all inputs (raw materials, labor, time etc) and all outputs (identifiable wastes inventory and profits) into consideration, it will be logical to assume that any additional input into the system, must yield some form of change in the value of the output. In the event that there is no beneficial change in the output, such an input can correctly be classified as a waste. Such an input could be an extra process added to the production line, a change in the specification of raw material, the hiring of an extra worker or a delay in the production line. Any of these changes, incidental or deliberate, could be considered to be a waste if it does not yield a profit at the output.

LEAN and **SIX-SIGMA** are two proven operations management tools that deal with waste identification, elimination and improvement of quality. By deploying these tools, the production environment becomes more challenging as the nature of waste continues to evolve in the drive for continuous improvement. While lean emphasis is on the identification and elimination of wastes in the production process, six-sigma is concerned with the reduction of defects in production thereby improving quality and customer satisfaction. Both concepts constitute the driving principles behind process improvement in operations management.

3.2 Lean and the Toyota Production System (TPS)

A better understanding of Lean manufacturing must take root in an exposition of the fundamental principles of its precursor, the Toyota Production System (TPS). Lean

manufacturing is basically the western variant of the Toyota Production System (TPS). Both are very closely related in principle and both have the same objectives;

- Provide customer satisfaction.
- Do so profitably. (Earley 2015)

Historically, both terminologies are separated by over four decades of manufacturing history, with the Toyota Production System (TPS) preceding Lean. The development of the Toyota Production System (TPS) started in 1949 and became fully established in the 1970s with development and implementation of Just-In-Time (JIT) by Ohno Taiichi who showcased the Toyota principles in his 1988 publication, *Toyota Production System: Beyond Large-Scale Production*. Just-In-Time (JIT) and Jidoka are known as the pillars of TPS. (Earley, 2015)

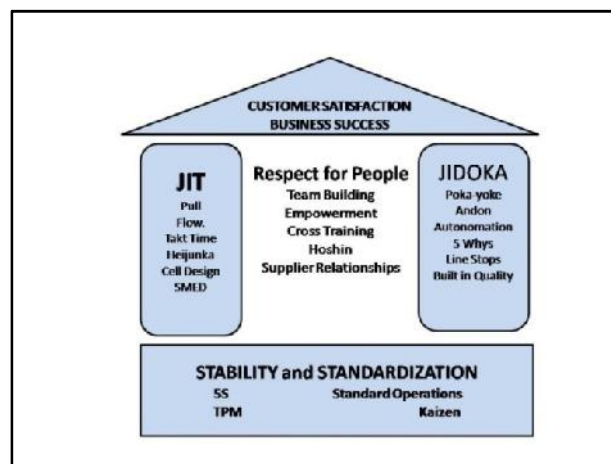


Figure 1: The Pillars of Toyota Production System (Earley, 2015)

3.2.1 The concept of Jidoka

Jidoka which means ‘autonomation or automation with a human touch’ dates as far back as 1896 with the invention by Sakichi Toyoda of a device that prevented defects in the product by stopping the shuttle whenever the thread broke in the loom. (Earley, 2015) This invention made it less likely for the loom to produce defects and also possible for several looms to be monitored by a single operator.

The concept of Jidoka is not just about autonomation, it is comprised of any series of activities which are broken down into four principles, the implementation of which results in improved quality and increase in productivity. These principles are;

- Discover an abnormality.
- STOP.

- Fix the immediate problem.
- Investigate and correct root cause. (Earley, 2015)

3.2.2 Just-In-Time (JIT)

Just-In-Time (JIT) is the core management philosophy of the Toyota Production System. It is a continuous-improvement approach to doing business in such a way that customer demands are met at the exact time, in the right quantity and at the right quality. In recent times it is mostly understood as the philosophy of manufacturing with minimum wastes. JIT is believed to have been developed in the 1970s by Ohno Taiichi who is also commonly known as the father of JIT. It was he who identified waste as the primary obstacle to profitability in Toyota and classified them into what are popularly known as the 7 deadly wastes. They are;

- Overproduction.
- Work-in-process waiting times.
- Unnecessary movement of raw materials and finished products
- Unnecessary movement of personnel
- Over-processing or non-value-adding processes
- Excess Inventory
- Defects (University of Cambridge)

It is worth mentioning however, that JIT relies heavily on the Statistical Quality Control (SQC) techniques that were taught to the Japanese by Dr. Edwards Deming in 1950. (Mazur, Online source) Even though the idea and practice of SQC was already in-place in Japan before Deming's lectures, his approach of total commitment by management to continuous quality improvement (Kaizen which literally means 'change for the better') and simultaneous waste reduction had a transforming effect on Japan's the manufacturing landscape in general and Toyota's fortunes in particular.

The main points of Deming's lessons were;

- Quality first, then waste reduction.
- Quality must begin with the customer. Therefore there is the need to know the customer better.
- Continuous, consistent and insistent commitment on quality by management.
- Quality improvement is a continuous process. He introduced the Plan-Do-Check-Act cycle for continuous improvement.

- System thinking. Consumer, supplier and producer are part of one network. All parties must work together to achieve better results. (Dowd, 2006)

Dr. Deming had taught these same principles in America with little or no effect as the Ford manufacturing model was taken to be the pinnacle of manufacturing culture at that time. The Japanese on the other hand bought into Deming's principles, religiously implemented them and achieved unprecedented global success that has kept Toyota ahead of the global car manufacturing industry ever since.

Toyota's entry and domination of global car markets prompted Ford executives to visit Japan to find out what they were doing differently. However, the principles they learnt were applied back home with little success mainly due to lack of in-depth understanding of the constituent concepts. In 1984, MIT launched an investigation into the global car manufacturing industry using Toyota as a model. The outcome of that study was summarized in the 1990 publication 'The Machine that Changed the World' by James Womack, Daniel Jones & Daniel Roos. (Brockberg 2008) It was also in this publication that they christened the Toyota Production System as LEAN PRODUCTION.

3.2.3 The Five Elements of Lean Production

According to Brockberg (2008), lean thinking can be summarized under five fundamental elements;

- IDENTIFY VALUE: It is important to understand and clearly define value from the customers' perspective. What is the end customer actually willing to pay for? Very often there are very specific activities and resources put into a product that actually add value from the end customers' point of view. All non value-adding activities constitute waste.
- MAP THE VALUE STREAM: All activities and processes from the supply of raw material to delivery of product or service to customer make up the value stream. Identify all the needed activities and remove all unnecessary ones.
- CREATE FLOW: Create a flawless process by removing all obstacles that cause interruptions in the production process. Eliminate machine downtimes, always

have a plan-B, ensure that all resources needed for production are available when needed.

- **ESTABLISH PULL:** It is not necessary to produce when the customer has not asked for a product. Let the customer drive the pace of production.
- **PURSUE PERFECTION:** Continuously scrutinizing the processes and activities across the lines will result in identifying better, faster and cheaper ways of delivering value to the customer.

These 5 elements of lean are the core principles that drive the Toyota Production System.

3.3 Six Sigma

Sigma (σ) as a measurement standard has been used in statistics to define standard deviation which is the distribution of data around a mean value. (Purdue University, Online source) It can be thought of as a measure of how much the values of a sample are spread-out from each other. The more spread-out a sample is, the higher the standard deviation. In the mid 1980s, the Motorola Company developed Six Sigma as a measurement standard to reduce process variation and improve product quality to the customer's satisfaction. (Barney 2002) Dissatisfied with the existing quality levels, the then chairman of Motorola Bob Galvin wanted to measure defects per million opportunities rather than the traditional measurement based on measurements in thousands of opportunities. Statistically a Six Sigma process or product is defined by Motorola as one that has no more than 3.4 defects per million opportunities or units. This change would seem to present a huge challenge when compared with traditional standards which, in the thinking of Motorola management, have become obsolete and are now inconsistent with the level of technological development in this era. The name Six Sigma is a registered trademark of Motorola Inc. (Barney 2002)

Table 2: The Sigma Scale (Elhefnawi 2015)

THE SIGMA SCALE		
SIGMA	PERCENT DEFECTIVE	DEFECTS PER MILLION
1	69%	691,462
2	31%	308,538
3	6.70%	66,807
4	0.62%	6,210
5	0.023%	233
6	0.00034%	3.4
7	0.0000019%	0.019

According to General Electric, one of the first adopters of this system, “*Six Sigma is a highly disciplined process that helps us focus on developing and delivering near perfect products and services*”. (General Electric, Online source) There are six key concepts central to the idea of Six Sigma.

- **Critical to Quality:** What is most important to customer?
- **Defects:** Failing to meet customer expectations.
- **Process Capability:** What is your process able to deliver?
- **Variations:** What is customer perception of the product?
- **Stable Operations:** Consistent and predictable processes to improve customer perception.
- **Design/Redesign:** Processes designed to meet customer needs and expectations. (General Electric, online source)

When Six Sigma is successfully deployed in an organization or process, it is expected to bring about change through three pathways;

- Process improvement
- Process design/re-design
- Process management (Department of Trade and Industry, 2004)

Two Six Sigma models used in the implementation these pathways of Six Sigma. Both are systematic in approach, but differ in that one DMAIC is used to improve

on existing processes, while the other DMADV is used to redesign or launch a startup process. Both models are abbreviations of five-step processes aimed at improving performance or as with DMAIC, designing a new process.

3.3.1 Process improvement with DMAIC

- **Define Opportunity:** A problem is identified, defined and a team is formed to solve the problem.
- **Measure Performance:** All available data that describes the problem is gathered and analyzed for insight into the cause of the problem.
- **Analyze Opportunity:** Insight gives rise to theories on what may be causing the problem. These theories are then tested to identify root cause.
- **Improve Performance:** Changes are made in the process to eliminate the root cause.
- **Control Performance:** New controls are put in place to forestall reoccurrence and to reinforce the improvement gained. (Rever, 2008)

3.3.2 Process design/re-design with DMADV

- **Define:** Define the goal from the customer's perspective and determine feasibility of the new product.
- **Measure:** Measure required quality standard by sampling the voice of customers and weigh it against production capabilities.
- **Analyze:** Analyze the process options and choose the most suitable solution.
- **Design:** Design a process to deliver the determined solution.
- **Verify/Validate:** Test the design to ensure that it meets all expectations of the customer. (Department of Trade and Industry, 2004)

3.3.3 Process management

Process Management, the third element of Six Sigma is believed to be the most challenging and demanding of all the elements because it involves a change in management attitude and adoption of a new management culture. The objective of process management is to understand and control the way inputs interact in a process to produce a desired output efficiently. In reality, the components of this

third element are already an integral part any one of **DMAIC** or **DMADV**. However, with efficient output in mind, process management tries to understand the impact of each individual input in the process vis-à-vis the final output.

Process management consists of four parts;

- Defining products, processes and essential customer demands.
- Measuring performance against predetermined standards and customer demands.
- Analyzing data to optimize process management in systems.
- Controlling process performance by continuously monitoring all operations, components of processes, inputs, outputs and responding to all deviations and anomalies quickly. (The Pennsylvania State University, 2008)

Variation, defects and nonconformance creates waste and undermines customer confidence. Result oriented implementation of Six Sigma targets a zero-defect process, thereby improving efficiency, reducing costs and reinforcing customer confidence.

3.3.4 Six Sigma responsibility hierarchy

Six Sigma employs a hierarchy of colored belts very similar to those used in martial arts. The colors depict an individual's level of mastery and the role in an organization's Six Sigma program.

Master Black Belt: They are mentors to the Black Belts and Green Belts. They are the highest level of technical and organizational proficiency in the implementation of Six Sigma and ensure that the Six Sigma culture is applied consistently across all sectors of the organization.

Black Belt: They are experts trained to lead Six Sigma projects. They possess in-depth statistical abilities, leadership and interpersonal skills. They are mentors to Green Belts and dedicated drivers of the Six Sigma culture.

Green Belt: For team members involved in the actual implementation, this is the foundational level of Six Sigma mastery. They are trained to adopt Six Sigma as part of their work culture and are guided in the process by the Black Belts.

Yellow Belt: This is the awareness level training given to employees in an organization as a way of familiarizing everyone with the rudiments of Six Sigma and the processes involved.

White Belt: They are at the lowest level of the hierarchy, the least experienced and often not considered to be Six Sigma professionals in the true sense. They help with problem solving and arrange tasks for research at the local level. (AIU, Online source)

At the very top of this hierarchy we have the executive leadership who provide the vision and empowerment, and the champions who provide the drive and momentum needed to keep the vision going. The success of Six Sigma is dependent on each level's understanding and commitment to the appointed task.

3.4 Models for Change Management

The factory workforce is comprised of men and women from very diverse ethnic, socio-cultural and ethical backgrounds. This diversity can be exploited for benefits or can be ignored at the risk of constant (and often undermining) conflict. From the Japanese experience, it can be easily deduced that the transformation from the norm to the 'Lean' way of doing things is by no means be an easy task in a homogeneous society let alone in one with a very diverse social-cultural structure.

The socio-cultural basis upon which the TPS was built took several centuries of socio-religious programming of an entire nation as far back as the 3rd century A.D when the Confucian teachings came into Japan. (Born 2009) What could be considered most significant in this process of transformation is the role of leadership in the entire change process. Confucianism was not only the religion and culture of the Japanese; it was also an integral part of the laws upon which its society was built. The leadership recognized the potential unifying benefits of the Confucian orientation so much so that it was infused into the constitution of the Japanese. The principle of **wa** or harmony, which is a very fundamental Confucian teaching appears in the Seventeen-Article Constitution of Shotoku Taishi, Promulgated in 604 A.D. (Born 2009) It was a deliberate and unrelenting process of transformation, driven and sustained by a committed leadership with specific and conscientiously communicated values.

According to General Electric, *“Six Sigma has changed the DNA of GE – it is now the way we work – in everything we do and in every product we design”*. (General Electric) Successful and effective implementation of Lean and Six Sigma require a certain professional disposition that demands a deliberate and significant cultural change.

Change of this nature is not only necessary, but is inevitable and must happen at two levels; firstly, at top management level and secondly at organizational level. The kind of change or transformation needed at one level is distinctly different from that needed at the next level. Therefore the change model suitable for transformation at top management level is decidedly different from, but complimentary to that needed at the organizational level.

3.4.1 Change at Organizational level: Kotter's 8-step model for leading change

John Kotter, a Harvard-Professor publish a widely acclaimed work 'Leading Change' in 1996 in which he outlined an 8-step model for leading change in an organization. According to Kotter (2007), "*leaders who successfully transform businesses do eight things right and they do them in the right order*". This model is the outcome of over 3 decades of observation, research and experience in guiding organizations through the change process. Kotter's 8-step model is categorized into two distinct stages; the first four steps make up the de-freezing stage which is prerequisite for change to take place and quite comparable to jolting individuals from their comfort zones, while the next four steps are the freezing stage during which change is established and reinforced. The model also outlines the attendant pitfalls which leaders often overlook and which inevitably lead to the failure of the change process.

Table 3: Kotter's 8-steps to leading change (Kotter, Harvard Business review, January 2007)

	STEPS	ACTION NEEDED	PITFALLS
1	Establish a sense of urgency	Examine market and competitive realities for potential crises and untapped opportunities. Convince at least 75% of your managers that the status quo is more dangerous than the unknown.	Underestimating the difficulty of driving people from their comfort zones. Becoming paralyzed by risks.
2	Form a powerful guiding coalition	Assemble a group with shared commitment and enough power to lead the change effort. Encourage them to work as a team outside the normal hierarchy.	No prior experience in teamwork at the top. Relegating team leadership to an HR, quality, or strategic-planning executive rather than a senior line manager.
3	Create a vision	Create a vision to direct the change effort. Develop strategies for realizing that vision.	Presenting a vision that's too complicated or vague to be communicated in five minutes.
4	Communicate the vision	Use every vehicle possible to communicate the new vision and strategies for achieving it. Teach new behaviors by the example of the guiding coalition.	Under-communicating the vision. Behaving in ways antithetical to the vision.
5	Empower others to act on the vision	Remove or alter systems or structures undermining the vision. Encourage risk taking and nontraditional ideas, activities, and actions.	Failing to remove powerful individuals who resist the change effort
6	Plan for and create short term wins	Define and engineer visible performance improvements. Recognize and reward employees contributing to those improvements.	Leaving short-term successes up to chance. Failing to score successes early enough (12-24 months into the change effort)
7	Consolidate improvements and produce more change	Use increased credibility from early wins to change systems, structures, and policies undermining the vision. Hire, promote, and develop employees who can implement the vision. Reinvigorate the change process with new projects and change agents.	Declaring victory too soon—with the first performance improvement. Allowing resisters to convince "troops" that the war has been won.
8	Institutionalize new approaches	Articulate connections between new behaviors and corporate success. Create leadership development and succession plans consistent with the new approach.	Not creating new social norms and shared values consistent with changes. Promoting people into leadership positions who don't personify the new approach

Change is a process that progresses so slowly that the benefits may not be immediately evident. This makes it very essential for management to be on the lookout for and celebrate small wins that will give the process the much needed momentum. Kotter's model is a top-down model in which top management and consequently corporate power plays a major role. It is then of the highest importance that the management is in the right position to lead; firstly by having the right vision and secondly by having and exuding the right attitude. Where this is in the slightest doubt, there arises the need for change of an entirely different kind.

3.4.2 Change at the Management Level: Senge's Mental Model

Our perception of reality or truth is comprised of deep-seated internal images from the world around us that define the way we act and take decisions. Peter Senge, an MIT senior lecturer in Leadership and sustainability described these images as mental models. According to Magzan (2012), "*mental models represent deeply ingrained assumptions or generalizations that influence how we understand the world and how we take action*". Mental models are based on data mostly unverified and gathered through observation. By interpreting and analyzing this data we make up theories to help us understand our observation. These theories will become our truths which in turn determine the way we take decisions or respond to our environment. This rapid and often unconscious move from the point of observation to the points of decision and action is called the Ladder of Inference. (King 2013)

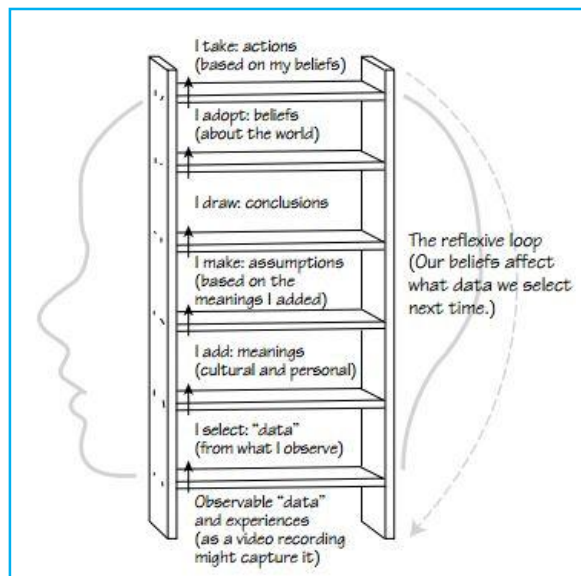


Figure 2: The Ladder of Inference showing the Reflexive Loop (Senge et al, 2000)

The ladder of Inference shows the bias in selecting data from a pool of available data based on previously held beliefs and theories. This bias could also come because we desire to select data that reinforces previously held beliefs. This influence of our previously inferred theories and beliefs on how we observe and interpret future events is known as the Reflexive Loop. (Senge et al, 2000) In a diverse work environment, limited understanding of the various social groups increase the likelihood of such presumptions and can influence leadership behavior significantly. Mental models are not bound only to individuals, they are also collective. Groups of people from similar socio-cultural background tend to interpret their environment using the same set of values and quite differently from a group from a different background. This kind of collective response helps us to understand that mental models can also be shared within an organization. People tend to align themselves with the perspective of the most influential figure within the organization. The mental model of the leader readily finds its way down the hierarchical ladder all the way through the whole organization, shaping its culture and values beyond existing socio-cultural barriers. Leadership plays the most important role of creating, shaping and guiding the vision of the organization and takes responsibility for its fortunes. The implications of this phenomenon cannot be overemphasized considering the important role of leadership on the whole and in the implementation of change, albeit Kotter's change model in particular. The wrong mental model is not likely to bring about lasting and permanent change, however brilliant the plan may be.

“Brilliant strategies fail to get translated into action. Systemic insights never find their way into operating policies. A pilot experiment may prove to everyone's satisfaction that a new approach leads to better results, but widespread adoption of the approach never occurs. We are coming increasingly to believe that this "slip 'twixt cup and lip" stems, not from weak intentions, wavering will, or even non-systemic understanding, but from mental models.” (Senge 1990)

Mental models can be changed. This change is a necessary prerequisite for organizational transformation. Wind et al (2005) proposes *“a four-step process for assessing and changing these models, and then using this shift in mindset to transform the world”*

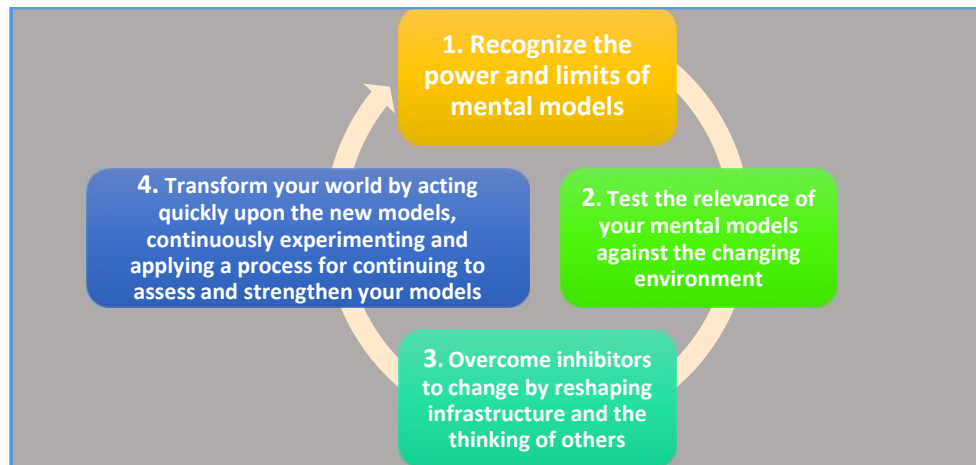


Figure 3: The 4-step Process for Mental Transformation (Soundview Executive Book Summaries)

- Recognize the power and limits of mental models. To take advantage of mental models, you have to know how they shape your possibilities. How do they limit your ability to see opportunities and threats?
- Test the relevance of your mental models against the changing environment; generate new models, and develop an integrated portfolio of models. As the world changes, do your models still fit? If so, how do you find new models and put together a portfolio of models to meet future challenges?

- Overcome inhibitors to change by reshaping infrastructure and the thinking of others. Your entire world is organized around your current models, and people around you may be much slower to change. To introduce a new order, you need to change the structures of the old world and the thinking of others.
- Transform your world by acting quickly upon the new models, continuously experimenting and applying a process for continuing to assess and strengthen your models. You need to continuously examine your models to keep them fresh and relevant, and apply your insights quickly and effectively, using informed intuition.

4 RESEARCH

4.1 Analysis of Performance Improvement Survey

4.1.1 Overview and structure of survey

The performance improvement survey was the first ever and a landmark in the history of the company. This is more so because it was part of the activities approved by the company for the quality systems ISO 22000, 14001 and 9001 certifications for food safety, environmental management and quality management respectively.

The survey was done for three specific reasons;

- To create a platform for employee feedback periodically.
- To set a reference point for measuring employee satisfaction in the future.
- To bring employees into alignment management expectations on issues concerning quality, waste and the work environment.

The survey was based on an anonymous questionnaire comprising 6 sections (Motivation, Performance, Teamwork, Supervision, Quality Assurance and Waste) and 53 questions. The number of employees available for the exercise was 32, but the number of respondents was 26, representing 81.25% of the total number of employees available.

Table 4: Participation of Respondents

PARTICIPATION		
Headcount	Number of Respondents	% Respondents
32	26	81.25

4.1.2 Research questions

Using Pearson's correlation analysis in IBM's SPSS, the survey attempts to find the relationship, if any, between employees' length of service, motivation and the level of exposure to issues relating to quality, waste, teamwork and the general work environment.

For the purpose of this study only responses to 9 questions from the questionnaire most relevant to the subject matter of this study will be used in the analysis. The questions are shown in the table below.

Table 5: Questions Relevant to the Study

	Questionnaire section	Question Number	Question
1	Employee motivation	1-1	How long have you worked in the company?
2		1-2	How much have you enjoyed working in the company?
3	Employee performance	2-3	Do you want more innovative tasks?
4	Team work	3-5	In the factory we work as a team.
5		3-8	More cooperation leads to better performance.
6	Quality assurance	5-1	I am aware of company goals about the quality of production.
7		5-3	I have received training about the standard/outcome of production.
8	Waste situation	6-8	We make more wastes when raw material is bad.
9		6-9	The factory loses money when we make too much waste.

1. The level of employee motivation is directly proportional to the duration of employment.

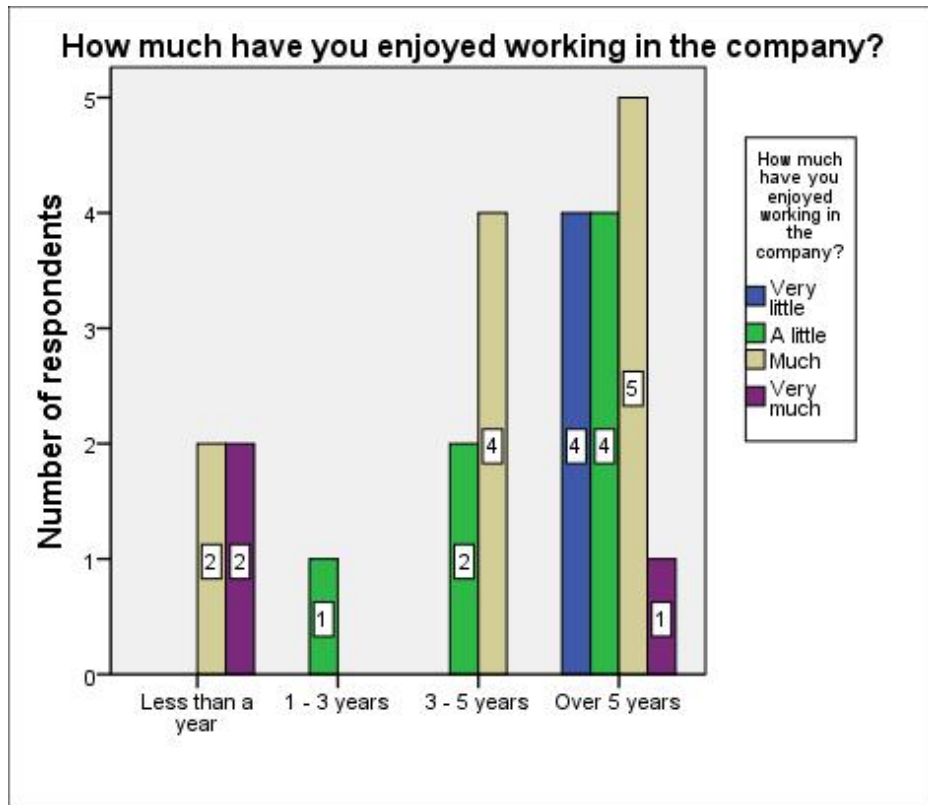


Figure 4: Relationship between duration of employment and employee motivation

Table 6: Correlation between duration of employment and employee motivation

Correlations			
		How long have you worked in the company?	How much have you enjoyed working in the company?
How long have you worked in the company?	Pearson correlation	1	-.483*
	Sig. (2-tailed)		.014
	N	26	25
	N	25	25

*. Correlation is significant at the 0.05 level (2-tailed).

The data analyzed above shows that there is a significant negative correlation between the length of service and job satisfaction (Pearson’s correlation= -0. 483*, $P= 0.014$, $N= 25$). By implication employees tend to be less happy with their work as they get older on the job. However, the data also shows that at least 10 respondents who have been working for over 3 years have enjoyed working in the company.

2. The employee disposition to team work is in proportion to the duration of employment.

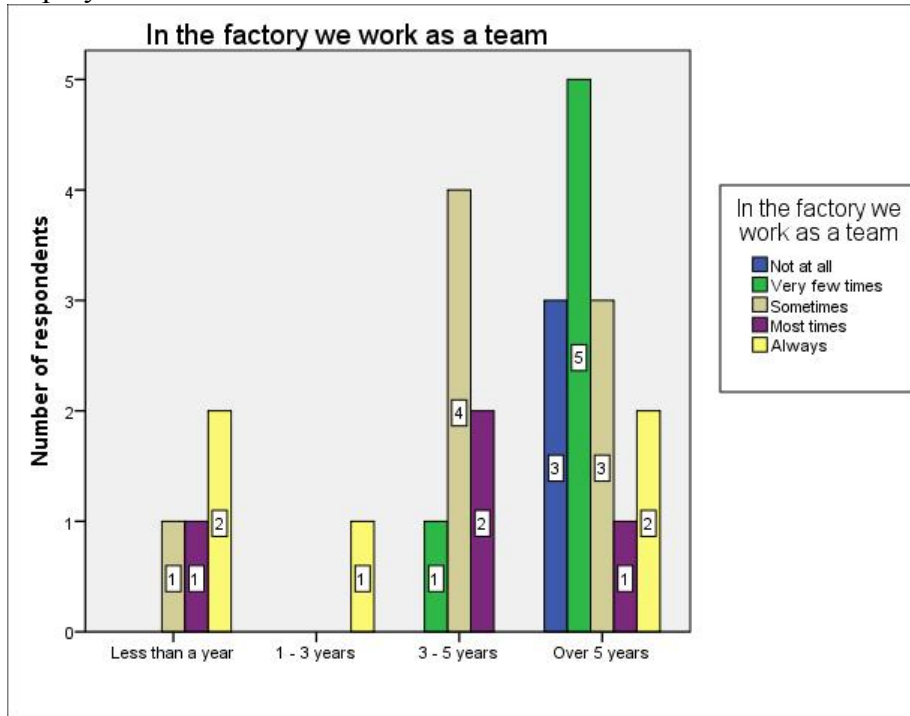


Figure 5: Relationship between duration of employment and disposition to teamwork

Table 7: Correlation between employee disposition to teamwork and duration of employment

Correlations			
		How long have you worked in the company?	In the factory we work as a team
How long have you worked in the company?	Pearson correlation	1	-.500**
	Sig. (2-tailed)		.009
	N	26	26
	N	26	26

*. Correlation is significant at the 0.01 level (2-tailed).

The data analyzed above shows that there is a statistically significant negative correlation between the length of service and employee disposition to team work (Pearson’s correlation= -0. 500**, $P= 0.009$, $N= 26$). By implication employees tend to be less disposed to team work and more individualistic with tasks as they get older on the job. There 5 respondents, 2 of whom have been working for over 5 years who agree that employees work as team always. This kind of disparity exists possibly because

there has been no formal team building program and perhaps the employees do not have a proper understanding of what teamwork entails.

- The employee longing for creative expression is in proportion to the duration of employment.

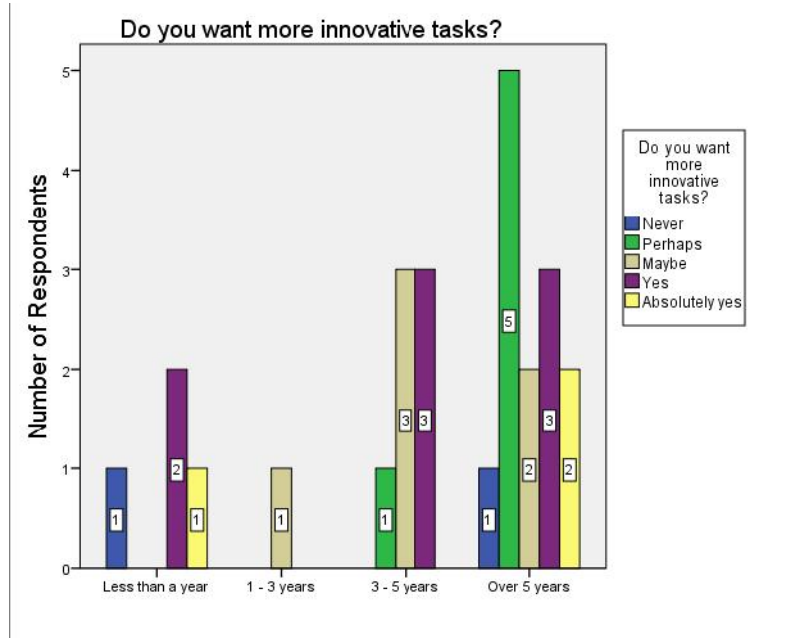


Figure 6: Relationship between duration of employment and employee desire for creative expression

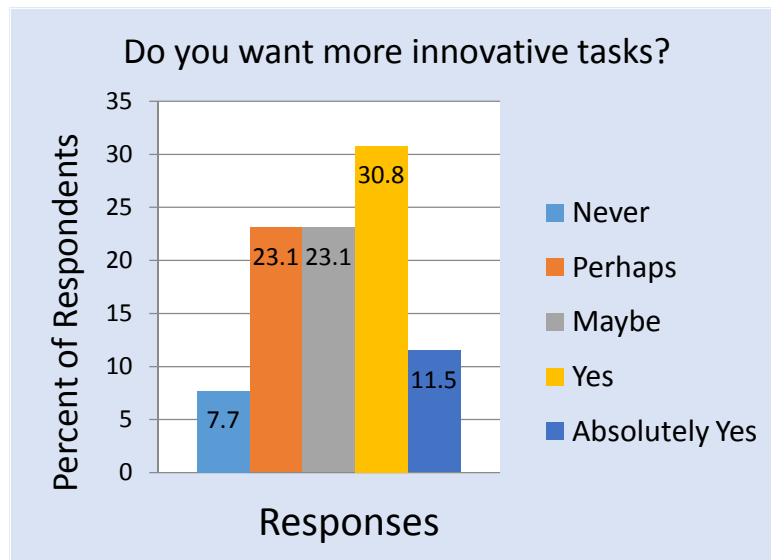


Figure 7: Employees desire for creative expression

Table 8: Correlation between duration of employment and employee desire for creative expression

		Correlations	
		How long have you worked in the company?	Do you want more innovative tasks?
How long have you worked in the company?	Pearson Correlation	1	-.147
	Sig. (2-tailed)		.483
	N	26	25
	N	25	25

The data analysis shows no significant correlation between the length of service and employee desire for creative expression (Pearson's correlation = -0.147, $P = 0.483$, $N = 25$). All individuals have that innate longing for creative expression and self-actualization. Self-actualization is at the peak of Maslow's five-stage hierarchy of needs published in 1943 by Abraham Maslow, an American psychologist. (Green, 2000)

4. The employee perception of teamwork is in proportion to the duration of employment.

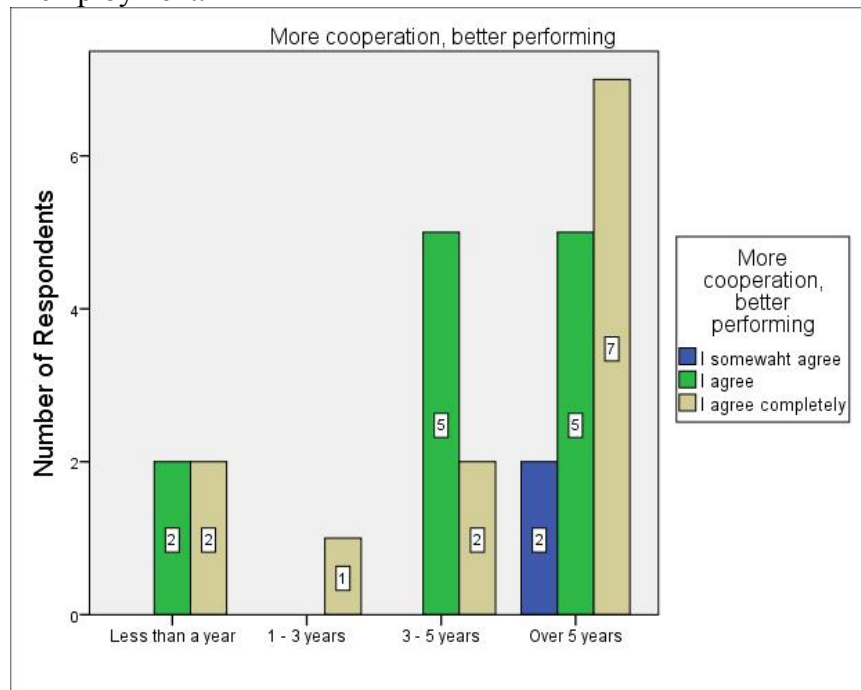


Figure 8: Employee perception of teamwork in relation to duration of employment

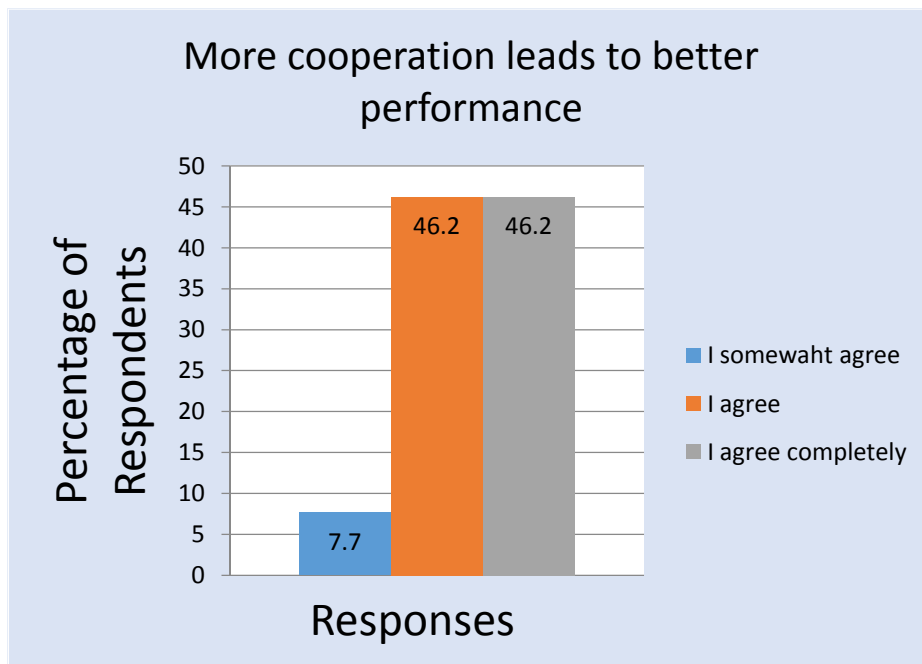


Figure 9: Employee perception of team work

Table 9: Correlation between perception of teamwork and duration of employment

Correlations			
		How long have you worked in the company?	More cooperation leads to better performance
How long have you worked in the company?	N	26	26
	Pearson correlation	1	-.105
	Sig. (2-tailed)		.610
	N	26	26

The data analysis shows no statistically significant correlation between the length of service and employee perception of teamwork (Pearson's correlation = -0.105, $P = 0.610$, $N = 26$). All employees share the same opinion regardless of the duration of service.

- There is a relationship between employees understanding of quality and the duration of employment.

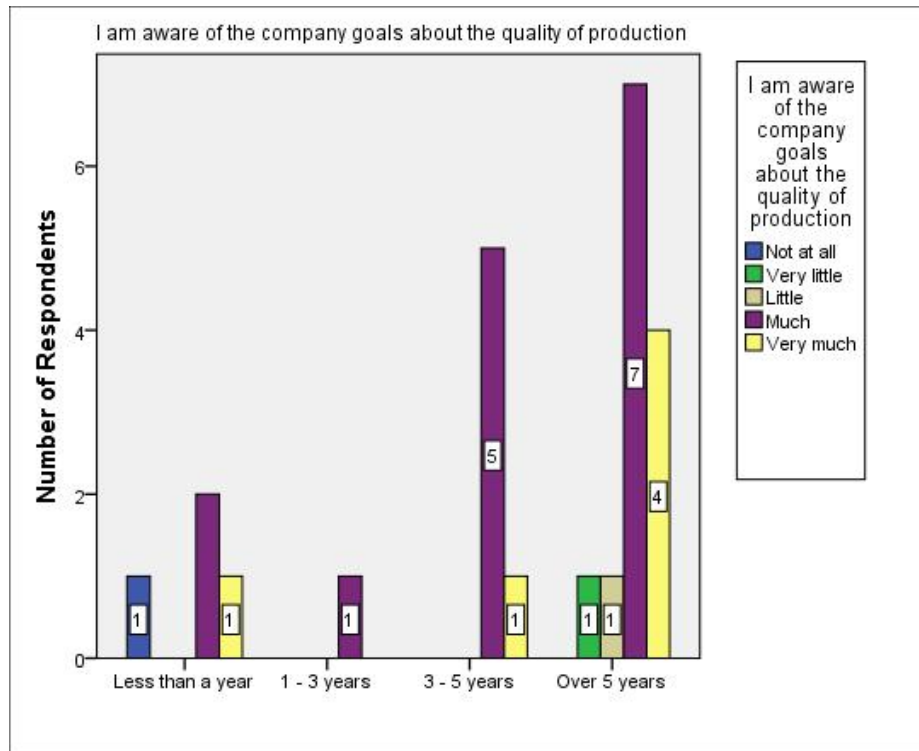


Figure 10: Relationship between employee duration of employment and the understanding of product quality

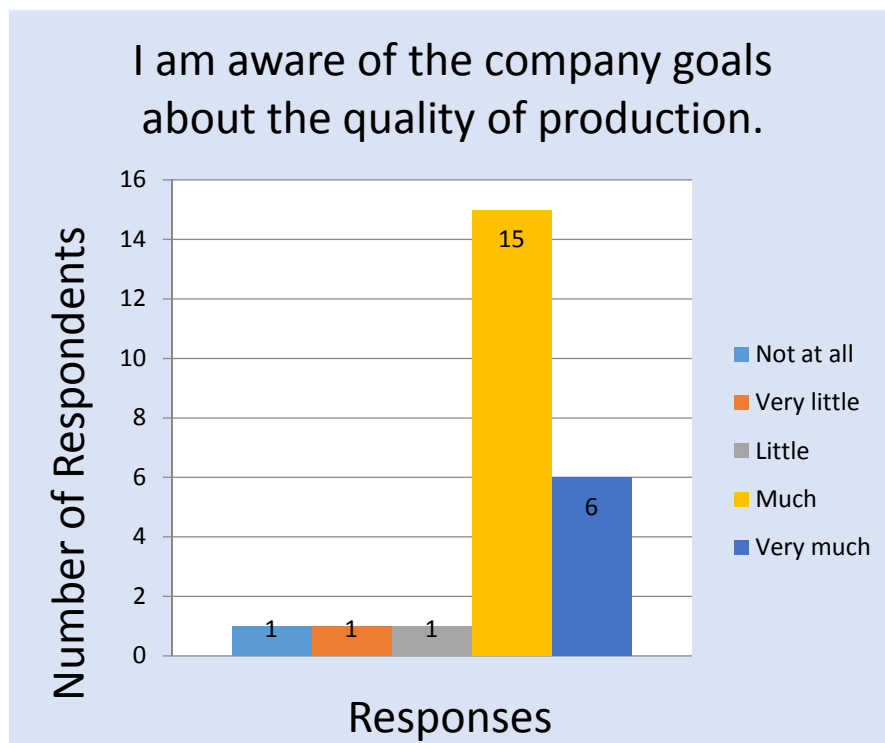


Figure 11: Employee awareness of quality standards

Table 10: Employee awareness of quality standards

I am aware of company goals about the quality of production		
	Frequency	Percentage
Very much	6	23.1
Much	15	57.7
Little	1	3.8
Very little	1	3.8
Not at all	1	3.8

Table 11: Correlation between awareness of quality standards and the duration of employment

Correlations			
		How long have you worked in the company?	I am aware of company goals about the quality of production
How long have you worked in the company?	Pearson correlation	1	.221
	Sig. (2-tailed)		.299
	N	26	24
	N	24	24

The table shows no positive correlation between the employees' awareness of quality and the length of service (Pearson's correlation= 0.221, $P= 0.299$, $N= 24$). The distribution appears to be irregular suggesting that there may be insufficient formal transfer of relevant information concerning quality of production. This conclusion is reinforced by the data which shows that 2 respondents who have been working for over 5 years have little knowledge about company standards on quality, while 1 respondent who has worked for less than a year knows nothing at all. Information about the quality of production should be of fundamental importance and must be formally communicated to every employee from the first day of engagement.

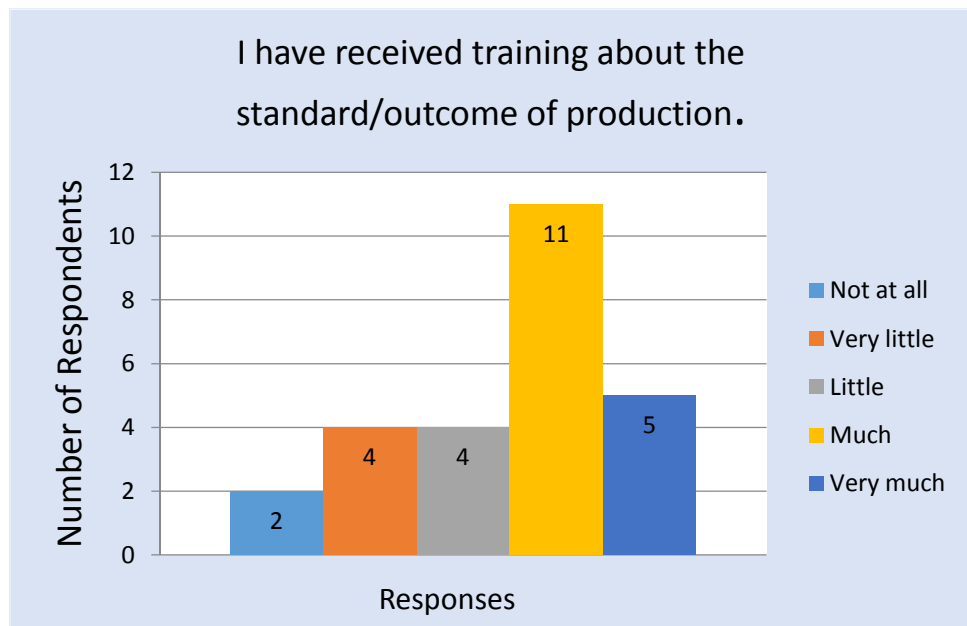


Figure 12: Employee awareness of instructions regarding product quality

Table 12: Correlation between employee training on quality and the awareness on quality standards

Correlations			
		I am aware of company goals about the quality of production	I have received training about the standard/outcome of production
I have received training about the standard/outcome of production	N	24	.24
	Pearson correlation	.186	1
	Sig. (2-tailed)	.383	
	N	24	26

The table shows no correlation between employees' knowledge about quality and the training received (Pearson's correlation= 0.186, $P= 0.383$, $N= 24$). There is no information on the content of the training received and whether the training was received prior to or during employment at the company. This still points to the possibility that there is no formal program for regular transfer of information about the quality of production.

6. There is a between work experience and fundamental understanding about production wastes.

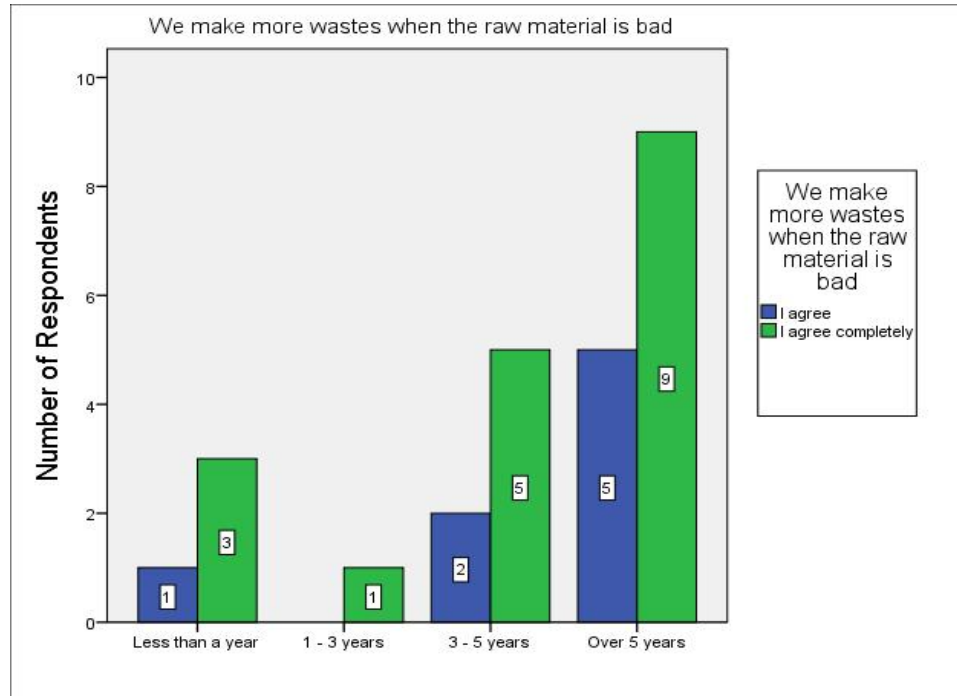


Figure 13: Employee understanding of relationship between quality of raw materials and production wastes

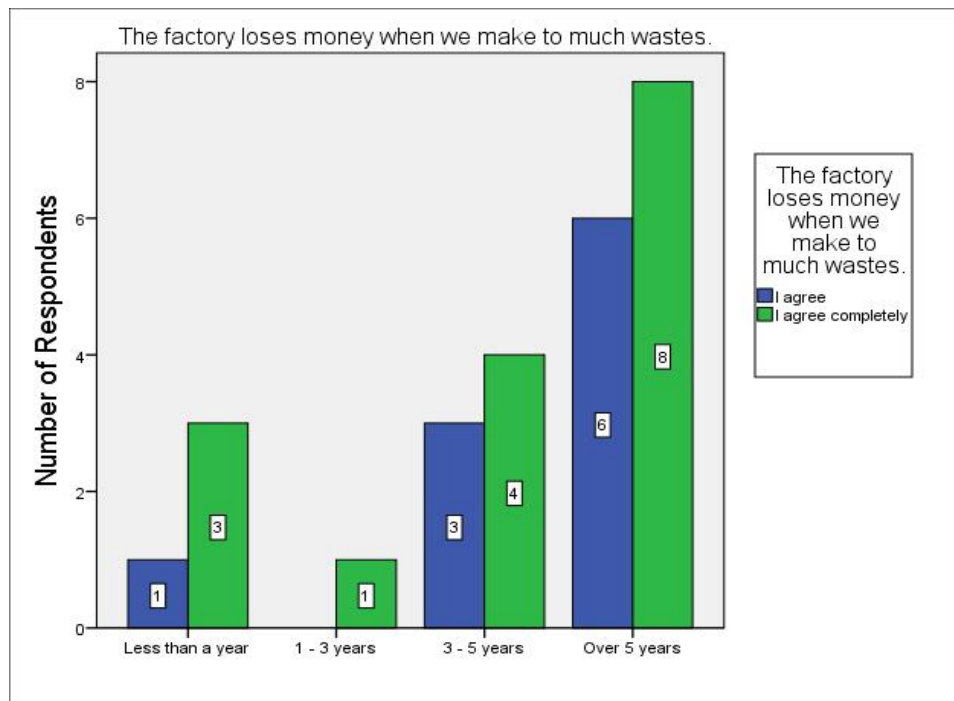


Figure 14: Employee understanding of relationship between production wastes and factory finances

Table 13: Correlation of duration of employment, understanding of wastes and factory finances

Correlations				
		How long have you worked in the company?	We make more wastes when raw material is bad.	The factory loses money when we make too much waste.
How long have you worked in the company?	Pearson correlation		-.101	
	Sig. (2-tailed)		.624	
	N		26	26
We make more wastes when raw material is bad.	Pearson correlation			.843**
	Sig. (2-tailed)			.000
	N		26	26
**. Correlation is significant at the 0.01 level (2-tailed).				

Correlation analysis shows that there is no correlation between length of service and understanding of production wastes (Pearson's correlation= -0.101, $P= 0.624$, $N= 26$). The understanding of production wastes is not influenced by the length of service. However there seems to be a statistically significant correlation between of understanding about raw material wastes and the effect on factory finances (Pearson's correlation= 0.843**, $P= 0.000$, $N= 26$). Every employee seems to understand the meaning and impact of production wastes regardless of the employee's length of service.

4.2 Process improvement case study

4.2.1 Introduction

This case study is based on a test carried out from the 1st – 9th July 2014, on the processing and packaging of two varieties (purple and white) of sliced onions in collaboration with experts from NNZ Scandinavia Aps. The study was carried out under normal production conditions in the production facility of the food processing company.

Participants during the tests included two production supervisors and some members of top management.

4.2.2 Theoretical background on processing properties of sliced onions

- Fresh-cut onions should have no discoloration, skin and core.
- Onion bulbs should be free of decay, dry, firm and 7.5 – 10 cm in diameter.
- Storage temperature at the core should be 1.5 degrees Celsius and 1- 3 degrees Celsius before and after processing to ensure quality.
- Bulbs are washed in water at 0 degrees Celsius before processing and onion rings washed in chlorinated water at 0 degrees Celsius after processing.
- Fresh-cut packed onions derive slight benefits from controlled atmosphere of 2% - 5% oxygen + 10% - 15% carbon dioxide and decreases respiration and microbial proliferation. It also retains sucrose and pungency of cut onions.
- Onions have antifungal properties due to the presence of oxides of disulfide, thiosulfinates and propene disulfide, known as bacteriostatics.
- Respiration rate of sliced onions is temperature dependent as shown in the table below.(Chrintz & Hultén, 2014)

Table 14: Respiration rate of sliced onions (Chrintz & Hultén, 2014)

Temperature °C	Respiration Rate $\text{mg CO}_2 \text{ Kg}^{-1} \text{ h}^{-1}$ <small>Chrintz & Hultén</small>
2	14.0
5	23.4
10	38.0
23	126 - 131

4.2.3 Problem Statement

The shelf life of sliced onions does not guarantee the freshness of the product within the set time limit for consumption of the product as stipulated in the product label. The suitability for consumption is determined by the end user on basis of appearance, texture and smell of the product. Generally sliced onion begins to lose its freshness when it appears translucent and gives off a strong sour smell indicating the onset of metabolic process.

4.2.4 Objective

To extend the shelf life of sliced and packaged onions by additional 2 days. (The current shelf life is 5 days, while the desired shelf life is 7 days).

4.2.5 Methods

- Purple and white onions used for the test are delivered as whole bulbs, sorted peeled and packed in plastic bags.
- All onions were washed with water at 2 degrees Celsius before slicing.
- Onions were sliced at a room temperature of 8 degrees Celsius and then centrifuged for approximately 25 seconds before packing.
- Sliced onions were packed in 1kg packages on the GS-CP 300 Vertical Form Fill Seal packaging machine, labeled accordingly and transferred to a cold storage facility of +3 degrees Celsius.
- Reference packing material is presently used packing material (XXXX Polypropylene 40my without perforation and anti-fog).
- Test packing materials supplied by NNZ Scandinavia are as follows;
 - ❖ Orientated Polypropylene (OPP) 40my with laser perforation and anti-fog.
 - ❖ Orientated Polypropylene (OPP) 50my with laser perforation and anti-fog.
 - ❖ Barrier film Toplex 76my with laser perforation
- 8 bags per product were packed per film for the test.
- Products were boxed separately and labeled for easy identification.
- Measurements were taken daily from 2nd to 9th July 2014, for O² and CO² using the calibrated Dansensor PBI checkmate 9900 and physical observation of appearance, texture, taste and smell. (Chrintz & Hultén, 2014)

4.2.6 Test Results

Table 15: Daily oxygen and carbon dioxide readings for sliced white onions (Company X)

Sliced White Onion													
Film code	Film	Sliced White Onion Daily % of O ₂						Daily % of CO ₂					
		02-Jul	03-Jul	04-Jul	07-Jul	08-Jul	09-Jul	02-Jul	03-Jul	04-Jul	07-Jul	08-Jul	09-Jul
1VA	XXXX PP 40my	10.1	2.5	0.1	0.8	0.4	0.6	7.9	12.6	18.1	33.6	38	41.6
3	SI-OPP 40my AF/L	16	13	10.3	8.5	5.1	6.3	4.5	6.9	9.3	13	16.3	16.8
4	SI-OPP 50my AF/L	13.8	10.4	6.4	1	0.9	2.1	7.4	10.1	13.7	28.1	32.3	33.5
5	Toplex 76my/L	15.4	11.7	7.8	0	0.1	0.3	4.6	7.4	10.6	18.7	20.4	24.2

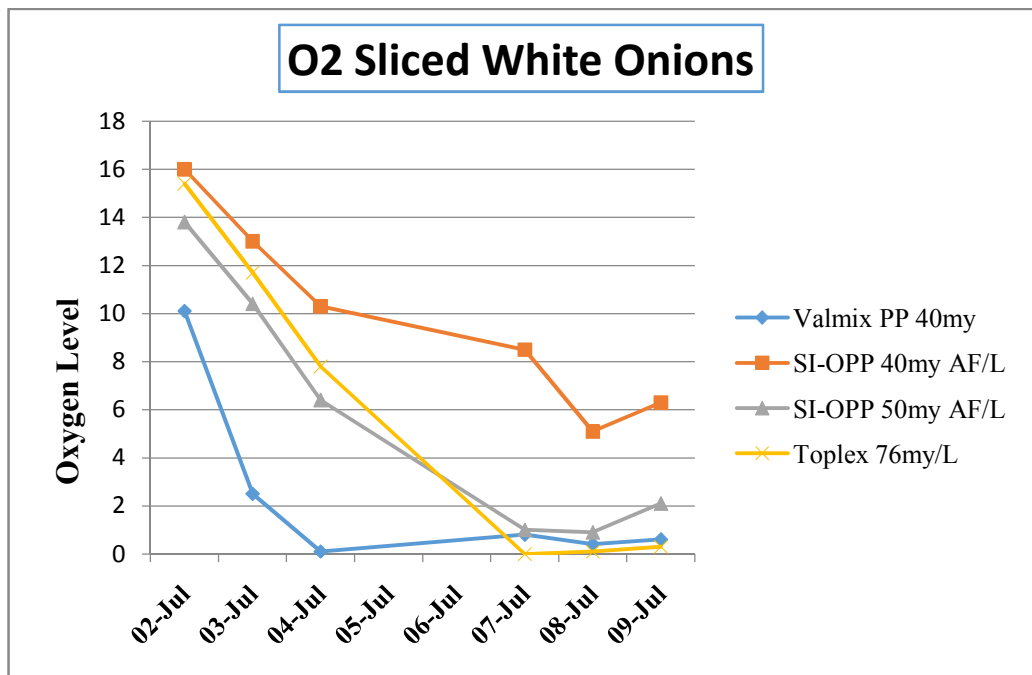


Figure 15: Oxygen level in packed sliced white onions(Chrntz & Hultén, 2014)

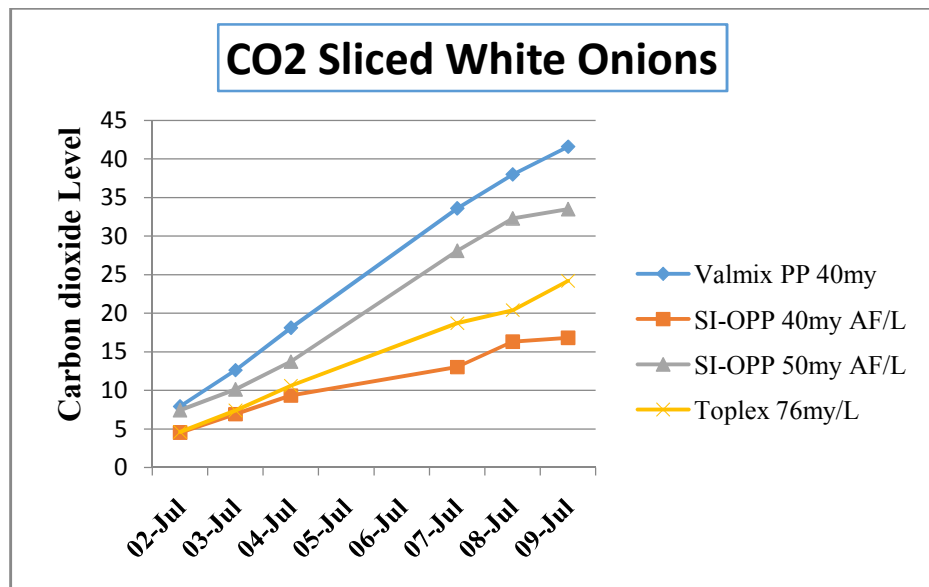


Figure 16: Carbon dioxide level in packed sliced white onions (Chrntz & Hultén, 2014)

Table 16: Daily oxygen and carbon dioxide readings for purple onions (Company X)

Sliced Purple Onions													
Film code	Film	Sliced Purple Onions						Daily % of CO_2					
		02-Jul	03-Jul	04-Jul	07-Jul	08-Jul	09-Jul	02-Jul	03-Jul	04-Jul	07-Jul	08-Jul	09-Jul
1VA	XXXX PP 40my	10.1	2.7	0	0	0.6	0.7	10.3	16.1	23.3	38.6	41.8	42
3	SI-OPP 40my AF/L	17.4	16.1	15.2	12.6	8.7	3.1	3.9	5.3	6.5	9.7	13.8	21.3
4	SI-OPP 50my AF/L	16.6	14	12.1	5.5	8.4	4.2	4.2	6.3	8.2	14	14	20
5	Toplex 76my/L	14.9	11.1	7.2	1.7	0.1	0	4.9	7.6	10.4	15.9	18.8	25.1

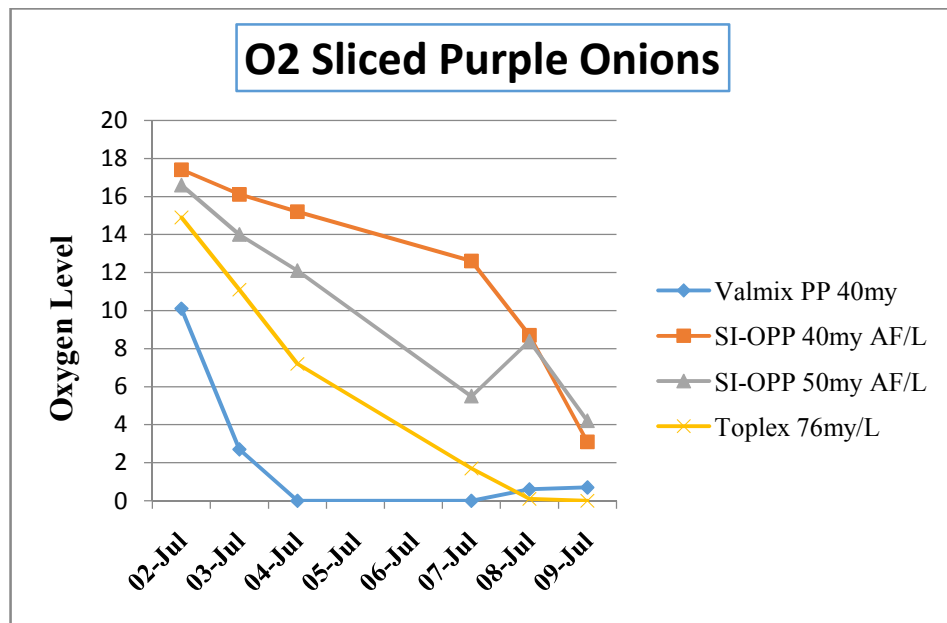


Figure 17: Oxygen level in packed sliced purple onions (Chrintz & Hultén, 2014)

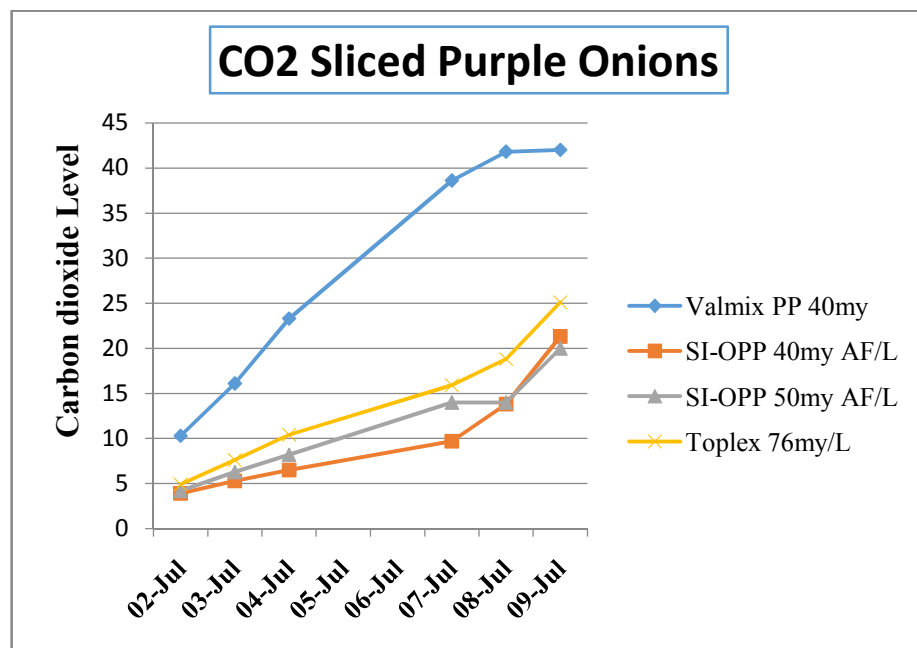


Figure 18: Carbon dioxide level in packed sliced purple onions (Chrintz & Hultén, 2014)

Table 17: Physical appearance of sliced purple onions (Company X)

SLICED PURPLE ONIONS 07072014				
FILM		APPEARANCE	TASTE	SMELL
	1VA	Pale, glassy discoloration.	Bad taste	Foul
	3	Looks fresh.	Crispy onion taste	Fresh onion odor
	5	Looks very fresh	Fresh and crispy with the characteristic onion sting	Fresh and strong onion sting
SLICED PURPLE ONIONS 09072014				
FILM		APPEARANCE	TASTE	SMELL
	1VA	Messy and completely discolored	-	-
	3	No Fog Still looking fresh	Sharp, fresh onion taste	No foul odor
	5	No Fog Still looking very fresh	Fresh onion taste	Fresh smell and onion sting

Table 18: Physical appearance of sliced white onions (Company X)

SLICED WHITE ONIONS 07072014				
FILM		APPEARANCE	TASTE	SMELL
	1VA	Glassy appearance. Moisture on foil	Did not bother to taste	Foul
	3	Looks fresh	Fresh taste	Fresh
	5	Fresh	Very Fresh	Fresh with the onion sting
SLICED WHITE ONIONS 09072014				
FILM		APPEARANCE	TASTE	SMELL
	1VA	Very soggy	-	-
	3	Fresh looking	Fresh	No foul odor
	5	Very fresh	Very fresh	Fresh smell

The observation of film no.4 was discontinued because it showed the least prospects of all the new films used for the onion tests.

General results showed that the high level of carbon dioxide generated in the reference film was not conducive for prolonged storage of sliced onions. More importantly, it was interesting to note that the laser-perforated films provided very good oxygen/carbon dioxide balance suitable for longer storage of sliced onions. Both products proved to be excellent on the 9th day of the test.

To better understand the possible impact of this case study on onion processing, we have to put the existing production situation for sliced onions into perspective. Production is done on a daily basis based on demand estimates. This means that production is done even before orders are received for the day. The daily estimate is usually between 100 kg and 140 kg which are usually sufficient for the day leaving a little excess as start-up for the next day. However this does not work out so well on Thursdays when it is mandatory that there can be no excess products at the end of the day. Very often the estimates for Wednesday spill over into Thursday and the estimates for Thursday exceed the demand and must be put away as waste. The challenge of processing onions daily has other drawbacks. Onions has a reputation for contaminating other products due to its pungency and the sulfur content. The machines for processing and packing onions are also used to process and pack several other products, thereby increasing the risk of contamination by onions. Setup times, processing and cleaning of machines for onion processing and packaging is over 3 hours daily. All of this is bound to the use of the existing packaging film with which production is hardly able to promise a fresh product by the fifth day after packing.



Figure 19: Shelf life of sliced onions packed in XXXX PP film



Figure 20: Shelf life of sliced onions packed in Si-OPP 40my AF/L film supplied by NNZ Denmark

Legend



The figures above show a graphical comparison of the properties of both films as observed from the case study. Figure 19 represents the properties of the old film (XXXX PP 40my) and shows that the observed last possible day of use is on the 4th day after production and is not good to be used on the promised 5th day.

The new laser-perforated film (SI-OPP 40my AF/L) is represented by Figure 20 and shows that the last possible day of use is 4 days after the marked last day of use. This shows that the product is still safe to be supplied to the customer on the last marked day of use. This outcome is consistent with the expectation of the manufacturers of the film as was claimed before the trial commenced. This outcome therefore is not an anomaly in any way except in the sense that the outcome fell short of manufacturers' expectations and several reasons were put forward for that shortfall.

- The raw material used for the trials was not of the best quality. There were already signs of spoilage on some of the raw material.
- The core temperature of the raw material was between 4° C and 5° C. the recommended core temperature for peel onions prior to processing is 0° C and 1° C.
- The temperature during processing and packing was also within the range of 4° C and 5° C.
- The storage temperature was mostly between 2.5° C and 3.5° C. This did not have significant positive effect on the temperature inside the packages as has been observed severally in the past. Temperature inside the packaging tended to remain mostly unchanged if the storage temperature is significantly lower or worse still tended to increase if the storage temperature was not low enough. This means that the temperature during packing must be as close to the ideal packing temperature as possible, which was in this case 0° C to 1° C. It is worthy of note that human traffic to and fro the storage area allowed inflow of warm air for several extended periods and temperatures as high as 10° C had been observed. Those storage conditions were very far removed from ideal.

The report that formed part of the theoretical guideline for this study was carried out by Natalia Dallocca Berno et al at the University of São Paulo (Universidade de São Paulo – USP), “Luiz de Queiroz” School of Agriculture in 2014 and the report is entitled “Storage temperature and type of cut affect the biochemical and physiological characteristics of fresh-cut purple onions”. It indicated that pre-processing and storage temperatures were the most significant determining factors in the shelf life of sliced

onions and was able to achieve a preservation time of 15 days when the product was processed at stored at 0°C.

Given that the new laser perforated film is a resource and the outcome of the study an opportunity, how would a production manager utilize this resource in order to maximize the benefits, if any, under the present circumstances? Figure 20 shows that it is possible to have all the sliced onions produced in one day without running any risk of spoilage. The immediate benefits are the savings in processing times and the significant reduction of risk to other products due to exposure to sulfur.

Any changes in the production operation must take into consideration the present production capacity and supporting infrastructure needed to implement necessary critical control points particularly in the area of raw material quality and temperature both of which have proved very essential factors in the whole production process. Incidentally, processing temperature which has been challenge for the general production environment and must now of a necessity be resolved if the full benefit associated with this resource is to be realized. The probable solution to this challenge lies in one of the recommendations found in page 5 of the report. It states thus; “Bulbs for onion rings are washed in cold water at 0° C before processing. It is recommended to wash chopped and sliced onions in chlorinated water after processing.” (Chrintz & Hultén, 2014) There are two benefits associated with these steps; firstly the temperature of the material is reduced to as near 0° C as possible and secondly washing in chlorinated water disinfects the processed onions effectively before it is packed, thereby further reducing the risk of bacteria proliferation during storage.

With that in mind, it is necessary to look at some production data in order to determine if production schedules and processes can be altered beneficially in view of the extended shelf life offered by the new packing material. The presented data below shows the daily and weekly amount of sliced yellow onions and sliced purple onions from week 14 to week 21 of 2015. When we examine this data set closely, three things are immediately evident;

- The daily demand for each product does not seem to conform to any trend; therefore demand forecasting based on previous daily demand data may not be reliable.
- The demand on the last day of the week is significantly high than on other days of the week and accounts for at least 29% of the total demand for the week.
- The weekly demand for sliced purple onions seemed to be mostly higher than the demand for sliced yellow onions.

Table 19: Demand for sliced onions from week 14 to week 21, 2015

	SLICED WHITE ONIONS		SLICED PURPLE ONIONS	
	DAILY AMOUNT (KG)	WEEKLY TOTAL (KG)	DAILY AMOUNT (KG)	WEEKLY TOTAL (KG)
WEEK 14	44		71	
	62		139	
	58		117	
	196		235	
	x		x	
		360		562
WEEK 15	100		96	
	105		94	
	84		137	
	193		199	
	x		x	
		482		526
WEEK 16	53		104	
	101		93	
	57		83	
	128		141	
	136		255	
		475		676
WEEK 17	110		82	
	115		97	
	98		80	
	84		111	
	254		275	
		661		645
WEEK 18	100		140	
	140		195	
	126		161	
	208		250	
	x		x	
		574		746
WEEK 19	57		112	
	74		87	
	89		89	
	83		171	
	144		194	
		447		653
WEEK 20	53		104	
	50		96	
	77		125	
	x		x	
	235		216	
		415		541
WEEK 21	64		97	
	104		132	
	94		102	
	133		159	
	182		210	
		577		700

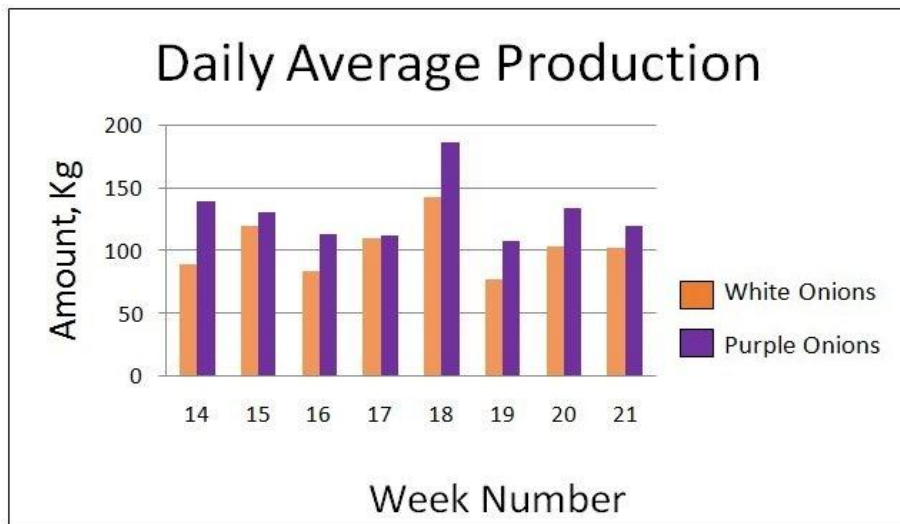


Figure 21: Daily average demand for sliced onions during the study period

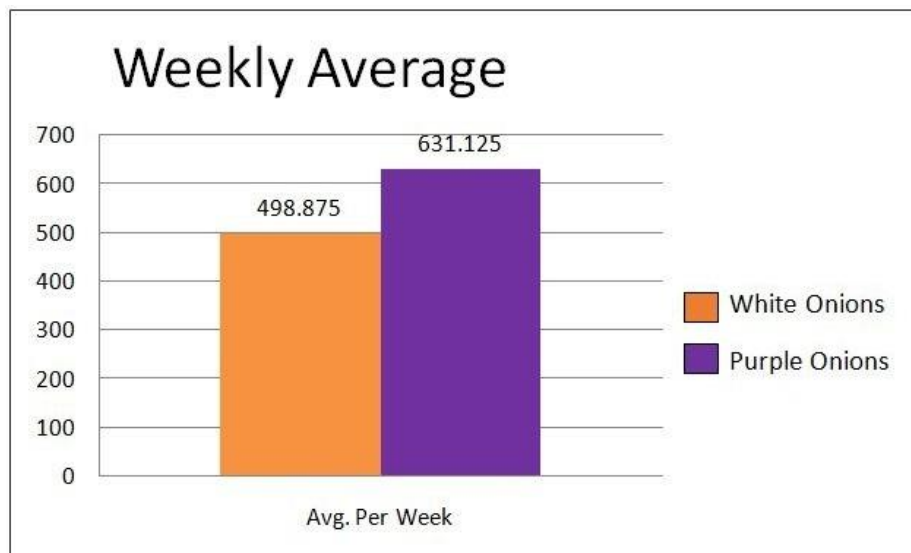


Figure 22: Weekly average demand for sliced onions during the study period

The weekly production data is of more relevance than the daily production data since the existing daily production schedule will not be necessary with the new laser perforated film. Weekly average for sliced yellow onions is 498 kilograms, while that of purple sliced onions is 631 kilograms. That is a total average of 1129 kilograms per week for sliced onions. Under the present circumstances this quantity would put significant strain on the production schedules if it were to be processed at once in one day. The target is to determine a safe limit for production taking into consideration the production capacity and the risk of inventory losses.

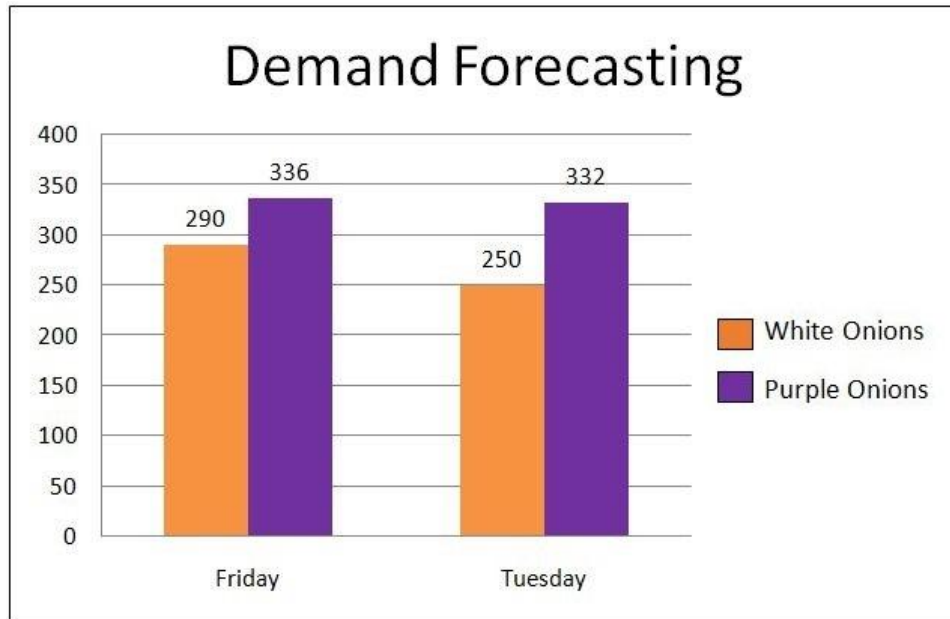


Figure 23: Demand forecasting based on the available data

Table 20: Weekly demand-forecasting for sliced onions

Weekly Demand Forecasting for Sliced Onions		
	Sliced White Onions (Kg)	Sliced Purple Onions (Kg)
Friday Production	290	336
Tuesday Production	250	332

The chart and table show the demand forecast based on the data from week 14 to week 21 of 2015. Processing of sliced onions is to happen in two batches weekly; Tuesdays and Fridays. The volume of production on Friday is slightly higher than it is on Tuesday because Friday is not a normal production day and the possibility of conflict with other production schedules is very limited. Production on Tuesday is more regulated since the products will not be supplied to customers after Thursday. The risk of excess production is higher for this batch.

The benefits expected from this change are not without risks. There must be very careful and consistent monitoring of the three most relevant critical control points. They are;

- Quality of raw material.
- Pre and post processing temperatures.
- Microbiological quality.

5 DISCUSSION

The study on a new laser-perforated packing material for sliced onions and certain aspects of the performance improvement survey have been dwelt upon extensively and hopefully not too extensively as to deemphasize the real purpose of this paper. The purpose of this paper is to seek out inconspicuous yet highly consequential wastes that litter the production operation from the top management all the way through the production processes, to the customer. In doing this, Lean and Six Sigma have been the production philosophies of choice, not just because they have been popular, but mostly because they centre on very fundamental core human values that are necessary for species survival. Diversity, inclusion, team spirit, collective responsibility, collective credit, innovative thinking, tenacity, the bigger picture and the list goes on. In spite of its popularity, Lean Six Sigma philosophy has been known to be notoriously prone to failure. The main reasons for this are;

- They are not just systems or sets of instructions to be implemented, but a cultural transformation that requires time, long-suffering and devotion. Many institutions do not have the right mindset and patience for the long wait.
- It is very challenging to teach a diverse collection of people well past the formative age and competing for individual recognition, a new work culture that is in total contrast to the norm. Resistance to change is a constantly recurring decimal in any change process.
- The workplace is a political environment. Workplace politics is one of the biggest obstacles to a successful Lean Six Sigma transformation. Most times the political environment is a direct or indirect response to the management style of the company. Individual tasks, individual credits, selective consultations as contrasted to wide consultation, exclusion as opposed to inclusion. These are some of the management styles that give rise to harmful responses like jealousy, backbiting, gossip, unhealthy rivalry, vindictiveness, tribalism, hatred and fear because every worker wants to be recognized by the employer as being relevant in the company.
- Ineffective flow of information and unwillingness to commit resources into staff training are very strong limiting factors. No organization can hope to institute Lean and Six Sigma without a significant investment in staff training. This investment is the ultimate act of faith in the management philosophy. If

leadership must run an organization in the spirit of Lean and Six Sigma, there is very little if any chance of success if the rest of the organization is not caught-up in the same spirit. People need to know, understand, accept and follow in the same direction and vision as the leadership, and then will there be some likelihood of success. This knowing, understanding, accepting and willingness to follow, constitute the 'baby steps' of the organization as it treads on the path of cultural transformation.

- Management must be absolutely united on all fronts. A disunited management needless-to-say breeds an equally disunited workforce.
- Finally Lean-Six Sigma is more of a journey than a goal. If management does not mark each little step along the way, there will never be a point where it can be said that the goal has been reached. With Lean-Six Sigma there is always another step to take.

Examining the case study and performance improvement survey from a certain perspective should expose some of the high points and shortcomings that make Lean Six Sigma the way to go for a food processing company. The outcome of the study on better packaging of sliced onions was beyond the expectation of the management and presented several beneficial possibilities. As a consequence, certain string of events followed according to the dictates of the management.

- Management determined which of the new films offered the best cost-benefit balance and directed the purchasing team to place an initial order.
- Purchasing team did not follow up on that directive and required intervention from production team before the order was placed.
- Similar off-book trials were made with some other products using the new film. The outcomes were equally extraordinary.
- During the first production trial of the new film, the supervisor decided to produce and pack sliced onions enough to meet the demand for 3 days instead of the usual daily production. This means that the last batch going out to the customer would be 7 days old by the last date of consumption.
- This decision triggered a protest from the workers in the packing station because the estimates would result in wastage due to over-production going by previous experience and demanded to know who would take responsibility. They were clearly unaware of the beneficial properties of the new film.

- After eventual clarification and observation of the benefits of producing 3 days demand in one batch, the workers still continued to produce on a daily basis unless there is a counter-directive from the supervisor.
- Certain circles within the management considered 7 day too long a time for the product due to fears relating to microbiological quality.
- On certain days, under certain circumstances, management determines that it is acceptable if the product is 7 or 8 days old by the last date of consumption. Otherwise production is on daily basis.

Considering the observed properties of the new film, these events show a misuse of a opportunity which is further compounded by a rather poor flow of vital information. What then would be a proper Lean and Six Sigma approach?

Under the same production environment the outcome of the case study would have been significantly different and more productive if certain elements had been taken into consideration as will be highlighted in each of the following steps.

- Broad-based participation and guiding coalition: Top management constitutes a team charged with the task of participating in the trial of the new film. The team must include not just the supervisors, but also the workers who do the actual work and interact with the product daily.
- Clearly defined goals and communication of vision: Top management meets with the new team, appoints a team leader, defines the problem, outlines the objectives of the team, demands a formal report on the outcome of the trial and sets a time-line for the project.
- Systematic approach: The trial of the new film is carried out by the team under existing production conditions and the observations are documented and submitted to the top management.
- Objectivity: Top management examines the report objectively, defines the limitations to achieving set goals and consults with the team to find immediate, simple and available solutions.
- Tenacity and Plan-do-check-act: The team carries out further trials, incorporating the proposed solutions and measures the level of improvements if any. All observations are documented and submitted to the top management as usual.
- Collective decision-making: A meeting is convened to examine the results of the trials and decide on acceptable modifications to the production processes.

- Empowerment, implementation and celebration of small wins: Management issues a formal directive to incorporate the changes into the production process of sliced onions and formally announces these changes to the entire factory in a typical lunchtime celebration.
- Continuous improvement: Another team is constituted to determine whether similar benefits can be obtained with other products by using the new process.

In the above steps we find present all the elements of Lean and Six Sigma as contrasted to the actual events as documented at the beginning of this chapter. We also observe the presence and active participation of the top management in the whole process as is consistent with the Kotter's 8-step change model. It is very important to note that there needs not be any significant change in physical infrastructure per se because Lean Six Sigma is mostly about people.

What are the prospects of Lean and Six Sigma in this company? Is the company ready and able to undergo the necessary cultural transformation? Are there any markers to predict the outcomes?

This is a company with a reputation for very pleasant surprises and there may be many more to come in future. Two events in the past stand out as significant markers by which we can determine the prospects for Lean Six Sigma.

- The transition from the old paper-based order processing system, to the new online Visma platform.
- The successful planning and implementation in 2014, of three quality systems; ISO 22000 for food safety, 14001 for environmental management and 9001 for quality management simultaneously.

The analysis of the survey questions in the 4th chapter give an insight into the potentials for success in this venture. The third question (Do you want more innovative tasks?), may be a pointer to a feeling of redundancy on the part of certain workers. These workers from diverse backgrounds have potentially valuable experiences behind them which they are not able to express in their new work environment, not due to a lack of willingness, but due to lack of the opportunity to do so. These represent a legitimate and rather unfortunate loss to the company for the inability to utilize this resource and to the affected workers, who are very demoralized by their inability to find fulfillment through

creative expression. This conclusion is further buttressed by the result of the correlation analysis of the first question (How much have you enjoyed working in the company?), which led to the conclusion that “employees tend to be less happy with their work as they get older on the job.” Could it be that the transition to the Visma platform and the quality systems projects presented challenges and opportunities much desired by the workers to show off a little of their competences?

The successful implementation of these two events continue to have very huge impact on the production environment and image of the company and tell the story like no other can, about the quality of leadership and workforce in this company.

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APPENDICES

Appendix 1. Performance Improvement Survey

TO WHOM IT MAY CONCERN

Sir/Madam,

**RE: QUALITY ASSURANCE AND WASTE MANAGEMENT SYSTEM FOR A
FOOD PROCESSING COMPANY**

A food processing company is presently undertaking a project to build the quality systems ISO 22000, 14001 and 9001 certifications for food safety, environmental management and quality management respectively. This is mostly in response to customer demands and industry trend.

The management of the company in collaboration with Chinedu Ohaegbunam who has been understudying the process as part of his final year thesis at the Environmental Engineering Department of TAMK University of Applied Sciences, has prepared this survey to assess the current status of the factory with particular regards to employee motivation, quality assurance and waste management. By taking few minutes to answer the questions in the following questionnaire you will be contributing immensely to the success of this project.

Please be assured that all your responses to the questions will be held in the highest confidence and will not be released for public scrutiny.

Thank you for your anticipated cooperation.

Warmest Regards

Chinedu Ohaegbunam

EMPLOYEE MOTIVATION | TYÖMOTIVAATIO

 LADIES SIDE MENS SIDE BOTH/MOLEMMAT

KUORIMO

1. How long have you worked in the company? Miten kauan olet työskennellyt yrityksessä?

- Less than 1yr (Alle 1 vuosi)
 Up to 1 yr (Noin vuoden)
 1-3 yrs (1-3 vuotta)
 3-5yrs (3-5 vuotta)
 Over 5yrs (Yli 5 vuotta)

2. How much have you enjoyed working in the company? Pidätkö työstäsi ++++++ssa?

- Not at all (En lainkaan)
 Very little (Ihan hiukan)
 A little (Ihan ok)
 Much (Paljon)
 Very much (Tosi paljon)

3. How do you feel about the work environment? Miltä työskentely-ympäristö tuntuu?

- Very unhappy (Tosi tyytymätön)
 A little unhappy (Hiukan tyytymätön)
 A little happy (Ihan ok)
 Happy (Tyytyväinen)
 Very happy (Tosi tyytyväinen)

4. Are you satisfied with the staff facilities? Eg: Locker rooms, Toilets, Parking, Cafeteria etc

Oletko tyytyväinen henkilöstön tiloihin, esim pukuhuone, taukotilat, WC, parkkipaikat?

- Very unsatisfied (Tosi tyytymätön)
 Somewhat unsatisfied (Hiukan tyytymätön)
 Unsatisfied (Menettelee)
 Somewhat satisfied (Tyytyväinen)
 Very satisfied (Tosi tyytyväinen)

5. Are you often recognized for your efforts? Huomataanko ponnistelusi ja saatko tunnustusta?

- Never (En lainkaan)
 A little (Joskus)
 Often (Usein)
 Very often (Tosi usein)
 Always (Aina)

6. Will you be happy to be recognised for your efforts? Nautitko, kun ponnistelusi huomataan?

- Very unhappy (En lainkaan)
 A little unhappy (En oikeastaan)
 A little happy (Ehkä hiukan)
 Happy (Nautin)
 Very happy (Nautin tosi paljon)

7. What has been your experience with your work in general? Oletko ylipäänsä tyytyväinen työhösi?

- Very unsatisfied (Tosi tyytymätön)
 Somewhat unsatisfied (Hiukan tyytymätön)
 Unsatisfied (Menettelee)
 Somewhat satisfied (Tyytyväinen)
 Very satisfied (Tosi tyytyväinen)

8. Would you recommend this company to a friend? Suositteletko ystävillesi?

- Never (En ikinä)
 Perhaps (Ehkä joskus)
 Maybe (Luultavasti)
 Yes (Kyllä)
 Absolutely yes (Aivan ehdottomasti)

What other suggestions do you have about improving your work experience? (Onko mielessäsi työtä koskevia kehittämisajatuksia?)

EMPLOYEE PERFORMANCE | TYÖNTEKO**1. Do you get to make independent decisions at work? Teetkö työssä itsenäisiä päätöksiä?**

- Never (En koskaan)
- A little (Joskus)
- Often (Usein)
- Very often (Hyvin usein)
- Always (Aina)

2. Do your tasks meet your skills and expectations? Vastaavatko työtehtävät taitojasi ja odotuksiasi?

- Never (En koskaan)
- A little (Joskus)
- Often (Usein)
- Very often (Hyvin usein)
- Always (Aina)

3. Do you want more innovative tasks? Haluaisitko tehdä vähemmän rutiininomaista työtä?

- Never (En koskaan)
- Perhaps (Ehkä joskus)
- Maybe (Luultavasti)
- Yes (Kyllä)
- Absolutely yes (ehdottomasti)

4. Do you have enough work equipments for the tasks you perform? Onko sinulla riittävästi työvälineitä?

- Never (Ei)
- Sometimes (Joskus)
- Often (Yleensä)
- Very often (Lähes aina)
- Always (Aina)

5. Is your job stressful? Onko työsi stressaavaa?

- Never (En lainkaan)
- A little (Joskus)
- Often (Usein)
- Very often (Tosi usein)
- Always (Aina)

6. Is your workload reasonable? Onko työkuormituksesi kohtuullinen?

- Never (Ei ollenkaan)
 Sometimes (Ajoittain kyllä)
 Often (Yleensä)
 Very often (Lähes aina)
 Always (Aina)

7. Would you like if your work schedule is more flexible? Pitäisikö työaikataulusi olla joustavampi?

- No (Ei)
 Sometimes (Joskus)
 Often (Yleensä)
 Very often (Lähes aina)
 Always (Aina)

8. Have you got enough training for your job? Oletko saanut riittävästi ohjausta työhösi?

- Not at all (En ole)
 Very little (Ihan vähän)
 Little (Vähän)
 Much (Paljon)
 Very much (Tosi paljon)

9. Is it easy for you to follow given instructions? Onko mielestäsi annetut ohjeet hyväksyttäviä ja ymmärrettäviä?

- Never (Ei)
 Sometimes (Joskus)
 Often (Yleensä)
 Very often (Lähes aina)
 Always (Aina)

What other suggestions do you have about improving your performance at work?
 (Minkälaisilla asioilla työntekemistäsi voitaisiin kohentaa?)

EMPLOYEE TEAM WORK | YHTEISTYÖ**1. My co-workers are very friendly. Työtoverit ovat tosi mukavia.**

- Not at all (Ei ole)
- Very little (Ihan vähän)
- A little (vähän)
- Much (Paljon)
- Very much (Tosi paljon)

2. My co-workers help me with my tasks. Työtoverit auttavat, jos tarvitsen apua.

- Not at all (Ei koskaan)
- Very few times (Harvoin)
- Sometimes (Joskus)
- Most times (Useimmiten)
- Always (Aina)

3. My co-workers get help from me. Tarjoan apuani työtovereilleni.

- Not at all (Ei koskaan)
- Very few times (Harvoin)
- Sometimes (Joskus)
- Most times (Useimmiten)
- Always (Aina)

4. Suggestions from other workers help me to improve my performance.

Työtovereilla on hyviä ehdotuksia, jotka helpottavat työtäni.

- Not at all (Ei koskaan)
- Very few times (Harvoin)
- Sometimes (Joskus)
- Most times (Useimmiten)
- Always (Aina)

5. In the factory we work as a team. Pyrimme tehtaalla tiimityöhön.

- Not at all (Ei koskaan)
- Very few times (Harvoin)
- Sometimes (Joskus)
- Most times (Useimmiten)
- Always (Aina)

6. In the factory no one cares about my work. Minusta tuntuu, että tehtaalla kukaan ei välitä työstäni.

- Never (Ei ollenkaan)
 Sometimes (Ajoittain kyllä)
 Often (Yleensä)
 Very often (Lähes aina)
 Always (Aina)

7. I understand my own work as a part of production. Ymmärrän oman työni merkityksen osana tuotantoa.

- Not at all (Ei koskaan)
 Very few times (Harvoin)
 Sometimes (Joskus)
 Most times (Useimmiten)
 Always (Aina)

8. More cooperation, better performing. Yhteistyöllä pärjäämme paremmin.

- I disagree completely (Täysin eri mieltä)
 I somewhat disagree (Eri mieltä)
 I somewhat agree (Jokseenkin samaa mieltä)
 I agree (Samaa mieltä)
 I agree completely (Täysin samaa mieltä)

9. My boss encourages cooperation. Esimieheni rohkaisee ja kannustaa yhteistyöhön.

- I disagree completely (Täysin eri mieltä)
 I somewhat disagree (Eri mieltä)
 I somewhat agree (Jokseenkin samaa mieltä)
 I agree (Samaa mieltä)
 I agree completely (Täysin samaa mieltä)

What other suggestions do you have about cooperation? (Onko sinulla ajatuksia yhteistyöstä?)

EMPLOYEES OPINION ON THE SUPERVISOR | AJATUKSIA ESIMIESTYÖSTÄ

- 1. Do you often get feedback from your supervisor for good work? Saatko esimieheltäsi palautetta hyvästä työstä?**
 - Not at all (En)
 - Very few times (Harvoin)
 - Sometimes (Joskus)
 - Most times (Usein)
 - Always (Aina)

- 2. Do you often get feedback from your supervisor for mistakes at work? Saatko esimieheltä palautetta huonosta työstä?**
 - Not at all (En)
 - Very few times (Harvoin)
 - Sometimes (Joskus)
 - Most times (Usein)
 - Always (Aina)

- 3. Is the supervisor easy to reach when needed? Onko esimies helposti tavoitettavissa?**
 - Not at all (En)
 - Very few times (Harvoin)
 - Sometimes (Joskus)
 - Most times (Usein)
 - Always (Aina)

- 4. How reasonable are the decisions made by your supervisor? Tekeekö esimiehesi järkeviä ja ymmärrettäviä päätöksiä?**
 - Not reasonable (Ei)
 - A little reasonable (Joskus)
 - Very reasonable (Usein)
 - Mostly reasonable (Yleensä)
 - Always reasonable (Aina)

- 5. Does your supervisor respond quickly to your requestis? Vastaako esimies nopeasti kysymyksiisi tai pyyntöihisi?**
 - Not at all (Ei koskaan)
 - Very few times (Harvoin)
 - Sometimes (Joskus)
 - Most times (Useimmiten)
 - Always (Aina)

6. Does your supervisor listen to employees before making decisions?**Kuunteleeko esimies työntekijöitä ennen päätöksentekoa?**

- Not at all (Ei koskaan)
- Very few times (Harvoin)
- Sometimes (Joskus)
- Most times (Useimmiten)
- Always (Aina)

7. Do you go to your supervisor when you have made a mistake? Menetkö esimiehen puheille, jos olet tehnyt jonkin virheen?

- Not at all (Ei koskaan)
- Very few times (Harvoin)
- Sometimes (Joskus)
- Most times (Useimmiten)
- Always (Aina)

8. How satisfied are you with your supervisors? Miten tyytyväinen olet esimiehesi?

- Very unsatisfied (Tosi tyytymätön)
- Somewhat unsatisfied (Jokseenkin tyytymätön)
- Unsatisfied (Tyytymätön)
- Somewhat satisfied (Jokseenkin tyytyväinen)
- Very satisfied (Tosi tyytyväinen)

What does your supervisor need to do to improve his/her performance? (Mitä esimiehesi pitäisi tehdä, jotta hän olisi parempi esimies?)

**QUALITY ASSURANCE |
LAADUNVARMISTUS**

- 1. I am aware of the company goals about the quality of production. Tiedän, minkälaisia tavoitteita on asetettu +++++n tuotannon laadulle.**

 - Not at all (En)
 - Very little (Todella vähän)
 - Little (Vähän)
 - Much (Paljon)
 - Very much (Tosi paljon)

- 2. I am aware of customer expectations concerning our products. Tiedän, minkälaista laatua asiakkaat odottavat saavansa.**

 - Not at all (En)
 - Very little (Todella vähän)
 - Little (Vähän)
 - Much (Paljon)
 - Very much (Tosi paljon)

- 3. I have received training about the standard/outcome of production. Minulle on kerrottu, minkälaisia laatuvaatimuksia tuotteille on asetettu.**

 - Not at all (En)
 - Very little (Todella vähän)
 - Little (Vähän)
 - Much (Paljon)
 - Very much (Tosi paljon)

- 4. I understand all the steps and protocols for quality assurance during production. Ymmärrän kaikki käytännöt ja säännöt, mitkä vaikuttavat laatuun.**

 - Not at all (En)
 - Very little (Todella vähän)
 - Little (Vähän)
 - Much (Paljon)
 - Very much (Tosi paljon)

- 5. I implement all the steps and protocols for quality assurance during production. Noudatan kaikkia laatuun vaikuttavia käytäntöjä ja sääntöjä.**

 - Not at all (Ei koskaan)
 - Very few times (Harvoin)
 - Sometimes (Joskus)
 - Most times (Useimmiten)
 - Always (Aina)

6. The quality standard of production is very good. ++++++n tuotannon laatutaso on tosi hyvä.

- I disagree completely (Täysin eri mieltä)
 I somewhat disagree (Jokseenkin eri mieltä)
 I somewhat agree (Jokseenkin samaa mieltä)
 I agree (Samaa mieltä)
 I agree completely (Täysin samaa mieltä)

7. The production environment in the factory is very good and equipments are easy to find. Tuotantoympäristö on kunnossa ja työvälineet on helppo löytää.

- I disagree completely (Täysin eri mieltä)
 I somewhat disagree (Jokseenkin eri mieltä)
 I somewhat agree (Jokseenkin samaa mieltä)
 I agree (Samaa mieltä)
 I agree completely (Täysin samaa mieltä)

8. I am satisfied with quality of raw materials I receive for my work. Olen tyytyväinen käytettävissäoleviin raaka-aineisiin.

- Very unsatisfied (Tosi tyytymätön)
 Somewhat unsatisfied (Jokseenkin tyytymätön)
 Unsatisfied (Tyytymätön)
 Somewhat satisfied (Jokseenkin tyytyväinen)
 Very satisfied (Tosi tyytyväinen)

9. I am satisfied with the quality of finished products. Olen tyytyväinen valmiiden tuotteiden laatuun.

- Not at all (Ei koskaan)
 Very few times (Harvoin)
 Sometimes (Joskus)
 Most times (Useimmiten)
 Always (Aina)

What are your suggestions about improving quality? (Miten laatua mielestäsi voitaisiin parantaa?)

WASTE SITUATION | JÄTEMÄÄRÄN HALLINTA

1. We always have excess products at the end of work. Työpäivän jälkeen meillä on aina valmiina ylimääräisiä tuotteita.

- Not at all (En koskaan)
- Very few times (Ani harvoin)
- Sometimes (Joskus)
- Most times (Useimmiten)
- Always (Aina)

2. We need to have excess products at the end of work. Meillä pitää olla ylimääräisiä tuotteita työpäivän jälkeen.

- Never (En koskaan)
- A little (Joskus)
- Often (Usein)
- Very often (Hyvin usein)
- Always (Aina)

3. We can stop making excess products. Me emme voi lopettaa ylimääräisten tuotteiden tekemistä.

- I disagree completely (Täysin eri mieltä)
- I somewhat disagree (Jokseenkin eri mieltä)
- I somewhat agree (Jokseenkin samaa mieltä)
- I agree (Samaa mieltä)
- I agree completely (Täysin samaa mieltä)

4. We can stop making excess products if we utilize scales during production. Voimme lopettaa ylimääräisten tuotteiden tekemisen, jos käytämme tuotannossa vaakaa.

- I disagree completely (Täysin eri mieltä)
- I somewhat disagree (Jokseenkin eri mieltä)
- I somewhat agree (Jokseenkin samaa mieltä)
- I agree (Samaa mieltä)
- I agree completely (Täysin samaa mieltä)

5. I know the weights of products when they are in plastic boxes and baskets used in production. Pystyn arvioimaan tuotannossa käytettävien laatikkojen, korien yms sisältöjen painot.

- Not at all (En koskaan)
- Very few times (Ani harvoin)
- Sometimes (Joskus)
- Most times (Useimmiten)
- Always (Aina)

6. There is too much raw material waste in the production. Tuotannossa haaskataan raaka-aineita.

- I disagree completely (Täysin eri mieltä)
- I somewhat disagree (Jokseenkin eri mieltä)
- I somewhat agree (Jokseenkin samaa mieltä)
- I agree (Samaa mieltä)
- I agree completely (Täysin samaa mieltä)

7. Wastes going to the floor during production can be reduced. Tuotannon aikana lattialle varisevan raaka-aineen määrää pystytään pienentämään.

- I disagree completely (Täysin eri mieltä)
- I somewhat disagree (Jokseenkin eri mieltä)
- I somewhat agree (Jokseenkin samaa mieltä)
- I agree (Samaa mieltä)
- I agree completely (Täysin samaa mieltä)

8. We make more waste when the raw material is bad. Jätettä syntyy enemmän, jos raaka-aine on huonoa.

- I disagree completely (Täysin eri mieltä)
- I somewhat disagree (Jokseenkin eri mieltä)
- I somewhat agree (Jokseenkin samaa mieltä)
- I agree (Samaa mieltä)
- I agree completely (Täysin samaa mieltä)

9. The factory loses money when we make too much waste. Liika jäte tulee tehtaalle kalliiksi.

- I disagree completely (Täysin eri mieltä)
- I somewhat disagree (Jokseenkin eri mieltä)
- I somewhat agree (Jokseenkin samaa mieltä)
- I agree (Samaa mieltä)
- I agree completely (Täysin samaa mieltä)

What is your suggestion about reducing waste during production?

(Miten mielestäsi syntyvää jätemäärää voitaisiin pienentää?)

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