

**Development of Integrated Lean Six Sigma-Baldrige  
Framework for Manufacturing Waste Minimization:  
(A Case of NAS Foods Plc.)**

**By**

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This is to certify that the thesis prepared by Selamawit G/yohannes, entitled **“Development of Integrated Lean Six Sigma-Baldrige Framework for Manufacturing Waste Minimization”** and submitted in partial fulfillments of the requirements for the degree of Master of Science (Mechanical and Industrial Engineering) complies with the regulations of the University and meets the accepted standards with respect to originality and quality. Signed by Examining Committee:

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## Declaration

I hereby declare that the work which is being presented in this thesis entitled **“Development of Integrated Lean Six Sigma-Baldrige Framework for Manufacturing Waste Minimization”** is original work of my own and has not been presented for a degree of any other university and all the resources of references used for the thesis have been duly acknowledged.

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Selamawit G/yohannes

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Date

This is to certify that the above declaration made by the author is correct to the best of my knowledge.

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Dr. Kassu Jilcha

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Date

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## Abstract

In this research the integration of some advanced tool for waste minimization and continuous quality improvement of biscuit industry on production process are investigated. Nowadays, food industry makes significant contribution to national economy in many developing countries. Here in Ethiopia less contribution in an improvement of biscuit industry analyzed and waste minimization. There are different wastes that are identified by Six sigma (DMAIC) on NAS food Plc.as a result the value of waste ratio is 36.7%, this shows non lean. The defect of the company also calculated and defect per million are 67,308. This shows that the biscuit production has a production capability with a failure of 67,308 every 1,000,000 productions. The other problem here is there are limited studies were conducted so far to implement waste minimization tools like six sigma, lean and MBNQA framework. The main objective of this study is to develop an integrated continuous quality improvement model so as to minimize waste of biscuit process manufacturing. The lean six sigma were created to define, measure and improve the process waste of the company in other way baldrige with six sigma were created to define, measure and improve management perspective. The tasks were integrated using both quantitative and qualitative analyses. As a result and improve by using FMEA was carried out at each stage of the existing process used to determine the failure of the process and to analyze and improve the production quality and the result of highest RPN on Stacking and packaging process so they should take action for waste minimization and continuous quality improvement. Also correlation and regression analysis result by using SPSS software shown strong relation between each variance. Lastly, it proposed continuous quality improvement model.

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## Acronyms

CQI	Continuous Quality Improvement
CTQ	Critical To Quality
DMAIC	Define, Measure, Analyze, Improve, Control
DPMO	Defects Per Million
FMEA	Failure Mode and Effect Analysis
JIT	Just In Time
LSS	Lean Six Sigma
MBNQA	Malcolm Baldrige National Quality Award
PCE	Process Cycle Efficiency
SPSS	Statistical Package for Social Science
TQM	Total Quality Management

## CHAPTER ONE

### 1. 1. Introduction

In the current globalization era, companies are more competitive and every detail is important if the business wants to improve its competitiveness. Since it is no surprise that the best continuous improvement strategies that could be developed for manufacturing industries provide to improve efficiency and effectiveness of whole systems. Though, automating production and improving process efficiency are two major objectives of the food industry worldwide. Since, implementing advanced continues an improvement strategy in the modern manufacturing provides to improve the performance of the process, reduce waste and ensure on time delivery of the sectors (Mahour M.Parast, 2006). Since the continuous improvement is a management philosophy that approaches to tackle the challenge of product and increase process improvement (Coskun Dalgiç, 2011). Particularly, the continuous improvement seeks continual improvement of machinery, materials, labor utilization, product quality and safety, and production methods through application of suggestions and ideas of team members. Since, these strategies, enhancing in the increased control of raw materials, production process, improve warehousing and dispatching and can have a significant impact on the profitability manufacturing industries. Furthermore, manufacturing firms apply continuous improvement strategies in their systems to provide and improve efficiency, effectiveness and the overall performance of the whole organizations. As a result, in global competition of the firm through optimizing their systems and improving performances continuous improvement tools have great roles (Alie , 2017). Thus, from numerous tools firms were invested to implement lean, six sigma, TQM and JIT strategies in their business process so as to enhance performance and compete at global levels, (Png, 2015).

The lean principle provides to identifying and eliminating non value add (wastes) through continuous improvement tools, flowing the product at the pull of the customer in pursuit of perfection (Mousa, 2013). Meanwhile due to comprise on quality development, process focus, continuous improvement and value stream management and worker empowerment future several companies invest in the implementation lean principles (Png, 2015). However, the lean principle provides for the persistent detection, identification, and elimination of waste in all business processes. Thus lean offer to achieve satisfy customer demands on the highest

possible level through waste reductions and improve productivity of the firms. While six sigma is a really effective tool for systematically attacking the highest priority production and support functional problems within an organization. Although the six sigma characterize as business process that allows companies to drastically improve their bottom line by designing and monitoring everyday business activities in ways that minimize waste and resources while increasing customer satisfaction by some of its proponents (Mousa, 2013). Six sigma is statistical measure of defect rate within a system and the practice requires the knowledge of basic and advanced statistical tools so as to reduce defects and variations within a work process in firm. But the main limitations are six sigma not effective for every problem reduction in the firms. Although the six sigma tackles process specific variation, while the lean is concerned with streamlining movement of goods or information between processes and reducing any wasted time, money or resources deemed non-value adding (Liang, 2014). Whereas, the Malcolm Baldrige national quality award (MBNQA) for helping excellence ever, improving value to marketplace success, improvement of overall organizational effectiveness and capabilities, organizational and personal learning. Since the criteria can be used as a tool for self-evaluation, and are widely recognized as a robust framework for design and evaluation of organizational systems. Thus, the Malcolm Baldrige national quality award (MBNQA) is used to assess an organization's performance, helping the organization identify its strengths, opportunities for improvement, and gaps blind spots (Link, 2001).

However from the above observe that a single improvement tools lacks to coherence to tackle the whole problems of the manufacturing firms. Single tools have good potential to tackle specific problems. Though an integrated continuous improvement strategies and methods have great power to improve the performance and the competitiveness of the firms (Alie , 2017). As long as fewer studies were investigate to implements the integration of lean with six sigma, lean with TQM strategies in the firm so as to improve the performance and global competitiveness (Mousa, 2013). But there were insufficient study could be conducted to the integration of lean with three or more continuous improvement strategies to implement manufacturing firm performance improvements. Though to improve the universality, potentials and the performance of continuous improvement tools, the integrations strategies have great impacts. Furthermore an integrated model could have great performances to tackle various problems in manufacturing firms. Therefore integrating three or more

continuous improvement strategies provides to enhance, quality of products, optimum product cost, timely delivery of products ,the flexibility of their internal business process, reduction of wastes and customer satisfactions, (Png, 2015). Thus, this study aims to develop an integrated frame work from lean, six sigma and the Malcolm Baldrige Criteria so as to improve the production performance, reduce waste and improve competitiveness of , NAS Foods Plc.

**Table.1.1 Comparison of Improvement Programs**

Program	Six Sigma	Lean thinking	MBNQA
Theory	Reduce variation	Remove waste	Quality awareness
Application and Principles	Define Measure Analyze Improve. Control	Identify value Identify value stream. Flow. Pull, Perfection.	Visionary Leadership, Customer-Driven, Excellence, Organizational and Personal Learning, Valuing Employees &Partners, Agility, Focus on the Future, and analysis and knowledge transfer and organization performance
Focus	Problem focused	Flow focused	Quality focused
Criticisms	System interaction not considered. Processes improved independently.	Statistical or system analysis not valued	Unfairness, superficiality and publicity the inherent value of the continuously improving award program far outweighs its limitations.
Tools	Flow chart, control chart, graphical chart	5S, VSM	Questioner, ABC
Type of CQI Initiative	<ul style="list-style-type: none"> <li>• Emphasis on processes and outcomes.</li> <li>• Best for processes plagued by wide variability—logging of pharmaceuticals, standardizing referral processes, etc.</li> <li>• Is a heavily quantitative approach to CQI?</li> <li>• Can be adapted for targeted changes to specific processes.</li> <li>• Typically combined with Lean when the focus is on efficiency and quality.</li> <li>• Ideal for practices that want to rigorously quantify improvements in safety, quality, and cost effectiveness</li> </ul>	<ul style="list-style-type: none"> <li>• Emphasis on process.</li> <li>• Simplifies overcomplicated processes and considers interdependencies.</li> <li>• Best for known problems with known system change solution.</li> <li>• Integrated throughout the organization or practice.</li> <li>• Ideal for large complex health care organizations and practice networks that want to standardize operations across multiple units or practice sites.</li> </ul>	<ul style="list-style-type: none"> <li>• Emphasis on structure and outcomes.</li> <li>• Best for practice-wide problem assessment and goal setting.</li> <li>• A broad, holistic approach to CQI initiated at strategic times.</li> <li>• Ideal for practices that want to establish a new CQI system or overhaul an existing one.</li> </ul>

Source: (Nave, 2002; Horne, 2009)

### **1.1.1. Background and problem Justification**

The NAS Foods Plc. is one of the largest privately owned food processing factories in Ethiopia, appeared as a lone bidder, interested to acquire the state owned Dire Dawa Food Complex, 530Km east of Addis Ababa.

NAS Foods Plc. was established in 1996 and began operation in August 2002. It is equipped with the latest technology imported from Italy, France and Turkey. Currently, it has over 300 employees including expatriates. It is the first company that produce and distributes varieties of international standard biscuits in Ethiopia its portfolio in to other food products. Ethiopia; NAS foods eyes to acquire Dire Dawa food complex NAS foods, which runs a Biscuit factory in Legetafo, 19km north of Addis Ababa, in the Oromia.

### **VISION**

NAS foods vision is to develop the regional food market while ensuring customer satisfaction and to be the leading biscuit manufacturer in Africa.

### **MISSION**

Maintain market leadership by continuously delivering quality products at affordable prices.

Nevertheless, despite largest and being in market for decades, through time the company lost most of its customers for newly emerging companies and the company's profit declined continuously even to the level that is almost close to not making profit at all. Since the NAS Foods Plc. can be characterized by low profit, high level of wastes like material loss and down time and not working for continuous improvement, lack of customer, low production capacity etc. Hence, to tackle such problems integrating models are critical to continuous quality improves of the biscuit manufacturer. Therefore, this study investigates how the six sigma, lean and MBNQA concept can be adapted and integrated in NAS Foods Plc. to improve the overall performance of company.

## 1.2. Statement of the problems

Nowadays food industry makes a significant contribution to national economy in many developing countries. Here in Ethiopia the economy depend on agricultural and which accounts 43.2% of gross domestic product (GDP) (Workneh, 2010). Also there is less contribution in an improvement of biscuit industry analyzed and waste minimization. Here is waste that identify in six sigma (DMAIC) on NAS food Plc. Currently the company only uses 30% of its capacity and produce 3000 carton per day via 349 workers but it can produce 10,000 cartons with 1,000 workers. as a result the value of waste ratio is 36.7%, this show, non-lean and can be categorized as a traditional company (George, 2002). The defect of the company also calculated and defect per million are 67,308. This shows that the biscuit production of has a production capability with a failure of 67,308 every 1,000,000 productions or equivalent to 6.73% loss and this indicates the production process still has a high failure rate. The other problem here is there are limited studies were conducted so far to implement waste minimization tools like six sigma, lean and MBNQA approach on Ethiopian food processing industries (Yasin, 2014).

### *The research questions raised includes*

Q1. What are the practices and the main gaps of existing continuous improvement strategies in waste minimizations in biscuit manufacturing?

Q2. What are the main challenges and potentials that should be considered to minimization waste in NAS Food industry?

Q3. How to integrate lean, six sigma and Malcolm Baldrige Criteria to minimization waste on NAS food industry?

## 1.3. Research Objectives

### 1.3.1. General objectives

- ✦ The main objective of this study is to develop an integrated continuous quality improvement model so as to minimize waste of biscuit manufacturing.

### 1.3.2. Specific objectives

- ✦ To identify the gaps and strength of previous researches related to continuous improvement strategies to minimize waste.
- ✦ To investigate the challenges and potentials of integrating continuous improvement strategies in the context of biscuit manufacturing.
- ✦ To develop an integrated continuous quality improvement models to reduce waste and enhance competitiveness of NAS food industry.

#### **1.4. Scope of the Study**

The scope of the study includes identifying the gaps of the previous research and the practice of continuous improvement strategies in the selected company are address. It also includes determining inventory levels and waiting time and finally, implementation detail prepared which minimize or eliminates the wastes and defects and improves the system by integrating lean manufacturing, six sigma and the Malcolm Baldrige Criteria techniques into one. The scope of the research is limited and conducted to NAS Foods Plc. as a case company, which means if others want to use the document they have to make it compatible with their condition.

#### **1.5. Significance of the Study**

The finding of this study proves that the contributions made by implementing the integration model through manufacturing in elimination of waste and improved continuous quality improvement and also benefit for NAS Foods Plc. by minimizing the production cost so that continuous improvement can be made to increase its profit, sales volume, while creating convenience for its workers and customer satisfaction.

#### **1.6. Expected Results**

- ✳ The problems and challenges in NAS Foods Plc. are investigated.
- ✳ The possible strategies on integrated continuous improvement models are investigated.
- ✳ An integrated continuous improvement model is developed so as to reduce waste and enhancing competitiveness of NAS Foods Plc.

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## CHAPTER TWO

### 2. Literature Review

The purpose of this literature review is to provide a background on challenges of waste, waste controlling mechanism and applicability of waste controlling strategies across a variety of industries. Since this understanding will help determine which waste controlling strategies and principles are appropriate for implementation within the food manufacturing industry, and detail topics discuss in this section are for history of waste minimization in manufacturing industry, lean manufacturing philosophy, six sigma and Malcolm Baldrige National Quality Award (MBNQA) principle, tools and technique in manufacturing industries as whole as well as a detailed summary of the literature concerning improvement and competitiveness problem of Ethiopian food processing industry. Though the principal sources of this information included company reports, published literature in textbooks and journals were incorporated.

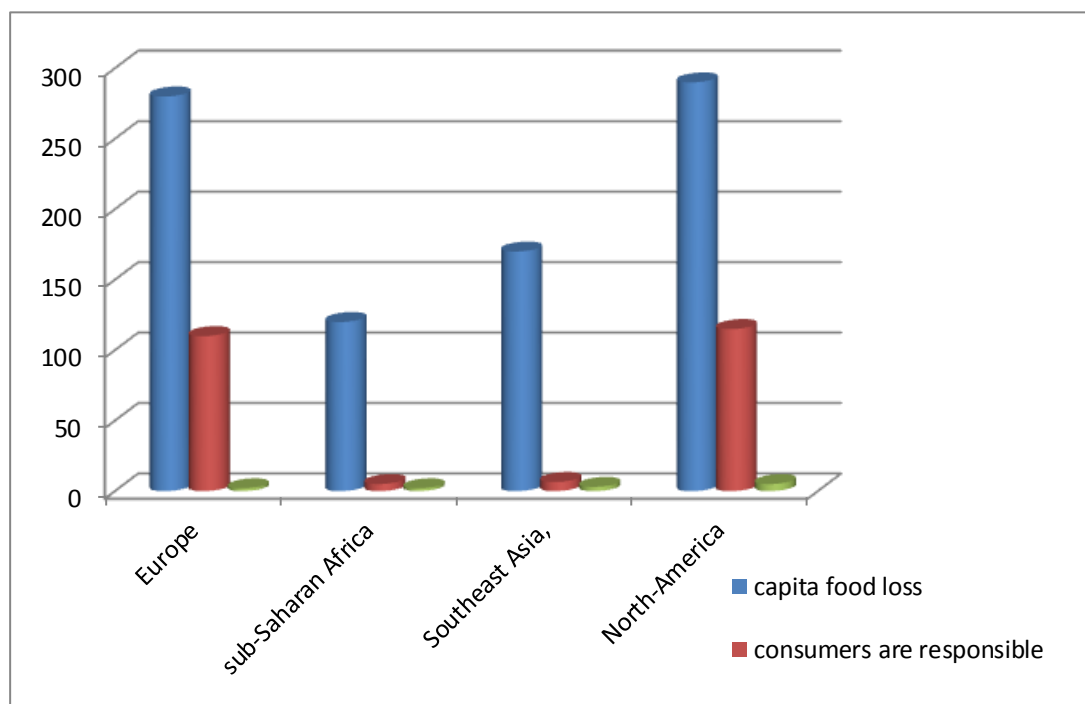
#### 2.1. What is Waste?

Wastes mean resources consumed by inefficient or non-essential activity, un wanted material left over from a production process, or output which has no marketable value, process or material that does not (from the viewpoint of the customer) add value to a good or service. Meanwhile waste is delivers to represents the loss of both material and energy resources. While in the case of manufacturing industries due to excessive waste generation is an indication of inefficient production processes, low durability of goods and unsustainable consumption patterns. Though the waste quantities can be considered as an indicator of how efficiently society uses raw materials. Although to tackle the problems and effects of waste, firms should control type of wastes by prevention, minimization or waste reduction. Depending on the type of firm type and production process, firms can use these terminologies as inter changeable manner. Although waste prevention: waste prevention also called source reduction seeks to prevent waste from being generated (EPA, 2013). The waste prevention strategies include using less packaging, designing products to last longer, and reusing products and materials. Particularly the waste prevention helps reduce handling, treatment, disposal costs and ultimately reduces the generation of methane. Since proper waste preventions improve the productivity and performance of manufacturing industries. Besides waste Minimization is about preventing and

reducing waste at source through the efficient use of raw materials, energy and water. This is at the highest level of the waste hierarchy and is based on the principles of prevention and reduction, to eliminate or reduce waste at source (Dametew, 2015). Though waste minimization is considered to be the highest level to reach in the waste management hierarchy as it achieves both environmental and economic benefits by reducing waste and costs at the same time. At the meantime waste minimization is considered to be one of the best approaches for improving sustainability performance in industry, including for the food and drink industry, as it achieves environmental, economic and social benefits by reducing waste at source, achieving cost savings and creating new employment opportunities. In manufacturing firms waste minimization can provide competitive advantage to business in four ways including cost savings, compliances, reduction the risk and market positioning (Young, 2001).

## **2.2. Wastes in the Food Processing Sector**

Food loss should mean the decrease in edible food mass throughout the food chain. Food losses take place in production, postharvest and processing stages in the food supply chains. Since a division is to be made whether the loss of resources happens in the early stages of the food supply chains (FSC) or the resource was wasted by the action of the retail sector or consumers. Though in the first case, the problems can call about food losses, while in the latter case about food waste. The food losses can be avoided by a correct action, e.g. by maintaining the cold supply chain or ensuring correct storage conditions for products. Since the food loss also occurs if the product that was originally intended for human consumption is recovered in the form of feed, fertilizer or energy (Imam, 2010), (Pap et al.. 2014). Besides the waste and food waste is more comprehensive and it includes all resources that are lost in the different sectors of the food supply chain, and will include also those parts that were originally not intended for human consumption.



**Figure 2.1. Food losses in industrialization countries** Source (Pap, Pongrácz, & Myllykoski, 2014; Gustavsson et al. 2011).

Food losses in industrialized countries are as high as in developing countries, but in developing countries more than 40% of the food losses occur at postharvest and processing levels, while in industrialized countries, more than 40% of the food losses occur at retail and consumer levels.

In the fig above shows that the total per capita production of edible parts of food for human consumption in Europe and North-America is about 900 kg/year, of which the per capita food loss is 260-280 kg/year (31-33%). Of this amount of wastage, consumers are responsible for 34-38%, some 95-115 kg/capita waste a year. Also in the case of sub-Saharan Africa and South/Southeast Asia, the per capita food production is 460 kg/year, of which food loss accounts to 120-170 kg/year (26-37%). However, food wastage by consumers is only 5-6.5%, some 6-11 kg/year per capita, (Pap & Myllykoski, 2014), (Gustavsson et al. 2011).

## 2.3. Waste Minimization Strategies and Mechanisms

### 2.2.1. Waste management

The waste is an important issue that should be treated in such a way that the benefits achieved from that will be in both environmental and social aspects. Since in manufacturing industries waste management providing to greater opportunities for

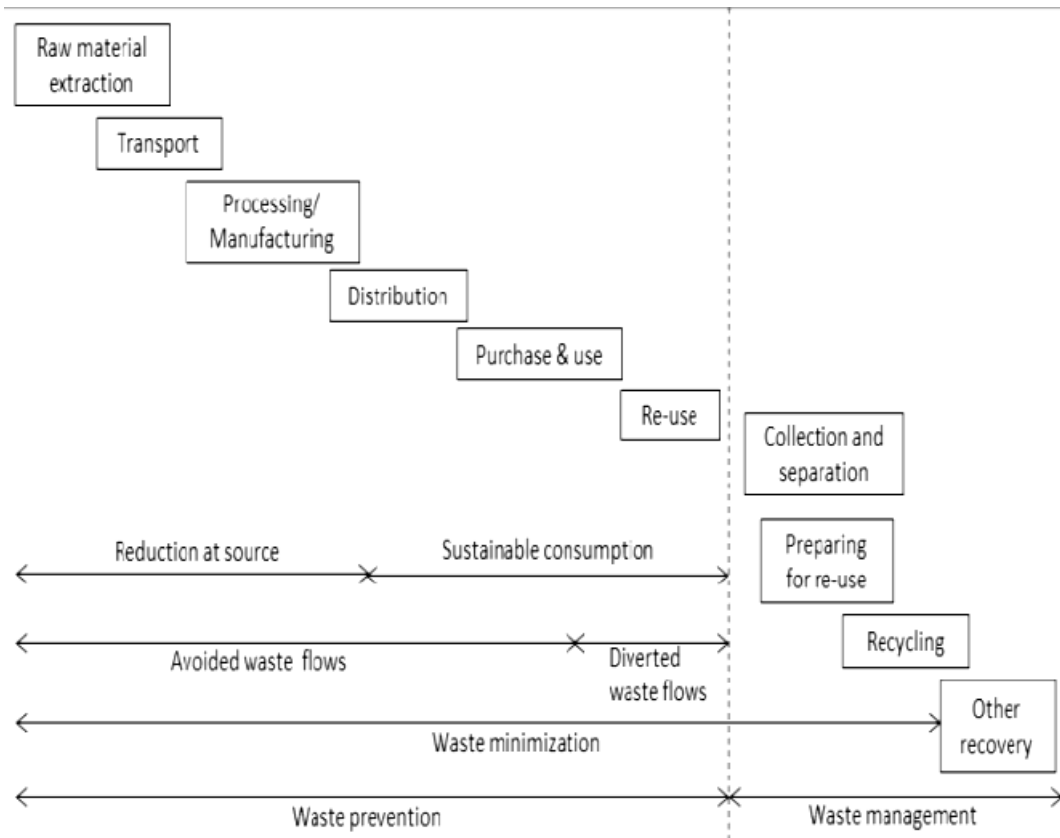
waste recovery and diversion of waste from landfill, and services suitable to businesses. Though according to (Imam, 2010) shows that waste management is favoring reuse and recycling before land filling, with the main idea of environmental sustainable society.

### **2.2.2. Waste Management Overview**

In the Europe there are quite much variety of waste management prioritizations for the total municipal solid waste stream (MSW), from those the heavily weighted towards land fill, to those weighted towards incineration. The average amount of MSW generated in Europe is 520 kg per person per year and projected to increase to 680 kg per person per year by 2020 (European Environment Agency, 2008). In the UK total usage of plastics both in households and commercial is up to 40 kg per person per year, although its only 7-8% by weight but on the other hand larger volume by proportion in MSW(Waste watch, 2003). The recycling is a waste management strategy but it can also be directed as implementing the concept of the industrial ecology, in that there are no wastes but only products in natural ecosystem (Frosch and Gallopoulos 1989;McDonough and Braungart 2002; Imam, 2010).

Since the waste prevention as measures taken before a substance, material or product has become waste that reduces:

- a) The quantity of waste, include re-use or extension of life-span,
- b) The adverse impacts of the generated waste, and
- c) The content of harmful substances in materials and products. Though once waste is formed, it should be recycled or recovered for better environmental and economic performance. The figure below illustrates the position of waste minimization amidst different waste management strategies.



*Figure 2.2. The Waste management and waste prevention strategies (source Liisa Myllykoski.etl.2015)*

#### 2.4. Continuous Improvement Strategies

Quality has become an increasingly important issue in organizations and so it is crucial to develop sustained resource management and therefore logistics emerges as an activity that allows, in a near term, the achievement of a great efficiency and economic benefits, and, in long term, to obtain competitive advantages. Though organizations can have improvement choices with time depending up on the way they track to meet their strategic and operational objectives. Science continuous improvement raises the competence of numerous processes and systems and is closely integrated with means of waste elimination and customer focus programs such as total quality management, supply chain management, just-in-time and kaizen. Furthermore continuous improvement involves an extensive journey, gradually building up performance, skills and capabilities within the organization to continuously find and solve problems pertaining to the company's activities. However manufacturing industries are to identify the exact quality problems, they need proper, identification tools and systems. Also they need to understand how to assess quality of products and systems by using a variety of quality control tools, how to interpret findings, and how to correct problems. There are many specific tools and techniques which can help

improve the process performance. Any organization needs to focus on quality of products, optimum product cost, timely delivery of products and the flexibility of their internal business process to adapt to rapid changes. Thus continuous improvement tools like Kaizen, Six Sigma, ISO9000, Lean thinking, TQM, SCM and JIT system is not new to the present situation of industrialization for achieving the above concepts. This technique is not limited to any particular industry but due to its large potential of benefit and it has a widespread application throughout the all industries. Many industries have adopted it and others are going to implement it for their survival in the fast competition at each stage in each area.

#### **2.4.1. The Concepts of Lean Manufacturing**

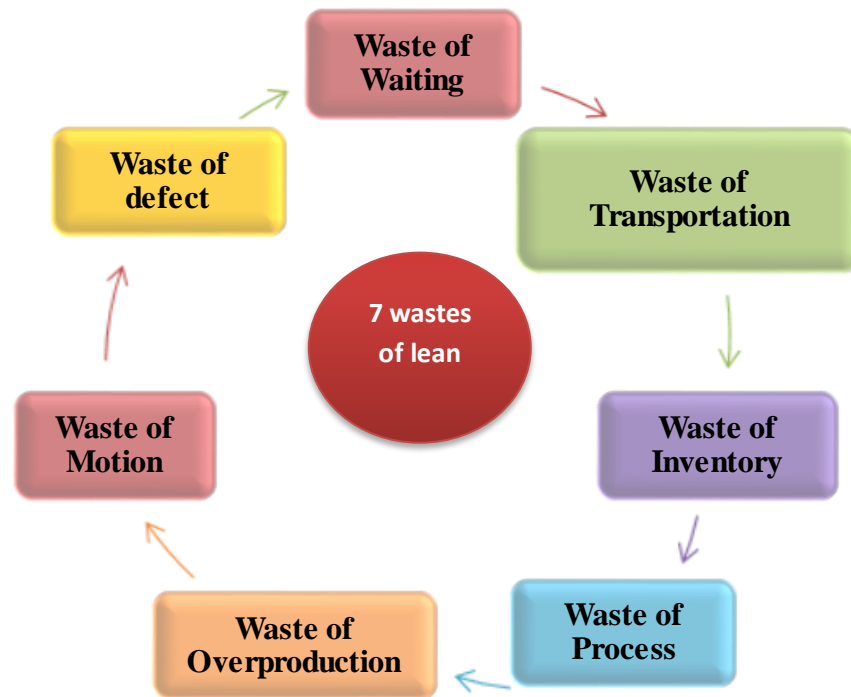
Historically the lean production system is the world famous production system developed and practiced by Toyota Company for a long time (Yasin A. , 2014; Dave, 2002). Though the basic ideas behind the lean manufacturing system are waste elimination, cost reduction and employee empowerment. Since this concepts leads to maximize customer value while minimizing all the wastes that come with that significance. Though lean processes can make jobs highly repetitive while eliminating critical rest time for employees (Eshetu, 2017). Since lean has been identified as simply an approach of using fewer resources to provide a satisfactory customers' value. The previous study (Effah-Kesse, 2017) shows that Toyota company , indicates that continuous improvement has been the main basis on which the production control system is based, with the objective of 'making the vehicles ordered by customers in the quickest and most efficient way, so that vehicles ordered can be delivered as quickly as possible. Since Japanese automobile manufacturers achieved high quality and low costs by removing buffers and impediments from the system, in lean. Eliminating excess inventory, for example, drives closer linkages between assemblers and suppliers, reshapes the factory floor, forces greater attention to first-time quality, and so on. Excess inventory means that manufacturing mistakes or broken equipment will not halt production because downstream processes can draw on inventories to keep going while the mistakes are remedied or the equipment is fixed. However, excess inventory costs money and can hide production problems that lead to greater problems later on. Mass production allows for excess inventory to provide a buffer against mistakes, while lean manufacturing aims to eliminate mistakes and hence the need for costly buffers. Though removing inventory buffers requires very tightly coupled processes that closely link different functions within the organization. Thus,

Lean is a philosophy that aims to maintain smooth production flow by continuously identifying and eliminating waste resulting in increasing value of activities in the production process (Kumar1 & Kumar2, 2012).

Even if the lean manufacturing concept was introduced by Toyota in the 1950s as a part of the Toyota Production System (TPS), but till it is not exercise and implemented in developing country manufacturing firms. As a result the performance in waste minimization, production capability and the overall performance of such firms are poor and weak (Eshetu, 2017; Agency, 2010). Further lean provides to enhance by reducing cost through elimination of waste and it requires constant effort at cost reduction to maintain continuous profits in manufacturing. The prime way to reduce costs is to produce only those products determined by sales in a timely fashion, to restrain excessive manufacturing and to eliminate all waste in manufacturing methods. There are various ways to analyze and implement cost reduction, from the start of designing all the way through to manufacturing and sales. One of the goals of lean manufacturing is to locate waste pragmatically in each process and then eliminate it. It is possible to uncover a very large amount of waste by observing employees, equipment, materials and organization in the actual production line from the perspectives of the process itself and the actual work involved. Some types of waste are obvious, but others are hidden. Waste never improves value; it only increases cost. The thorough elimination of waste leads to greater employee self-respect and to major cost reductions by preventing unneeded losses (Mahour M.Parast, 2006).

#### **2.4.2. Waste Reduction and Waste Removal through Lean**

Main goal of lean thinking is to reduce and remove waste. Since lean strategy is a potential tool to minimize and then remove waste so as to achieve sustainable development of manufacturing firms. Though the lean strategy reduction is one of the main functions of Lean Manufacturing implementation plan (Kumar1 & Kumar2, 2012). Since all the form of waste i.e. overproduction, defect, transportation, work in progress inventory, over processing, waiting and motion are reduced with Lean manufacturing implementation.



*Figure 2.3 The Seven wastes that controlled by Lean underutilized*

**Overproduction(Unbalanced production and demand):** manufacturing perspective It means producing more than the customer wants, producing faster or earlier than what is required by the next process and producing overlarge batches. For instance: computer customer wants 200 computers and the producing customer order of 400 units at the beginning of the month and later customer makes changes to the order. Further, producing too early occupied unnecessary space. Since this is waste for the manufacturer. This is unbalanced on production and demand, this unbalanced demand and production results over production wastes.

**Wastes in Waiting:** This is occurred due to on the shop floor, because operator and material shortage and unavailability of machine. As well improper shop management, lack of regular maintenance, lack of motivation and attitude of the worker are the reason for operator inefficiency and this is the reason for low speed of conveyor increase waiting wastes.

**Unnecessary Transportation:** There is problem when moving material from one section to other due to the layout of the shop floor; the presence of burrowed floor result fatigue on the worker during movement of material from store to different sections (Dametew, 2015).This results 24.53% of wasted transportation time and fatigue on the worker who are assigned on transportation of material. Also the presence of temporary material location due to disorganized work place makes

transportation time to increase. Furthermore from service perspective: is the movement of materials and information, which should be reduced for activities that do not add value or are related to occurrence of waiting time and queues that dissatisfy customers (Mohamood, 2014).

**Over processing:** It is the performing more work on a product than the customer is willing to pay for. Producing higher quality product than the customer asked or carrying out unnecessary tasks. This indicates that over machining on a part due to initial large blank, can be avoided by buying a smaller blank. Other unnecessary tasks are test and inspections as they are considered to be waste.

**Unnecessary Motion:** This type of motion does not add value to services, because it only takes additional time and cost related to unnecessary movement of employees. The motion is very hard to measure in service. In addition in manufacturing firms, it happens when there are unnecessary movement of people and machines. Unnecessary motions may also be harmful from an ergonomics point of view (Eshetu, 2017).

**Manufacturing or Service Defects:** It involves any waste which involves costs related to delay, warranty and repairs. Produce defective products results in waste because wrong product has made and need to be corrected, mostly customer are not willing to pay for this. Besides, it happens when services are not performed within specification of customers. Some of the services are not costly to correct mistakes, but organizations should consider that they might also lose customers. For instance lack of information or inaccurate process of documentation can cause delays which dissatisfy customers. Since in healthcare, infections that patients get due to lack of hygiene and poor treatment are considered as defects (Mohamood, 2014), (Eshetu, 2017).

**Inventory:** involves the over existence of raw materials, WIP and finished goods in organizations. This is considered waste because of the excess of cost spend on them. This indicates that When employees are unable to provide services according to customer's requirements due to lack of supplies. Providing substitute of products or services, not what was asked by customers (Mohamood, 2014). Since through the implementation of lean the above wastes can be tackled. Though Ethiopian manufacturing industries should implemented lean manufacturing principles so to improve their performance and productivity through waste minimizations.

*Table 2.1 Types of wastes, their definition and causes in manufacturing (Walder, 2007)*

Types of waste	Definition	Causes
Over-production	Produce only the amount of goods necessary-not faster, sooner, or more	<ul style="list-style-type: none"> <li>- volume incentives (sales, pay, purchasing)</li> <li>- high capacity equipment</li> <li>- line imbalance; poor scheduling</li> <li>- poor production planning</li> <li>- cost accounting practices that encourage buildup of inventory</li> </ul>
Defect	Perform each operation without error. Build quality into every process	<ul style="list-style-type: none"> <li>- unclear customer specifications</li> <li>- incapable processes</li> <li>- lack of process control</li> <li>- unskilled personnel</li> <li>- incapable suppliers</li> </ul>
Unnecessary inventory	Provide material when needed by the customer and only in the quantity required	<ul style="list-style-type: none"> <li>- over-production</li> <li>- unbalanced line</li> <li>- long lead times</li> <li>- high rework rate</li> <li>- lack of material requisition and issuance standards</li> </ul>
Inappropriate processing	Provide only the required amount of processing and effort for each operation	<ul style="list-style-type: none"> <li>- unclear customer specifications</li> <li>- frequent engineering changes</li> <li>- unclear work instructions</li> </ul>
Excessive transportation	Minimize the distance between processes, and avoid temporary material locations	<ul style="list-style-type: none"> <li>- poor route planning</li> <li>- complex material flows</li> <li>- poor layout</li> <li>- disorganized workplace</li> </ul>
Waiting	Assure machine availability. Perform preventive maintenance. Use man/machine charting to ensure optimization of operator's time	<ul style="list-style-type: none"> <li>- line imbalance</li> <li>- inflexible work force</li> <li>- unscheduled machine downtime</li> <li>- long set-up</li> <li>- material shortage or delay</li> <li>- manpower shortage or delay</li> </ul>
Unnecessary motion	Simplify standardized work sequence to eliminate unnecessary movements	<ul style="list-style-type: none"> <li>- poor lay-out and housekeeping</li> <li>- disorganized work place and storage locations</li> <li>- unclear, non-standardized work instructions</li> <li>- unclear process and materials flow</li> </ul>
unused Talent and creativity	encouraging and making constructive use of the creativity	ingenuity of the people actually doing the work

### 2.4.3. Principles of Lean

Lean organizations are highly customer focused, providing the highest quality, lowest cost products in the shortest lead time possible. According to the book “Lean Thinking” by James P. Womack and Daniel Jones, the Lean approach can be summarized in five principles (Womack, 2003).

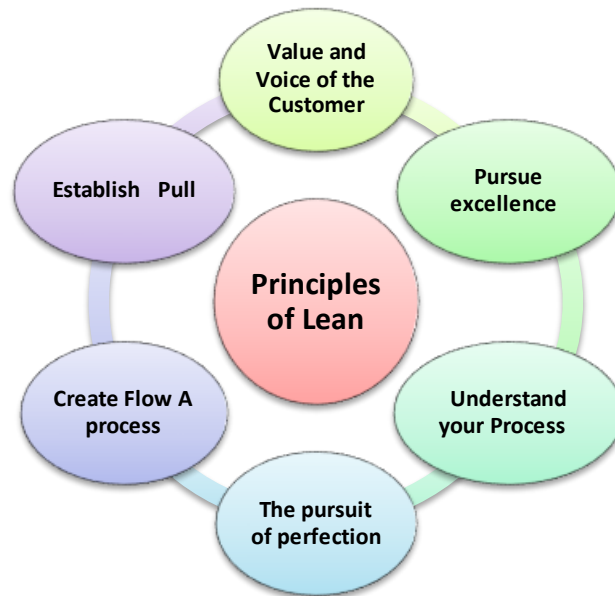
1) Voice of the Customer: Identify who your customer is and identify value from their perspective. Typically, a value-added activity must meet three criteria: This is something the customer would be willing to pay for, if they had to it is something “physical” done to change the product or service, it is something done correctly the first time, without need for re-work

2) Understand your Process mapping allows you to have a picture of your process so you can begin making improvements. Without it, it is difficult to have transparency and see where the problems are. It also helps the team gain an understanding of everyone’s role in the process. There are five different types of process maps you do not need to do all of them, just the ones that help you understand the process.

3) Create Flow a process “flows” from person to person, department to department, or facility to facility. Flow is about moving people or product through a service process—one at a time, without stopping or waiting.

4) Establish Pull Many of our processes are pushed or “given” to the next user. This creates many forms of waste in many cases the next area or person may not be ready causing inventory and backlogs. This is the very reason we have so many waiting rooms or holding areas. Having a system of pull means you only supply what the customer wants, when they want it.

5) Pursue excellence lean thinking is rooted in the continuous quality improvement philosophy. Lean is not a one-time event but rather a journey to continually improve our processes and always strive to supply the customer with value, from their perspective. Though, lean thinking is the belief that there is a simpler, better, easier way to complete our work. Since those tools help in implementing, monitoring and evaluating Lean efforts and its results. (Md. Mazedul Islam, 2013; Andersson, et al 2006; Ahmed, 2013).



*Figure 2.4 the principles of lean*

Accordingly the literature review in the table 2.6 shows different research results, method their objectives those were done by various researchers in related to continuous improvements strategies, so as to use a body of knowledge in my study.

#### **2.4.4. The Driving Power on Lean Implementation**

In manufacturing firms the implementation of lean provides to improve quality, reduce cost, fast delivery and efficient queue time along with increased flexibility. These is due to lean plays a significant role in organization's success because it involves vast understanding, strong commitment and thorough analysis of problems (Mohamood, 2014). Since for the overall success of the firm, lean implementations are a critical tasks. While the implementation of lean were inflected by various critical success factors are includes management commitment, organization cultures, the goals and objective, problem solving, skills, financial capabilities, performance measure, change, are the common (Effah-Kesse, 2017; Mohamood, 2014; Dave, 2002). Besides, during the implementation process and after implementation firms should also know the challenges of these strategies. Though there were challenges that have been facing during the implementation of lean as it's not a short term process and to mold into lean organization takes time. According to (Sarkar 2009) invisible process, insufficient skill and knowledge, large and complex processes are considered as the challenges of lean implementations. Since employee understanding, good skill and knowledge, understanding the goal and objectives , knowing customer

expectations, good experience and experts consultants those have their roots in manufacturing sector and can be able to support by giving practical examples from lean manufacturing are crucial. Likewise, during the implementation of integrated lean manufacturing in Ethiopian food processing industries everyone from higher level to bottom have knowledge to these critical success factor and willingness to participate lean implementation.

#### **2.4.5. Limited success of lean**

Besides in the automotive industry's adoption of lean does not escape criticism (Rinehart et al., 1997). This seems to stem from a lack of understanding, direction and/or commitment from management (Hancock and Zayko, 1998), not helped by the heavily unionized culture of the industry (Hall, 1992). Management and their communications provide the backbone of any continuous improvement effort, while employees require transparency from management and their own education and empowerment in the change process. Since in a development beyond lean's initial application to low-variety, high-volume facilities, attention has been given to the viability of applying lean principles to "job-shop" companies, i.e. high-variety, low-volume (Winter, 1983; Jina et al., 1997; Hendry, 1998; Irani, 2001). Research (Boughton and Arokiam, 2000) suggests that lean applications are essential for survival and growth in today's job-shop industry. This has been brought into question through the suggestion that value-added activities do not take into account the size, complexity or manufacturability of a product. Therefore if the theory behind lean is flawed, then the "universality of lean must clearly be questionable" (James-Moore and Gibbons, 1997). As discussed by Irani (2001), job-shops face the toughest obstacle when trying to map and analyses the flow of 100-2,000 p product routes through their facility. Complicated and in-depth algorithms and often prohibitively expensive IT solutions are needed to overcome this difficult scheduling task. Ultimately, lean implementation has not been as successful here as in their mass producing counterparts for three main reasons. Firstly, huge product portfolios mean that each "job" is likely to be different and therefore production approaches cannot be standardized. Secondly, the products' characteristics create production constraints. Thirdly, the job-shops or smaller firms simply cannot match the dominance or resources that the larger firms enjoy, allowing them to be inflexible along their supply chains (Bamber et al., 2000). The view that lean is pro-company, not pro-employee, has some validity, and cannot be dismissed. For example, it is said that employees

feel a sense of insecurity, perceiving lean as a redundancy threat. The opinion is also held that management avoid accountability when problems arise, letting it filter downwards onto the lower levels of hierarchy (Parker and Slaughter, 1994). This is to miss the fundamental underpinning of empowerment and cultural change, resulting from a failure by management to approach lean with the correct goals. Lean requires and relies on a review of organizational values, which in itself is important to sustainability of lean. Without this we see an adverse effect on morale, increasing levels of worker unhappiness and withdrawal, ultimately leading to operational failures (Hines et al., 2004).

## **2.5. Six Sigma**

Six sigma is a business management and QI strategy that originated in the Japan manufacturing industry; it seeks to improve efficiency by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes (NLC, 2013).

Motorola was the first company to launch a six sigma programmer in the mid-1980s (Rancour and McCracken, 2000). In 1988, Motorola received the Malcolm Baldrige National Quality Award, which led to an increased interest of six sigma in other organizations; see (Pyzdek, 2001). Today, a number of global organizations have developed six sigma programmers of their own and six sigma is now established in almost every industry. Six sigma is defined: as a business process that allows companies to drastically improve their bottom line by designing and monitoring everyday business activities in ways that minimize waste and resources while increasing customer satisfaction by some of its proponents, see (Magnusson et al., 2003).

Six sigma could also be described as an improvement programmer for reducing variation, which focuses on continuous and breakthrough improvements.

Improvement projects are driven in a wide range of areas and at different levels of complexity, in order to reduce variation. The main purpose of reducing variation on a product or a service is to satisfy customers. The goal of six sigma is that only 3.4 of a million customers should be unsatisfied, see (Magnusson et al., 2003). There are two major improvement methodologies in six sigma, one for already existing processes and one for new processes. The first methodology used to improve an existing process can be divided into five phases, see (Pyzdek and Magnusson et al, 2003). These are:

- (1) Define: which process that needs improvement. Define the most suitable team members to work with the improvement. Define the customers of the process, their needs and requirements, and create a map of the process that should be improved.
- (2) Measure. Identify the key factors that have the most influence on the process, and decide upon how to measure them.
- (3) Analyze. Analyze the factors that need improvements.
- (4) Improve. Design and implement the most effective solution. Cost-benefit analyses should be used to identify the best solution.
- (5) Control. Verify if the implementation was successful and ensure that the improvement sustains over time. As well the second methodology is often used when the existing processes do not satisfy the customers or are not able to achieve strategic business objectives, see (Eckes, 2001). This methodology can also be divided into five phases; define measure, analyze, design, verify, according to (Magnusson et al., 2003). In summary, the two different methodologies have obvious similarities (Roy Andersson, 2006).

#### **2.5.1. Roles of Six sigma on improvement**

Many companies use this methodology to achieve competitiveness. Six sigma methodologies are used to improve the quality of the product and process dramatically. Sigma,  $\sigma$ , is a letter of the Greek alphabet that is employed to measure the process variability and the sigma level is measured to determine the performance of the business processes (Pyzdek, 2003). The six sigma methodology was introduced by (Motorola, 1980) and resulted in the accomplishment of business quality in Motorola. (Snee, 2010) states that six sigma concept was constructed by Bill Smith, then an engineer at Motorola who wins the 1988 Baldrige National Quality Award. Then, the deployment of six sigma concept is led by Allied-Signal and General Electric (GE).

#### **2.5.2. The Lean Six Sigma**

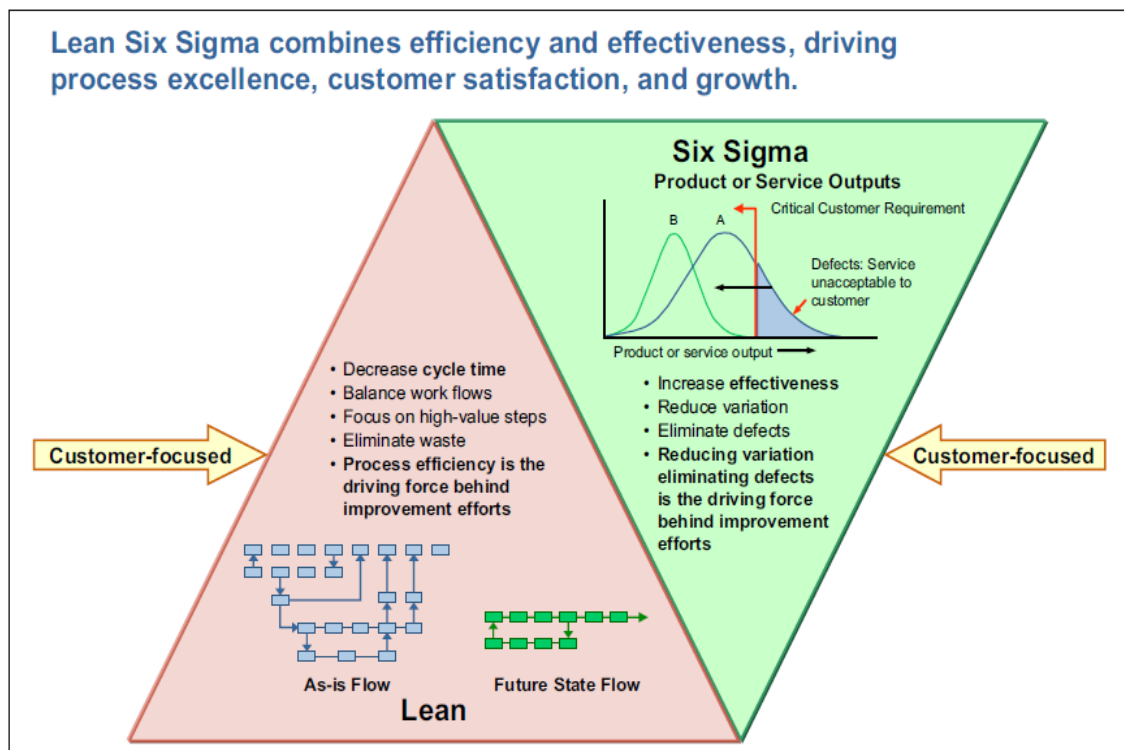
Another concept for the process improvement is lean six sigma or lean sigma which is integration between lean and six sigma concepts. According to Bain and Company (2012) in Myerson (2012), lean manufacturing aims to eliminate waste and six sigma supports companies in decreasing errors. Lean six sigma can support companies to achieve the advantages of the quicker process with the lower cost and higher quality. Bendell (2006) states that lean six sigma or lean sigma is a combination of two

process improvement approaches, i.e.: lean thinking and six sigma. Lean thinking focuses on reducing and eliminating the waste with the analyzing of value and process. Six sigma focuses on reducing and eliminating the variation with statistical tools application and supporting software. (Higgins, 2005) in Pepper and (Spedding, 2009) mention that six sigma is implemented by a several appointed individuals within a company, but lean stages empower and educate the employee in the organization to recognize and remove non-value added activities. Many companies implement lean six sigma to improve their business and obtain a competitive advantage. Many organizations have adjusted Lean and Six Sigma and used them to fulfill their specific requirements (Oppenheim et al., 2010). Since the lean six sigma becomes a methodological approach in improvement strategies and techniques. (Sharma, 2003) depicts the advantages of utilizing the six sigma techniques in combination with lean, where the objectives of strategic improvement are provided by the leaders of the company. Then, the quality function deployment (QFD) tool is applied to emphasize the project. Also, lean six sigma become a breakthrough concept of the innovations to improve their business performance. The leading companies utilize lean six sigma and they pursue the larger innovation agenda (Byrne et al., 2007). According to (Snee, 2010), lean six sigma is a methodology and strategy of business that enhances the performance of the process, generating in increasing customer satisfaction and enhanced bottom line results. While the lean six sigma can be used to analyze the root causes of the problem and design the improvements. (Martin, 2007) proves that lean six sigma methods are effective in investigating the root causes of the problems as well as removing them from the process. Steps for the lean six sigma use the DMAIC (define, measure, analyze, improve, control) cycle to solve the problem. Moreover the (Besseris, 2011) states that lean six sigma is a blueprint for any project of improvement to offer a brief method-based approach and concept on how to work with robust decisions on the pathway to product and process.

*Table 2.2 Integration of Lean Tools in the DMAIC Framework*

	<b>Define</b>	<b>Measure</b>	<b>Analyze</b>	<b>Improve</b>	<b>Control</b>
<b>Lean tools</b>	Value Mapping	Process Mapping	FMEA	Production Smoothing	Standard Work
	Project Charter	Cause and Effect Matrix	Bottleneck Analysis	Kaizen Events	5S Poka-Yoke

Source :( Snee, 2005; Png, 2015)



*Figure 2.5 lean six sigma combines (Hans, 2013)*

## 2.6. Just-In-Time (JIT)

JIT is a systematic approach to achieve competitiveness and excellence in manufacturing industries by eliminate sources of manufacturing waste for getting right quantity of raw materials and producing the right quantity of products in the right place at the right time. Scholars (Matsui), (Areview, 2013)shows that JIT is as a powerful tool for continuous manufacturing improvement based on the elimination of wastes in all phases of manufacturing process. According to these study JIT highly impact financial, time and flexibility performances of manufacturing companies. As result due to its effectiveness in reducing production costs, improving product quality and enhancing financial performance, IT which can lead to achieve the competitive advantage for manufacturing companies over others in the same industry in light in the ongoing fierce competition among industrial firms. However, the implementation of JIT allows manufacturing system a fast and efficient production of high quality products that fully meet customer needs. By producing products only when needed and with a strong quality control, manufacturing system prevents the creation of waste and thus reduces the amount of energy, raw materials and other used resources, which presents an important management tool in building ecologically sustainable business (Milovanoi, 2011). Additionally some selected articles are presented in the table, then

discuss the main concepts and roles of JIT on manufacturing industries and identify the gap and based on the concepts improvement model is proposed to food processing industries.

*Table 2.3 the influence of JIT implementations for competitiveness literature*

Author	Findings	Journal Name
AkbarJavadian Kootanaee. et.al(2013)	Identifies the hidden problems in the value chain and reduces the production waste of the system	International Journal Of Economics, Business and Finance
ZaidahmedZ. Khan,&,Dr. Sanjay Kumar,	Eliminate sources of manufacturing waste for attaining manufacturing excellence in an industry.	International Journal of Application or Innovation in Engineering & Management (JAIEM)
Sandeep Phogat(2013)	It is a systematic approach to achieve competitiveness and excellence in manufacturing industries	International Journal of Latest Research in Science and Technology
SultanSingh1&Dixit Garg (2011),Sanjay Paliwal et.al(2013)	JIT system is mainly to reduce buffer stocks, reduce costs, and increase the flexibility and to enhance the profitability.	International Journal of management and Business studies(IJMB), International Journal of Emerging Trends in Engineering and Development
Ignatio Madanhire. et.al (2013)	JIT is to improve cost effectiveness of operations, quality and to achieve world class benchmarks on all facets of the engineering entity as competitiveness in product delivery is getting to be mandatory for business survival.	International Journal of Science and Research (IJSR)
MahdiSalehi.et.al (2010)	The implementation of JIT impact on financial Performance.	Global Journal of Management and Business Research

Wide range of research work was conducted related to JIT concepts. This literature review analysis to summarize the concepts in the table above and it give lights on to different aspects of JIT implementation on manufacturing industries as continuous improvement tools. In addition to these, during the implementation of JIT practice on manufacturing industries we should know the JIT Principles, including attack fundamental problems, eliminate waste, strive for simplicity and devise systems to identify problems.

## **2.7. Malcolm Baldrige National Quality Award**

In an effort to improve quality management practices and the competitiveness of U.S. firms, President Ronald Reagan signed the Malcolm Baldrige National Quality Improvement Act on August 20, 1987. The Malcolm Baldrige National Quality

Award (MBNQA) was created to promote quality awareness, identify the requirements for quality excellence, and share information about successful quality strategies and benefits (Robert J. Vokurka, 2000). Each year, organizations in the manufacturing service, small business, healthcare, education and nonprofit/government sectors applied for the award. More than 1,600 organization have applied for the Baldrige award since its inception. In total, 113 awards have been presented to 106 organizations including seven repeat recipients (NIST, 2016; Cindy et al., 2017) The Baldrige Criteria focus on helping organizations use a focused and systematic approach to performance management that results in: (Paul Grizzell, 2006)

- Delivery of ever-improving value to customers, contributing to marketplace success
- Improvement of overall organizational effectiveness and capabilities
- Organizational and personal learning.

The Baldrige core values and concepts are includes visionary leadership managing for innovation, customer-driven, excellence, management by fact, organizational and personal learning, social responsibility, valuing employees and partners, focus on results and creating value, agility systems perspective and focus on the future are the common values. (Paul Grizzell, 2006).

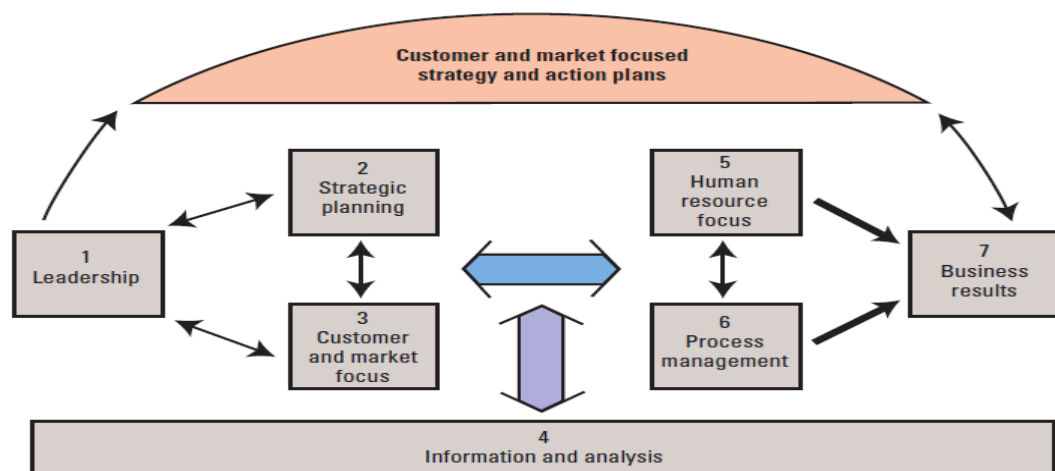


Figure 2.6 Baldrige award criteria for performance excellence framework (Robert J. Vokurka, 2000).

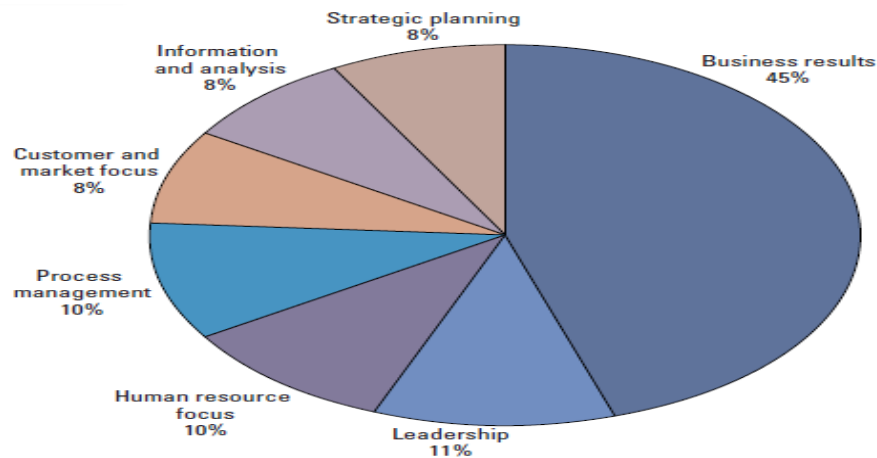
### 2.7.1. Other quality awards

Quality awards has many objects to continuous improvement and waste minimization there are different awards in the world we try to see some of it Ethiopian, Europe, Canadian, Australian and Deming (Japans) quality awards. Award criteria for successful and established programs continue to improve, reflecting changes in the

quality arena. (Robert J. Vokurka, 2000) The countries from which these awards are administered represent a significant amount of the world’s production of goods and services and, collectively, account for approximately 74% of the world’s gross national product (Herndon, 1998).

**Table.2.4 Percentage Emphasis of Baldrige Award Criteria and different award**

Australian quality award	Europe quality award	Canadian quality award	Malcolm baldrige quality award	Ethiopia quality award
Leadership Information and analysis Policy and planning People Quality of process, products and service Customer focus	Leadership People management Policy and strategy Resources Processes People satisfaction Customer satisfaction Impact on the society Business result	Leadership. Planning. Customer focus. People focus. Process Management. Supplier focus. Organizational Performance.	Leadership Information and analysis Strategic quality planning Human resources development Management of process quality Quality and operational results Customer focus and satisfaction	Leadership Policy and strategy Resource management Processes Customer focus Impact on society Business performance
17% 13% 8% 20% 22% 20%	10% 9% 8% 9% 14% 9% 20% 6% 15%	24% 5% 17% 17% 10% 10% 17%	9% 8% 6% 15% 14% 18% 30%	15% 8% 12% 15% 25% 10% 15%



**Figure 2.7 Percentage Emphasis of Baldrige Award Criteria (Robert J. Vokurka, 2000)**

While MBNQA helps organizations realize their inadequacies in innovation, it does not actively help them to improve it. The Baldrige Criteria is essentially a self-assessment checklist. Self-assessment leads to an organization realizing its shortfall and providing opportunities for innovation. That is how innovation might happen

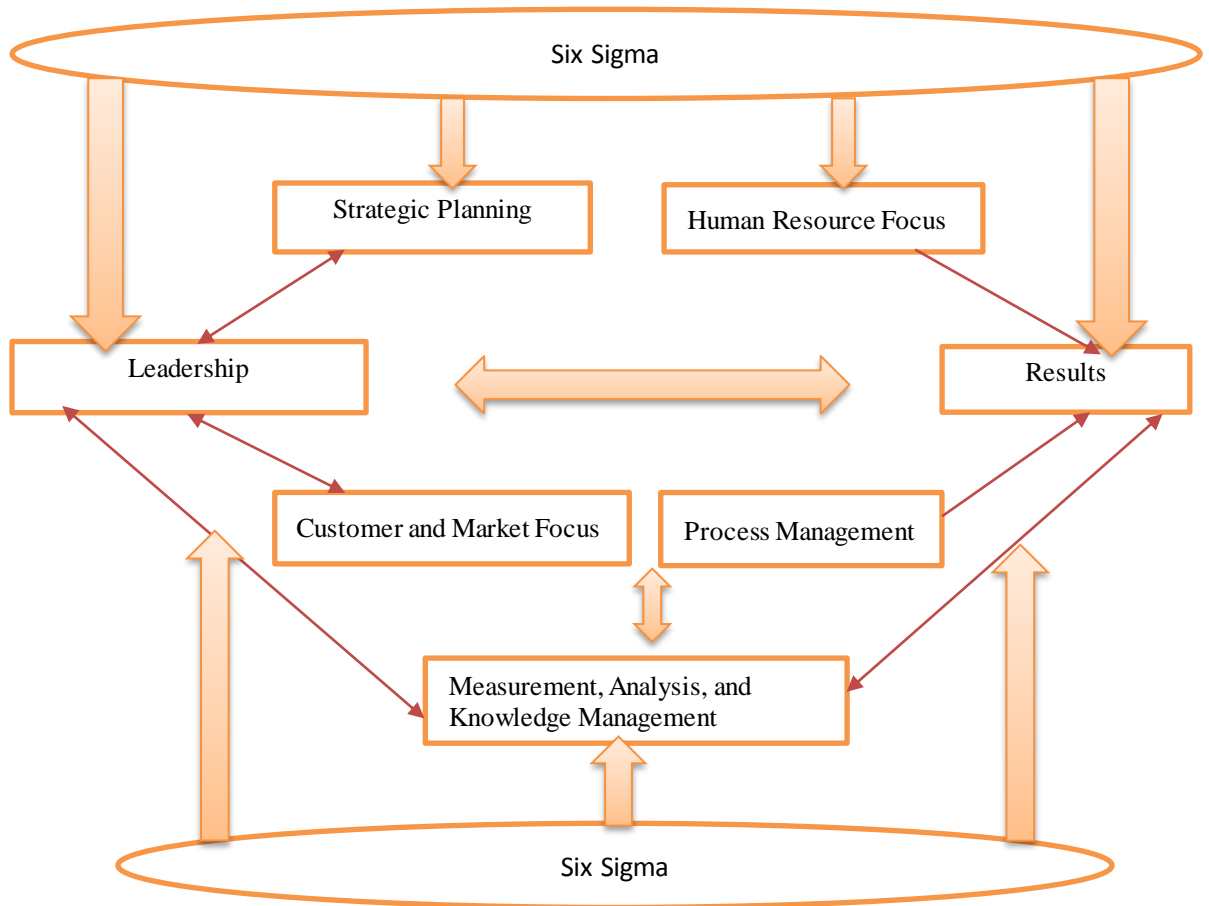
when an organization applies the Baldrige framework. However, it remains difficult for an organization to innovate because the Baldrige framework does not provide tools for innovation to happen. The realization of a lack of innovation does not necessarily result in successful 35 innovations even though firms might attempt to change them. The concern of some critics is that firms dedicate resources to win the award than functionally necessary to actually improve quality and innovation processes (Gopalakrishna & Chandra, 1998).

Different categorization techniques have been applied to the factors in which these two frameworks will be Contrasted. The first category is called the Conceptual factors, where the theoretical and philosophical. Essence of these two frameworks are compared and examined. Conceptual analyses of frameworks have been previously conducted by other authors for other quality tools like Total Quality Management (Ford & Schellenberg, 1982; Montes et al., 2003; Png, 2015). The second category is called the Execution factors, where the frameworks are compared based on how they are deployed and implemented. Empirical studies have categorized factors that can be used to analyze the effective implementation of these frameworks (Denis & Gary, 2000). The third category is called the Impact factors, where the results of the implementation of these two frameworks are contrasted. Similarly, studies conducted on Quality frameworks have used Impact factors as a means of analysis and they are adapted here for this research (McAdam, 1999; Shortell et al., 1995; Png, 2015) these three categories are presented in Table below.

**Table 2.5 Comparing Lean Six Sigma and Malcolm Baldrige National Quality Award in different category**

Category	Area of comparison	Lean six sigma	Malcolm Baldrige national quality award
<b>Conceptual Basis</b>	Fundamental philosophy	Usage of scientific data to guide decisions and improvement in an organization	Quality comparison of an organization's performance against an optimum benchmark
	focus	Action and actual improvement	Assessment and compliance
	scope	Specific processes	Entire business system
	purpose	Improve specific outcomes within an organization	National recognition and holistic view of company performance

<b>Execution Basis</b>	Situations applicable for	Process improvement	Wide range of organizations
	Situations not applicable for	Product design	N.B
	Personnel involved	Management external consultants	management
	Frequency of execution	Irregular, depends on the need for improvement	Once a year
	Training requirements	To learn application of tools	No training required
	Focus on Control and Sustainability	Yes	No
	Support from External Organizations	Yes	No
	Human Resource Focused	No	Yes
<b>Impact Basis</b>	Types of Returns Expected	Cost savings and productivity improvements	Weak evidence for actual improved performance
	Financial Returns	Yes, if executed successfully	Yes, stock price proven to outperform market
	Recognition Awarded	Typically unknown	Yes
	Organization Culture Influence	Continuous improvement mindset, customer centricity, process and data centricity	Not specific. Depends on the outcome of the management's Reflection.
	Societal Impact	Typically not obvious, usually expressed through better products and services for Customers.	Dramatic impact. Winners of award tour the country, share their knowledge and motivate other companies toward quality excellence
	Period Before Significant Results are Achieved	Long Term	Long Term
Source (Png, 2015)			



**Figure 2.8 An Integrative Approach to Six Sigma Implementation in the Baldrige Model; Mahour M. Parast, (2006)**

Analysis on Baldrige model with six sigma methodology they state that “Baldrige provides the framework, Six Sigma the methodology.” According to Sumberg (2005); Mahour M. Parast, (2006) the Six Sigma quality laid the foundation for Motorola to be the first company to win the Baldrige award. Such a link between the Six Sigma methodology and the Baldrige model exists in practice.

- They help to provide continuous quality improvement.
- They require high level of management commitment.
- They represent a culture change of the organization.
- They implemented as part of a strategic plan.
- They have systematic structures.

**Table 2.6 Continuous Improvement Investigations**

Author	Title	Objective	Methods	Results
<b>(Samuel, 2010)</b>	Integrated lean TQM model for global sustainability & competitiveness	To explore an integrate total quality management (TQM) model for global sustainability	'5S'	Show some evidence to help organizations overcome the damages caused by the financial tsunami
<b>(Dave, 2002)</b>	How to compare six sigma ,lean & the theory of constraints	Choosing conceptual framework from lean tool for organization	Six sigma Lean thinking and theory of constraints	Discuss the basics of the 3 improvement methodologies & present a model the help you understand their conceptual & similarity & differences
<b>(Shahin, 2010)</b>	GT & lean production a conceptual model for enhancing productivity	A conceptual model has been proposed for enhances productivity through the application of GT in lean production system	GT & lean	The result confirm the high correlation between the elements of the proposed model in both companies
<b>(Praveen, 2012)</b>	Reduction of working in process inventory & production lead time in bearing industry using value stream mapping	To reduce the production lead time & WIP in order to increase the production rate in TEI company	Value stream mapping	Indicate that company should be incorporate production kanban & pull system
<b>(Martin K. , 2014)</b>	Development of collaborative green lean production	To integrate sustainable thinking &	Lean & green production	How to integrate and implement company green lean production

	system	environmental care into operation management to improve process	system	system
<b>(Daniel, 2016)</b>	Proposal for a conceptual model for evaluating lean production development performance	To design a conceptual model that can be used in the evaluation of LPD performance in the manufacturing industry	10 core lean enable	present a conceptual model for evaluation of LPD performances by identifying and analyzing the core existing LPD enabler
<b>(Fatin, 2016)</b>	Lean tools for reducing production time & satisfying employees	To apply suitable lean tools in order to reduce production time while keeping	5S & SMED	First it is possible to satisfy the employees with arranging the work area by 5S & reduce the production time by SMED
<b>(Fatemeh, 2011)</b>	Continuous improvement through an integrated maintenance model	To identify the critical success factors of six sigma and TPM practice through the conceptual model in achieve organization effectiveness and productivity	Six-sigma & TPM	Emphasizes on the importance of maintenance in continuous improvement
<b>(Mohamed, 2013)</b>	Continuous improvement (CQI) strategies to optimize your practice	To optimize continuous quality improvement strategies	Six-sigma lean and Baldrige quality award criteria.	It optimize(CQI) strategies by using Six-sigma lean & Baldrige quality award criteria

<b>(Same, 2016)</b>	Development lean six-sigma conceptual implementation model for manufacturing organization	To investigate the suitability of the proposed model for manufacturing organization.	Use lean & Six-sigma based on DMAIC approach	Proposed conceptual lean six-sigma implementation model &LSS implementation 26 LSS tools
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Though in the table above shows that the trends and practices of continuous improvement strategies in various organizations were investigated. According to the results most researchers try to finding waste minimization using integrating lean with other tools and develop conceptual model but there is a gap that developing lean tools integrating with quality award principle and develop conceptual model that help the eliminating waste and continuously quality improvement.

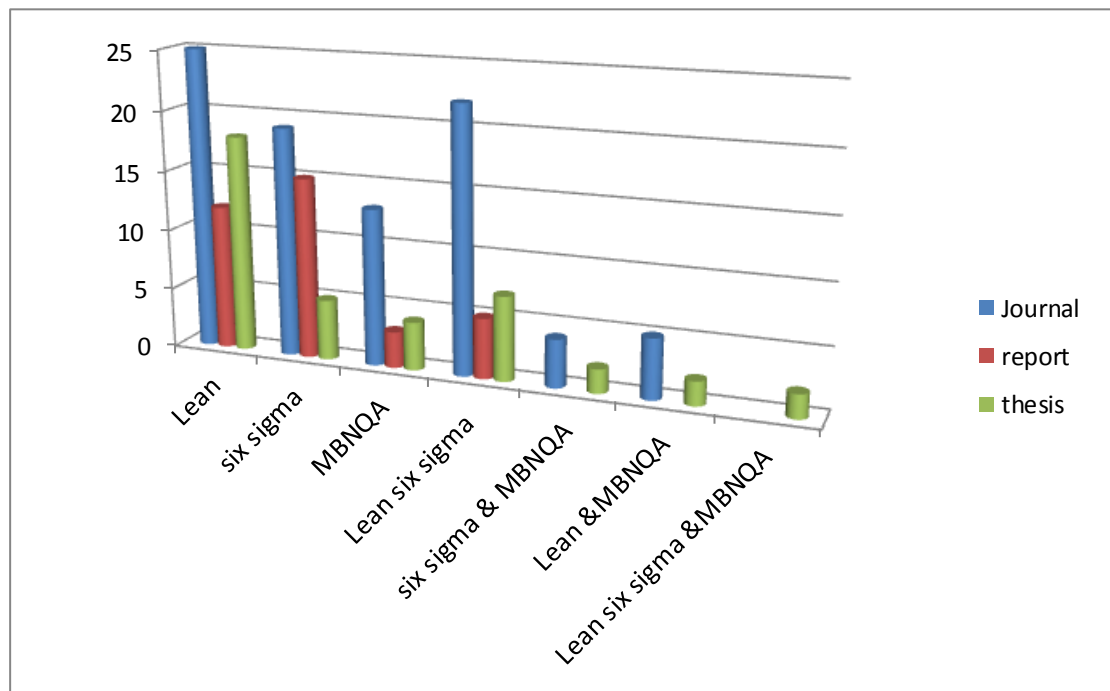
## 2.8. Comparative Analysis

In this section the comparison analysis of each continuous improvement strategies were done. Since the analysis were considered and performed based on the literature review results on the pervious sections. While the lean, six sigma and Malcolm Baldrige National Quality Award (MBNQA) concepts are often combined, they share the common goal of delivering and continuously improving business processes. Since all Lean Six Sigma focus on defining success from the customer's perspective and require a complete understanding of the business process in order to implement improvements. Besides lean thinking mainly emphasis on removal of wastes but six sigma concerns on reduce variation. Whereas Malcolm Baldrige National Quality Award works for excellence and Quality awareness. As well the MBNQA disapproval on unfairness, superficiality and publicity the inherent value of the continuously improving award program far outweighs its limitations. In the principle point of view the MBNQA belonging to works on visionary leadership, customer-driven, excellence, organizational and personal learning, valuing employees &partners, agility, focus on the future, and analysis and knowledge transfer and organization performance. Whereas the lean thinking principle are includes identify value, identify value stream, flow and pull, perfection. Also the lean is intended to review the entire process to identify and eliminate waste within the process, whereas six sigma focuses on individual sources of defects to determine the root cause and improve the process

to reduce or eliminate those defects. While the six sigma that want to rigorously quantify improvements in safety, quality and cost effectiveness. Too MBNQA is ideal for practices that want to establish a new CQI system or overhaul an existing one.

## 2.9. Summary of the Literature Review

Several researches have been conducted related to six sigma, TQM and JIT practices on global competition and firm performance were mostly concerned on the developed world Kongolo & Dlamini (2014). For example Kaizen, TQM, Lean and JIT manufacturing has been practiced in Toyota Production system in which still apply in implemented in developed nations (Akbar, 2013). But competitiveness is not only the result of having reach production factors; rather it demands the efficient and effective integration of the factors of production to get the required product or service meeting healthy and sustainable customer requirements of the world. Although in the developing world, the study of continuous improvement management practices and organizational competitiveness performance is insufficient. In addition to this the challenges involved lean, six sigma, TQM and JIT implementation is due to infant stage of Ethiopia food processing industry the progress and their manufacturing contribution to the global competitiveness environment being almost insignificant. As result industries in many developing countries are working on outdated technology and techniques of manufacturing systems.



*Figure 2.9 summary of literature review*

## 2.10. Literature gap

To get enough information about the topic raised so many literatures are reviewed from different sources, among these journal articles, reports, and unpublished master thesis is the main one. During literature survey recent documents concerning waste minimization tool lean, six sigma and Malcolm baldrige quality award are collected from different sources then each document critically examined in order to filter gaps below.

- ✚ (Roy Andersson, 2006; Hans, 2013; Ahmed, 2013; Samuel, 2010; Nave, 2002; Same, 2016 ;Shahin, 2010; Walder, 2007 & Yasin, 2014) these papers deal integration of lean six sigma with different tools but not integration awards perspective.
- ✚ Paul Grizzell,(2006)& Png,(2015) these papers see the alignment and reviewed of Lean Six sigma and Baldrige but not integrate all.
- ✚ The organizations are not able to reap out the benefits of Lean Six sigma, Baldrige and other advanced tools practices due to lack of awareness.
- ✚ Integrated Lean, Six sigma and Baldrige approach in Ethiopia Industries is not explored and not much has been found in food industry.

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## CHAPTER THREE

### 3.1. Research methodology

To deal with the key research objectives, this research utilizes both qualitative and quantitative i.e. mixed methods and combination of primary and secondary sources. The qualitative data support the quantitative data analysis and results. The result are triangulated while the researcher utilizes the qualitative and quantitative data types in the data analysis.

#### 3.1.1. Research Methods

Research methods explicit as all those methods and techniques that are used for conduction of research. Since the research methods refer to the instruments used in selecting and constructing research technique of the study. While research techniques refer to the instruments we use in performing research operations such as making observations, recording data, and techniques of processing data. Since this section report about the target population, sample size and the sampling procedure used to evaluate the current conditions of the defect waste on the selected company.

### 3.2. Research Sampling

#### 3.2.1. Sampling Methods

A sample is hopefully representative collection of units from a population used to determine truths about that population. In other expressions it is the method of attain information about an entire population by examining only a part of them (McMillan, 1996).Samplings is apple in this research due to resources including time, materials, money and workload. So that in this study I used random sampling technique because the selectivity which is built into an equal probability sample derives from the researcher targeting a particular group. However, simple random sampling technique is a part of the sampling technique in which each sample has an equal probability of being chosen that is most effective when one needs to study a certain cultural domain with knowledgeable experts and used with both qualitative and quantitative research techniques (Tongco,2007).

#### 3.2.2. Sample Size

The sampling method which was applied in this study is the simple random sampling method. A simple random sample is a sampling method in which every member of the population has an equal and independent chance of being chosen. To get a representative and reasonable sample size that supports the research findings, the

following equations were used. Equation (1) is applied to compute the initial sample size. Since the population is finite (less than 50,000), Equation (2) is used to compute the new sample size. These equations developed by Johnson et.al, (2009) and Freedman et al., (2007) according to (Othman, 2014).

$$n_0 = \frac{z^2 * p(1-p)}{c^2} \dots\dots\dots 1 \quad n_f = \frac{n_0}{1 + \frac{n_0 - 1}{N}} \dots\dots\dots 2$$

Where:

n0 = initial sample size

nf= target sample size

Z = Z-values for confidence levels are (1.645 for 90% confidence level, 1.96 for 95% confidence level and 2.576 for 99% confidence level)

p = percentage picking a choice, expressed as decimal 0.5 used for sample size needed

c = confidence interval, expressed as decimal; 0.08 = ±8

N = Population = 349 workers

$$n_0 = \frac{1.96^2 * 0.5(1-0.5)}{0.08^2} = \mathbf{150.063} \quad n_f = \frac{150.063}{1 + \frac{150.063 - 1}{349}} \approx \mathbf{101}$$

Since, total sample sizes of 100 responses are considered form NAS Foods Plc industry and the targeted government organization as a whole to accomplish the analysis research work.

**Table3.1 Target respondent**

<b>Department</b>	<b>Total staff</b>	<b>Sampling size</b>
<b>Production</b>	239	239x(101/349)=69
<b>Quality</b>	27	27 x(101/349)=8
<b>Technic</b>	10	10 x(101/349)=3
<b>Human resource</b>	18	18x(101/349)=5
<b>SCM</b>	21	21x(101/349)=6
<b>Sales</b>	24	24 x(101/349)=7
<b>Finance</b>	5	5x(101/349)=1
<b>Logistics</b>	5	5x(101/349)=1

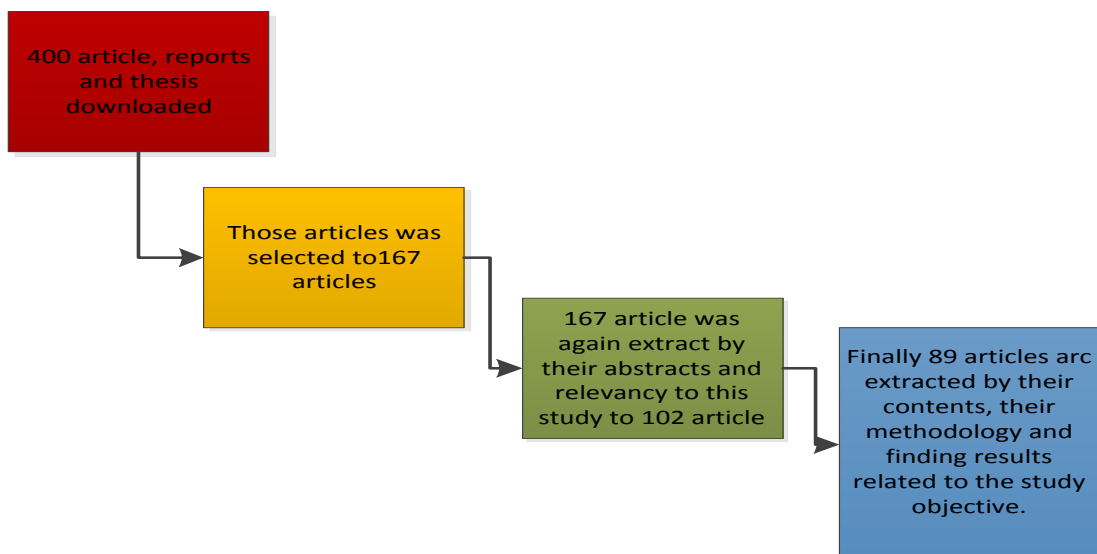
### 3.3. Data sources

**Primary data:** The primary data was collected by physical field observation, interviews, questioners and company reports from NAS Foods Plc. Responsible and targeted groups considered under survey on this study.

**Interview for manager;** the researcher has contain 14 interview questions and answer by 1 management and 2 supervisor of the NAS Foods Plc. during visiting. The aim of the interview was to find the problems that NAS Foods Plc. currently facing the reasons why the factory is not competitive in international market and why not use effectively there capacity.

**Questioners for employees;** the research also used to collect data from employees by using questioner to find detail the problems that NAS Foods Plc. currently facing. In the questioner their ranking and scoring questions answer by 100 employees.

**Secondary data:** To meet the research objectives, reviewing the existing research work 89 journals, government reports, some reference books & paper related to lean thinking, six sigma, Malcolm Baldrige national quality award programs, strategies, role impacts on manufacturing and food processing industries. The key challenges, potentials and strategies to integrating continuous improvement tolls also considered. The Early search results that a total of 400 article reports and thesis were found from various textbooks, academic and professional journals from 1998-2016/2017 G.C. Then read and sort for relevance to the continuous improvement and waste minimization strategy and tools and for their integration. The article would be assessed of methodology, method of measurement and finding results. Finally 89 article, reports and thesis selected which are important and related to the study.



*Figure 3.1 selections of articles*

### 3.4. Data analysis and presentation

The research was continued with the analysis stage i.e. analyzing the causes of the occurrence of waste. The analysis was performed using the Failure Mode and Effect Analysis (FMEA) tool. According to (Stamatis, 1995), FMEA is a methodology used to evaluate failures occurring in a system, design, process, or service. Identification of potential failures is performed by scoring each mode of failure based on the occurrence, severity, and detection levels. Both quantitative and qualitative analyses of data employed. The data was analyzed by taking the information from primary and secondary sources. During analysis of the data Microsoft Office 2013 Excel used to manipulate the raw data collected and the response rate of questionnaire. The qualitative and quantitative analysis process done using statistical quality control tools (SPSS). Also the statistical quality control tools like cause and effect diagram also used to make decisions based on the identified problem.

### 3.5. Reliability Analysis

This study help to testing the research questions previously, the survey measures used examined for the reliability and validity by using SPSS and the inter-item reliability consistency (alpha) was used to measure its reliability. Construct validity is determined by how well certain constructs explain the variance of responses to a set of survey items Page & Meyer (2000).

SPSS Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. It is considered to be a measure of scale reliability. The internal consistency of a set of measurement items refers to the degree to which items in the set are homogeneous. Internal consistency can be estimated using a reliability coefficient such as Cranach's alpha Changiz & Azadeh (2011); Syum (2010); Hermela ( 2016). Consequently, the reliability of each questionnaire was calculated by Cronbach's and the results of Cronbach's alpha for the questionnaires based on each perceptive is as shown below .

**Table 3.2 cronbach's alpha result for each waste minimization measures.**

Waste minimization measurement	Reliability statistics	
	Cronbach's Alpha	N of items
Awareness of waste measures	0.953	7
Malcom frame work measures	0.976	7
Waste minimization tools	0.712	6
Competitiveness measures	0.970	5

As the studies of (Perry R, 2004) an alpha score above 0.75 is generally taken to indicate a scale of high reliability. 0.5 to 0.75 is generally accepted as indicating a moderately reliable scale while figure below this generally indicates a scale of low reliability. Cronbach's alpha value is a “commonly used threshold for acceptable reliability”, and thus, is considered acceptable as Table 3.2 shows, all alpha scores for each waste minimization measures were in the acceptable range from 0.712 to 0.976.

- 0.90 and above shows excellent reliability.
- 0.70 to 0.90 shows high reliability.
- 0.50 to 0.70 shows moderate reliability.
- 0.50 and below show low reliability.

### 3.7. Research design

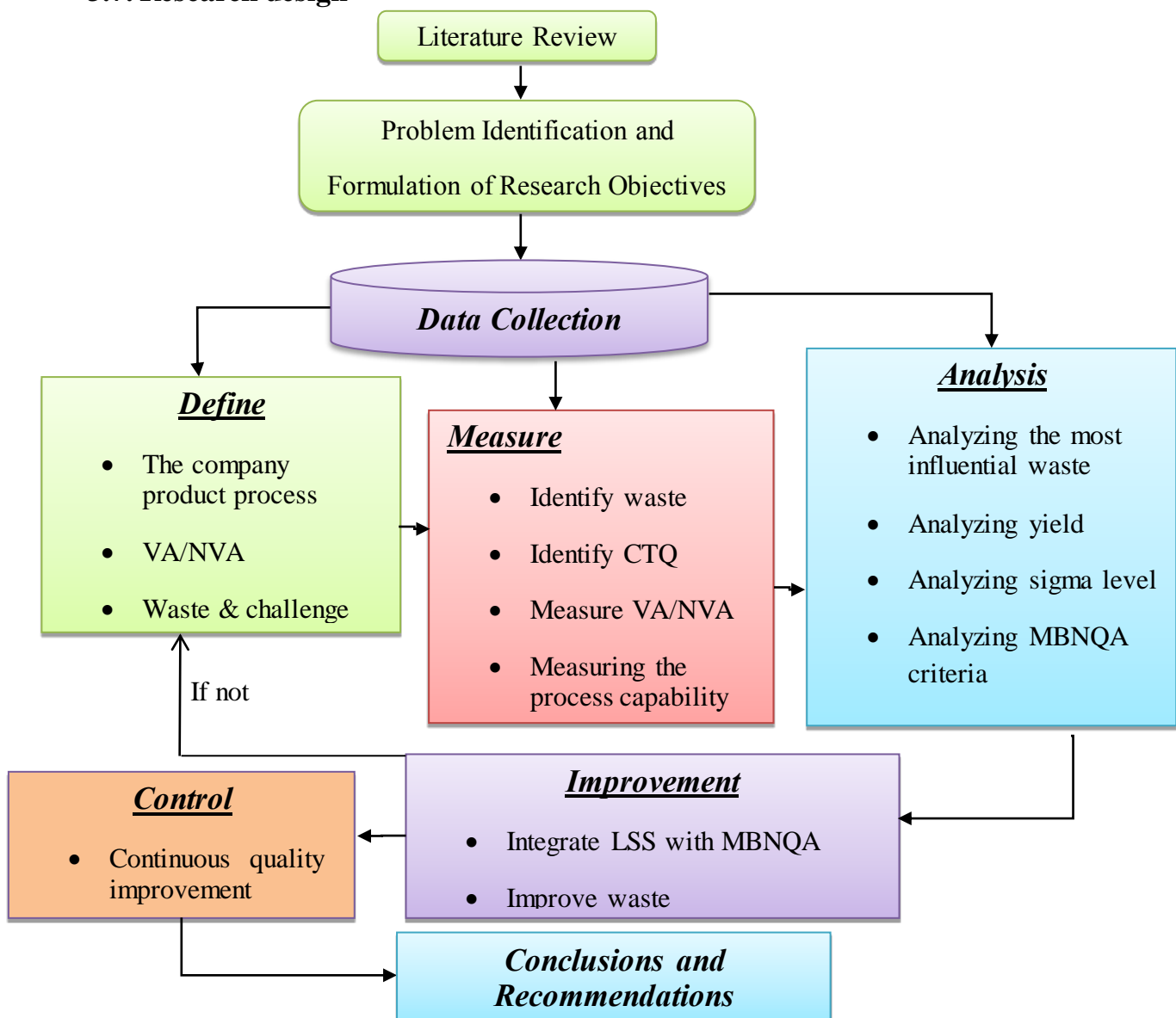


Figure 3.2 research framework

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## CHAPTER FOUR

### 4. Data Collection

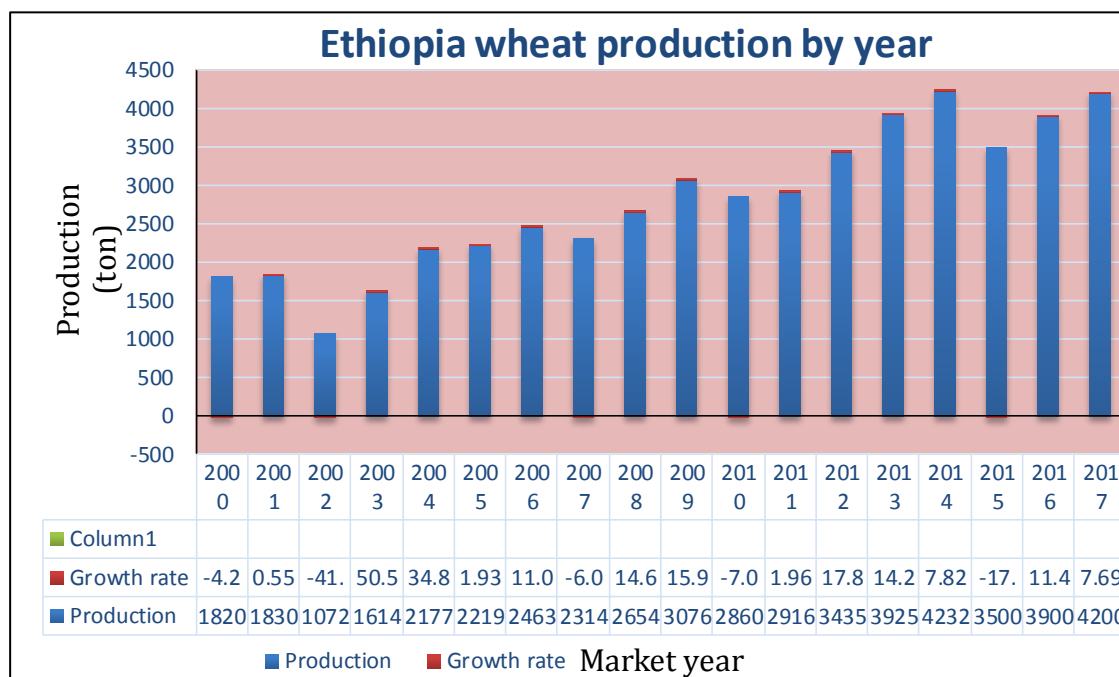
This part of the study deals with displaying and interpreting the data obtained from questionnaire, interviews and different secondary sources are analyzed in different statically tools and also tabular, graphical and textual form, and also the row data from the company and the sector are presented.

#### 4.1. Overview of the Ethiopian wheat sub-sector

Ethiopia is the largest wheat producer in sub-Saharan Africa with about 0.75 million ha of durum and bread wheat. It is one of the major cereal crops in the Ethiopian highlands, which range between 6 and 160N, 35 and 420E, and from 1500 to 2800m. At present, wheat is produced solely under rain fed conditions (Gebre-mariam, 2018). The Ethiopia government through the agricultural growth program is active in efforts to improve the production and productivity of wheat to increase domestic supply (AGP, 2018).

##### 4.1.1 Production experience of Ethiopian wheat industry

Wheat is one of the most important cereal crops in terms of area and production in the world. Wheat in Ethiopia is primarily grown in the Amhara, Oromia, Tigray and Southern nations, nationalities and peoples (SNNP) regions. These regions account for more than 90% of national wheat production it was grown on more than 216 million hectare (ha) of land with a total production of 651 million tons of gain in 2010 (FAO, 2012). In 2012/13 the estimated cultivated area under wheat was more than 1.5 million hectares of land with annual production of nearly 3 million tons. It is estimated that over 4.5 million farmers are annually involved in wheat production. 65% of the wheat produced is of the dread wheat type while 35% of durum wheat type and indigenous to Ethiopia (AGP, 2018).



*Finger 4.1: Ethiopia wheat production per Year: source USDA's PSD online, 2018*

The experiencing in the country is rapidly growing rate of urbanization and increased expansion as well as newly emerging food processing industries that have contributed for increased demand for durum wheat production such as biscuit, macaroni and spaghetti in local market in Ethiopia.

#### 4.1.2 Import experience of Ethiopian wheat industry

The Ethiopian commodity exchange reported that farm households consume above 60% of wheat produced:20% is sold: and the remains are used for seed, in-kind payment for labor and animal feed. As indicated above the gap between domestic wheat production and consumption has growth significant which resulted in higher wheat price. Hence, commercial and subsidizes wheat imports have become an option to offset the shortfall in domestic production as well as to stabilize the exorbitant increase in wheat price. For example, in the year 2015/16, EGTE Imported 750,000MT of wheat mainly from Russia and Argentina and around 300,000 MT through food aid mainly from the United States (CSA, 2014/15; AACCSA, 2017).

Currently, there are around 300 flour mill in Ethiopia with a total 3.7 million tons of milling capacity per year. The flour mills are able to obtain required wheat from the Ethiopian grain trade enterprise (EGTE),which controls all commercial wheat imports and makes wheat available to flour mills at a government subsidized rate (CSA, 2014/15). These wheat import account for roughly 33% of the wheat market. The

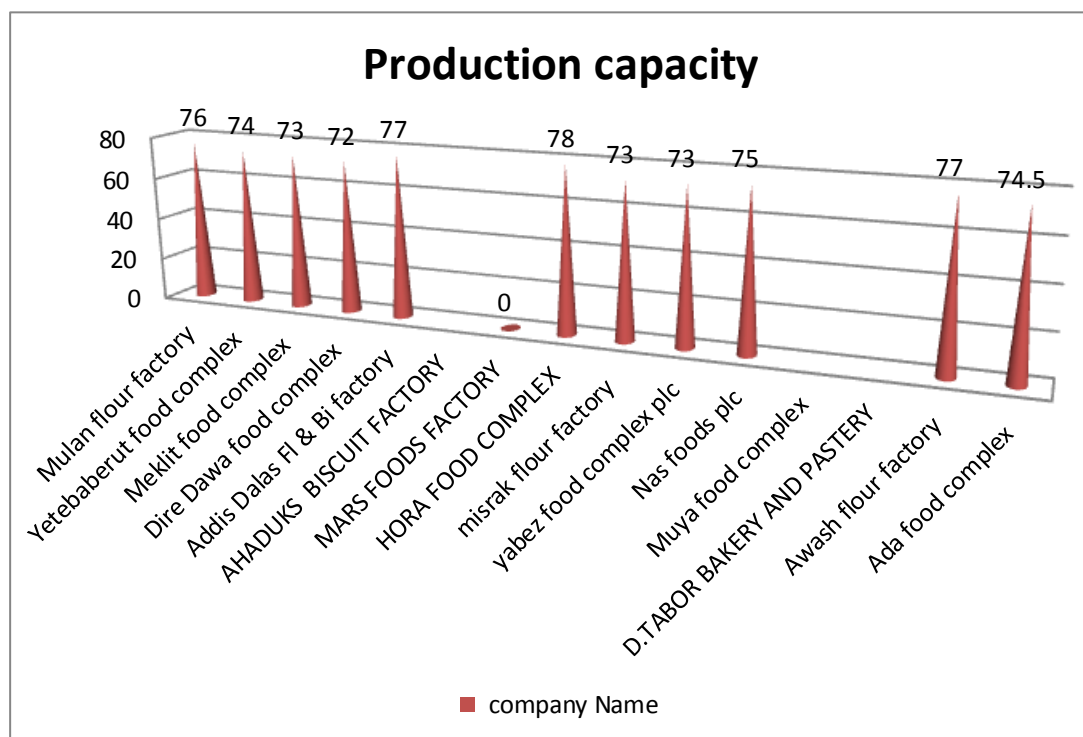
flour mills get the remainder of the wheat supply from the local market. In this fiscal, the wheat price in the local market is about 42% higher than EGTE wheat prices and its quality is much better than imported wheat (EMA, 2016; AACCSA, 2017).

*Table 4.1 Total wheat imports from Ethiopia revenue and custom authority*

Marketing year begins in October			
Country of origin	2010/2011	2011/2012	2014/2015
Russian federation	335	388	450
United states	207	261	300
Italy	89	-	-
Oman	45	-	-
Pakistan	33	-	-
Argentina	-	212	300
Belgium	-	42	-
Brazil	24	120	-
Turkey	14	-	-
China	-	25	-
Others	49	2	-
Total	796	1050	1050

## 4.2 Overview of Ethiopian Biscuit Manufacturing

From the Ethiopia food beverage and pharmaceutical industry development institution data there are 14 biscuit company and 11 of them are in production area their capacity is almost the same as we see in the next graph but most of company they produce below their capacity. NAS food one of company which produce biscuit that we see as a case to analyze.



**Finger 4.2: Ethiopia biscuit company and their capacity:**

(Source: from Ethiopian food beverage and pharmaceutical industry development institute)

### 4.3. Case Company Analysis a (NAS Foods Plc.)

NAS Foods Plc. was established in 1996 and began operation in August 2002. It is equipped with the latest technology imported from Italy, France and Turkey. Currently, it has over 300 employees including expatriates. It is the first company that produce and distributes varieties of international standard biscuits in Ethiopia its portfolio in to other food products. Ethiopia; NAS foods eyes to acquire Dire Dawa food complex NAS foods, which runs a Biscuit factory in Legetafo, 19km north of Addis Ababa, in the Oromia.

#### Management

With over 10 years of hands-on practical experience in Europe, Africa and Asia, the management team at NAS foods is comprised of a seasoned group of locals and expatriates. Motivated by the remarkable market opportunity in Ethiopia's food sector and challenging market, the management team at NAS food seeks to further invest in the industry so as to ensure and sustain their market leadership position.

#### 4.3.1. Production performance of the Company

From the data obtained during filed observation, during January 2009, NAS food produces over 26 different kinds of biscuits. Currently NAS is producing ten different kinds of biscuits and these products are classified into three categories based on consumer demand and market segmentation. The company produces various types of biscuit products to local markets. Mainly the products have three including Category A, includes long-packed biscuits in a variety of flavors, both with and without cream. These products are mainly targeted at the high income segment of the market. Since the topical cream long packet biscuits consists, the Chocolate, Vanilla, Banana, Strawberry, Lemon, Orange, Caramel, Coconut, Mango, Apple, Pineapple and Mint. Also under this category, the non-cream long packet biscuits include, petit beurre, Finger, Morning coffee and Sesame are the common products under this categories. As well in the second category B, category represents the economical, high quality biscuits in a variety of flavors and forms (cream and non-cream), Hip hop (chocolate, vanilla, strawberry, orange/fasting, caramel), ORA, Glucose special/glucose energy, Slim (diet biscuits). The third Category is Category C, represents the widely available and affordable mass biscuits for the lower-income segment of the market. The Petit beurre, Alfa/star, Almi and Fasting are found under the third category. Besides the challenged with maintaining market leadership in the biscuit category and NAS Foods has adopted various integrated programs and targeted produce for the local market. Introduced in 2004, NAS Foods fasting biscuit was the first to target Ethiopia large orthodox Christian community and their frequent abstinence from dairy products. In addition to capitalizing on unique market opportunities.



Figure 4.3 Main product of the company

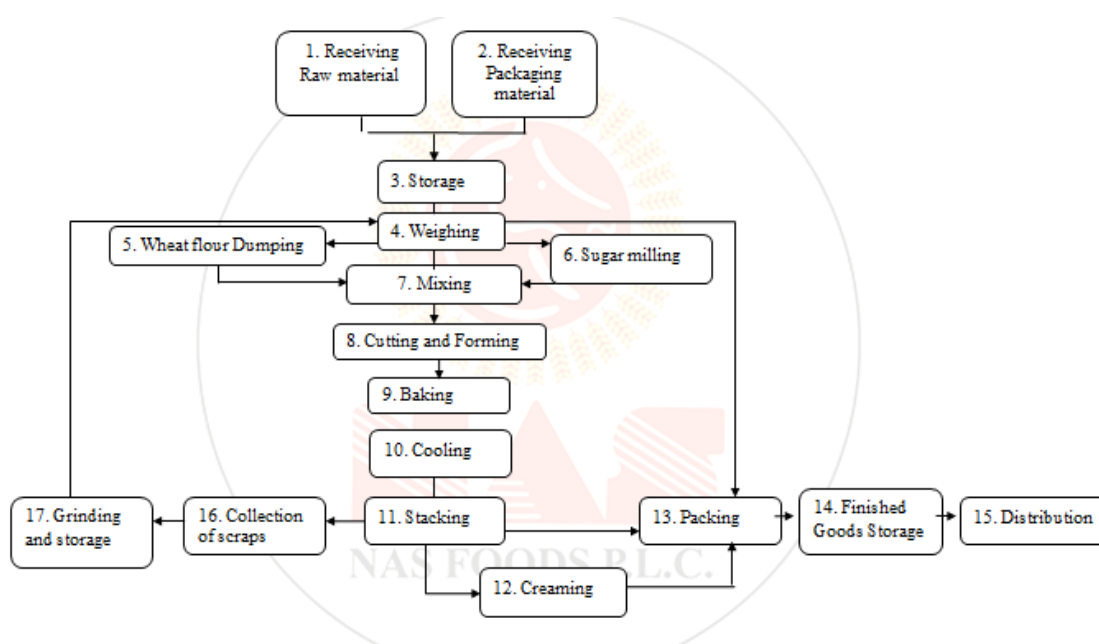
### 4.3.2 Products and Capacity

Company's main products in Legetafo factories include all products. Currently the company only uses 30% of its capacity and produce 3000 carton per day by 350 workers but it can produce 10,000 cartons with 1,000 workers. The company at this time it has 127 male 222 female permanent workers and work on 3 shift for 22 hour and ware house capacity for raw material 15,000 and 3,000 for finished products.

*Table 4.2 NAS patented products*

Royal	Pouch	Alfa
Nas baby	Slim	Snack small
Star	Finger	Rich tea
Almi	Tea meat	P. beurre
Nas fasting	Pick pack	Royal
Q.P beurre	Hip hope	Tropicana
Q.sesame	Salted snack	Finger
Morning coffee	Ora	
Glucose	Peti beurre	

Figure 4.4 describes the production process of NAS food starting from the raw material preparation, mixing, forming, baking, creaming or stacking, cooling and packing.

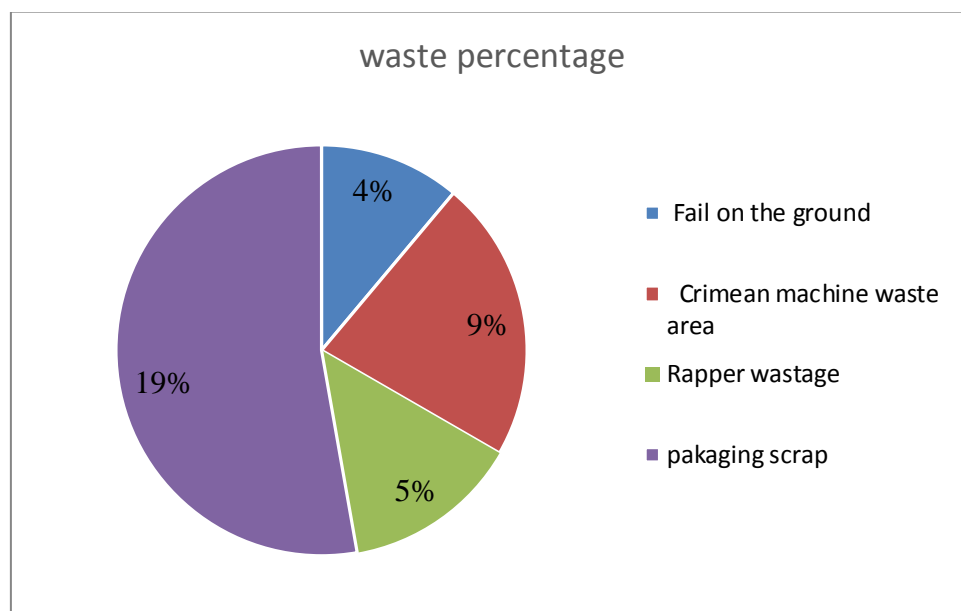


*Figure 4.4 Biscuit production process Source from the company*

### 4.3.3. Waste of the company

The waste is an important issue that should be treated in such a way that the benefits achieved from that will be in both environmental and social aspects. Though according to (Imam, 2010).Some of the company waste that search from the reports.

- Fail on the ground 4%
- Crimean machine waste area 9%
- Rapper wastage 5%
- Packaging scrap 19%



*Figure: 4.4. Waste percentage in the company*

### Challenges

Company has different types of raw material like flour, sugar, oil and baking powder is the main for the production and the challenges that in the company has a shortage of flour, oil & carton supply, because of governmental policies, poor leadership system and packaging problem.

Some visual problems that have been seen in NAS food manufacturing are shown below. Here we can see how they remove the defects, poor working environment, impure raw material storage and there is nothing advance tool they use before.



*Figure: 4.5. Defects during production*



*Figure: 4.6. Poor working environment*

*Figure: 4.7. Impure raw material storage*

## CHAPTER FIVE

### 5. Result and Discussion

From filed observation and literature review the various strength and challenges on the sectors are investigated. Since a good quality products, highly marketable products, the government support and good market potential to food and agro processing industries are investigated the main strength and opportunities of the sector. Besides waste problems, insufficient raw material, unbalanced production demand and supply, power supply fluctuations, old production & manufacturing processes, improper leadership systems, infrastructure problems and poor quality management system are the main challenges of the sector and case company as well. As a result of the above challenges the market sharing, the performance of food and agro processing industries are poor and weak. But the level and the ranges of each problem on sectors problem impacts are different. While the following section describes how and what extents the biscuit factory affected by the various factors wear incorporated.

### 5.1 Quantitative Result

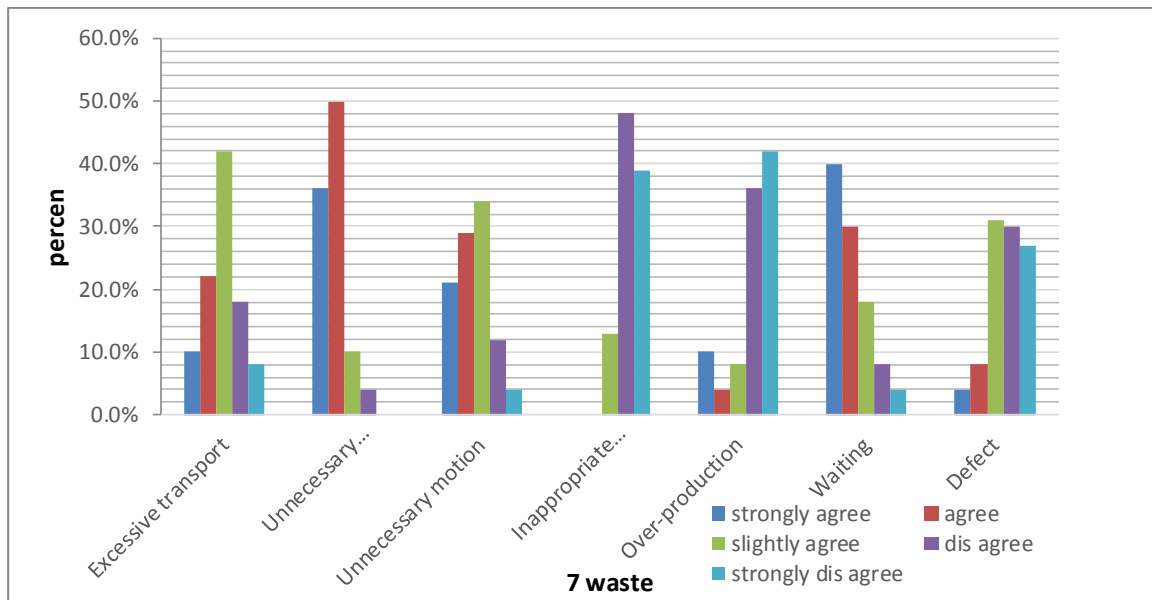
#### 5.1.1 Questioner survey result

The main objective of the research questioner was to determine the problems that a NAS Foods Plc. currently facing and how they manage waste in their production. This study shows the respondent result and it has 4 sections and 25 questions all this section in order to see all correlations of all indicators it is better to make analysis using SPSS.

- a) Section I: In this section it is all about the concept and awareness regarding waste measurement and improvement in NAS food Plc. as shown below Table 5.1.

*Table 5.1 section one respondents result in percentage*

Awareness of waste measurement (AOW)	Strongly agree	Agree	Slightly agree	Dis agree	Strongly dis agree
Excessive transport	10.0%	22.0%	42.0%	18.0%	8.0%
Unnecessary inventory	36.0%	50.0%	10.0%	4.0%	0.0%
Unnecessary motion	21.0%	29.0%	34.0%	12.0%	4.0%
Inappropriate processing	0.0%	0.0%	13.0%	48.0%	39.0%
Over-production	10.0%	4.0%	8.0%	36.0%	42.0%
Waiting	40.0%	30.0%	18.0%	8.0%	4.0%
Defect	4.0%	8.0%	31.0%	30.0%	27.0%

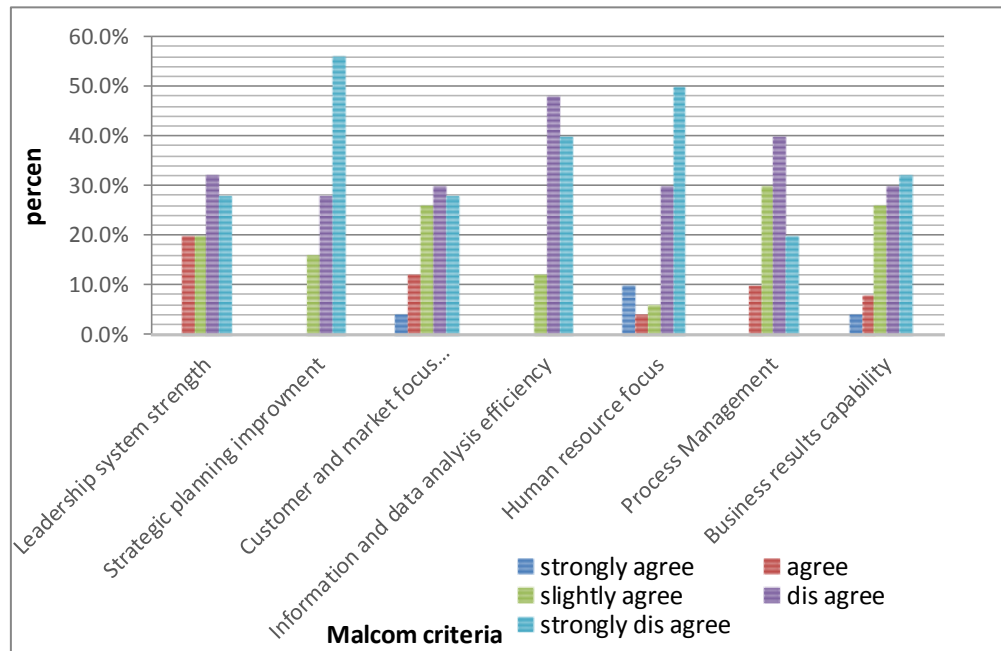


The result for awareness of waste as shown in the above table the respondent in NAS Food result for the questioner show that level of understanding is moderate but they only consider what their annual profit is and not focus on waste minimization.

b) Section II: The second section it designed for MBNQA criteria from the framework to get the importance of improvement of quality awards in each quality measurement perspective in NAS food PLC. So this Section is answered related to baldrige awards as shown below Table 5.2.

**Table 5.2 Section two respondents result in percentage.**

Malcom framework measurement	strongly agree	agree	slightly agree	dis agree	strongly dis agree
Leadership system strength	0.0%	20.0%	20.0%	32.0%	28.0%
Strategic planning improvement	0.0%	0.0%	16.0%	28.0%	56.0%
Customer and market focus management.	4.0%	12.0%	26.0%	30.0%	28.0%
Information and data analysis efficiency	0.0%	0.0%	12.0%	48.0%	40.0%
Human resource focus	10.0%	4.0%	6.0%	30.0%	50.0%
Process Management	0.0%	10.0%	30.0%	40.0%	20.0%
Business results capability	4.0%	8.0%	26.0%	30.0%	32.0%

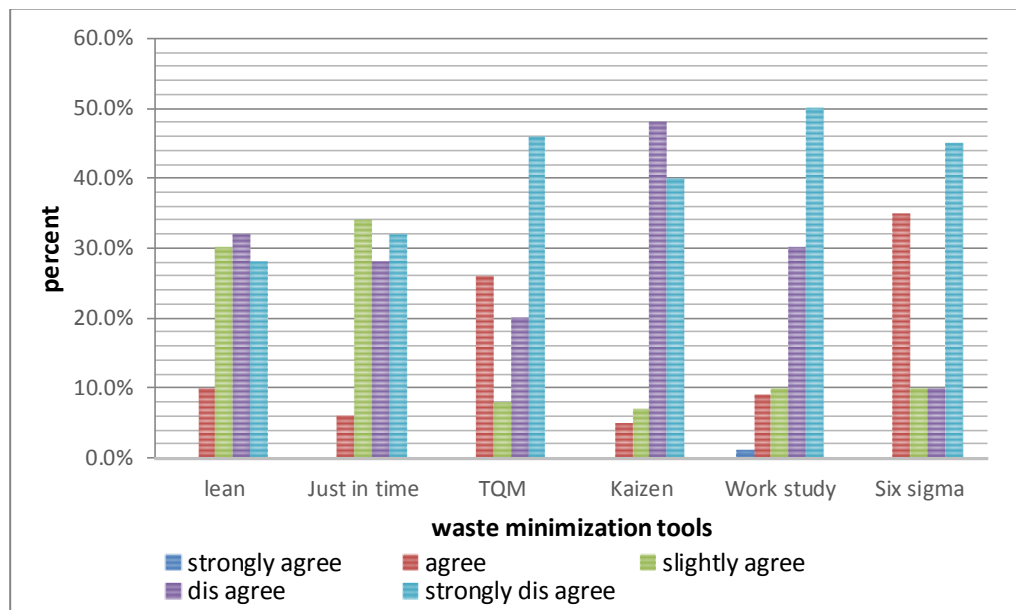


The result for Malcom framework measurement as shown above Table 5.2 the respondent in NAS Food result for the questioner show that level of understanding and improving is low so this is one of the reason that the company in all the organization poor continuous quality improvement.

c) Section III: This section it designed for waste minimization tool to get the importance of improvement of waste minimization in each advance tool measurement perspective in NAS food PLC. So this Section is answered related to practice advance tools that minimize waste as shown below table 5.3.

**Table 5.3 section three respondents result with respect to waste minimization tool in percentage.**

Waste minimization tool measurements	strongly agree	agree	slightly agree	dis agree	strongly dis agree
lean	0.0%	10.0%	30.0%	32.0%	28.0%
Just in time	0.0%	6.0%	34.0%	28.0%	32.0%
TQM	0.0%	26.0%	8.0%	20.0%	46.0%
Kaizen	0.0%	5.0%	7.0%	48.0%	40.0%
Work study	1.0%	9.0%	10.0%	30.0%	50.0%
Six sigma	0.0%	35.0%	10.0%	10.0%	45.0%

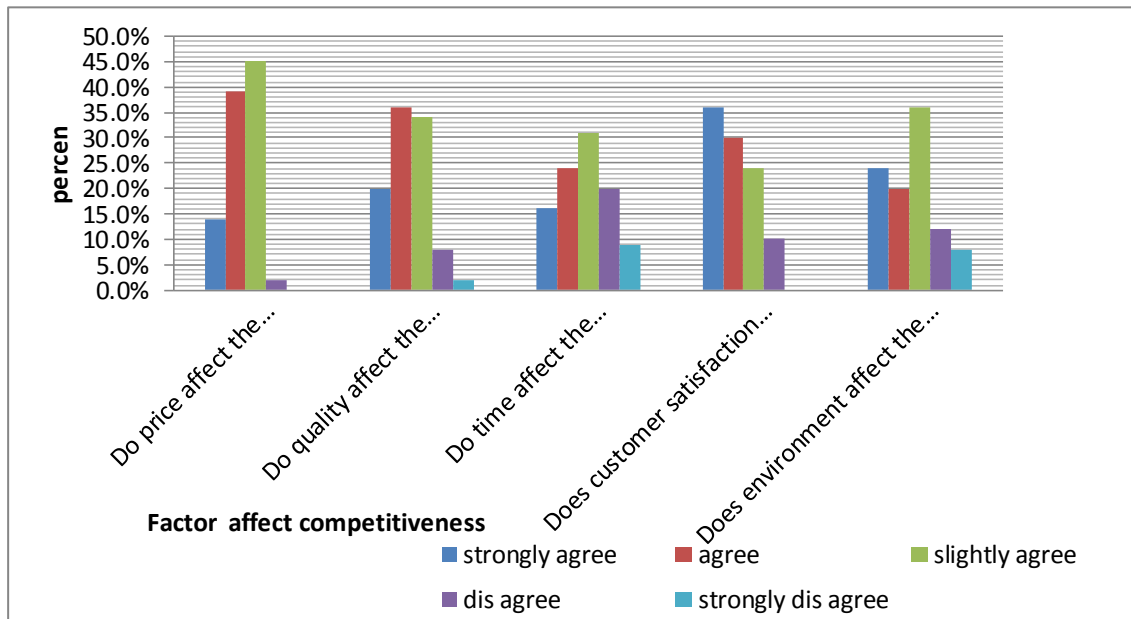


The result for waste minimization tool measurements as shown above Table 5.3 the respondent in NAS Food result for the questioner show that level of understanding and usage advance tool like lean, JIT, Kaizen etc. Are poor and they only consider what their annual profit is but not focus on waste minimization.

d) Section IV: This is the last section it designed for competitiveness measurement to see that the perspective of price, time, customer satisfaction, quality and environmental affect the competitiveness of biscuit product as shown table 5.4.

**Table 5.4 section four respondents result with respect to competitiveness measurement in percentage.**

Competitiveness Measurement	strongly agree	agree	slightly agree	dis agree	strongly dis agree
Do price affect the competitiveness of biscuit product	14.0%	39.0%	45.0%	2.0%	0.0%
Do quality affect the competitiveness of biscuit product	20.0%	36.0%	34.0%	8.0%	2.0%
Do time affect the competitiveness of biscuit product	16.0%	24.0%	31.0%	20.0%	9.0%
Does customer satisfaction affect the competitiveness of biscuit product	36.0%	30.0%	24.0%	10.0%	0.0%
Does environment affect the competitiveness of biscuit product	24.0%	20.0%	36.0%	12.0%	8.0%



The result for competitiveness measurement as shown above table the respondent in NAS Food result for the questioner show that level of understanding is slightly and price, time, quality, customer satisfaction and environment affect the competitiveness of biscuit product so to improve quality and waste minimization we should analyze this factors that affect the competitiveness of biscuit.

## 5.2 Correlation Analysis

### Bivariate Correlation

Correlation analysis is used to quantify the association between two continuous variables (between an independent and a dependent variable or between two independent variables). This particular type of analysis is useful when a research want to establish if there are possible connections between variables.

In this research for correlation analysis used SPSS software and it has three types of menus for the correlation analysis,

- ✦ Bivariate,
- ✦ Partial Correlations, and
- ✦ Distances correlations.

Bivariate Correlations measure how variables in each perspective are related. Before calculating a correlation coefficient the bivariate Correlations procedure computes the pair wise associations for a set of variables and displays the results in a matrix. It is useful for determining the strength and direction of the association between two scale or ordinal variables (Hermela, 2016).

For this analysis the study use bivariate correlations process because the available information is states with weight. So that all the scores which have been registered by the respondents, have been feed to SPSS data entry module Shimelis (2015); Hermela( 2016).

In the SPSS data entry module the analysis will demonstrate as Pearson Correlation (r) and significance (p) value of the two variables therefore, it will be energetic to remind the properties and interpretation of r value (or Pearson Correlation), based on (Jay Devore & Nicholas Farnum , 1999).

- ✳ Pearson r correlation Pearson r correlation is the most widely used correlation statistic to measure the degree of the relationship between linearly related variables.
- ✳ Pearson product moment correlation coefficient denoted ranges between -1 and +1 and quantifies the direction and strength of the linear association between the two variables.
- ✳ The correlation between two variables can be positive(i.e., higher levels of one variables are associated with higher levels of the other)or negative ( i.e. higher levels of one variable are associated with lower level of the other)

-1	-0.5	0	+0.5	+1
Strong negative correlation	stronger	no correlation	stronger	strong positive correlation

Based on the above principle the study develop the relationships between the waste measurement variance as we see in the next (Table 5.5) the SPSS output Pearson correlation r (value of statistical test) should close to +1 and the sig(2-tailed) or p-value is less than 0.05 for strong relation. As we see the tables below there is strong relation in each relation.

### 5.2.1 Analysis of awareness of waste measurement

Waste measures are included seven perspectives in lean typical. In this study it identified each because waste issue is different from process angle and to see further correlation between each viewpoint. Waste minimization is the basic for any organization, in this study waste minimization of NAS food plc. The awareness of each respondent comprised.

Table 5.5 Bivariate Correlation in between waste measurement

		Correlations						
waste measurement		Excessive transport	Unnecessary inventory	Unnecessary motion	Inappropriate processing	Over-production	Waiting	Defect
Excessive transport	Pearson Correlation	1	.749**	.662**	.579**	.696**	.630**	.680**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000
Unnecessary inventory	Pearson Correlation	.749**	1	.898**	.692**	.661**	.920**	.779**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000
Unnecessary motion	Pearson Correlation	.662**	.898**	1	.822**	.814**	.899**	.848**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000
Inappropriate processing	Pearson Correlation	.579**	.692**	.822**	1	.906**	.762**	.903**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000
Over-production	Pearson Correlation	.696**	.661**	.814**	.906**	1	.659**	.894**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000
Waiting	Pearson Correlation	.630**	.920**	.899**	.762**	.659**	1	.828**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000
Defect	Pearson Correlation	.680**	.779**	.848**	.903**	.894**	.828**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	
**. Correlation is significant at the 0.01 level (2-tailed).								
b. Listwise N=100								

When we see the above relationship of each variable in waste perspective they have strong relation with significance level of 0.01 and the causal Pearson Correlation of variable of excessive transport vs. inappropriate process their value is 0.579 which show moderate positive relationship and the highest Pearson correlation in waste perspective is between unnecessary inventories vs. waiting their value is 0.920 it mean that waiting in NAS food is highest factor in unnecessary inventory analysis. There is also highest Pearson correlation that the value is greater than 0.9 between inappropriate processing vs. over production and inappropriate process vs. Defect.

### 5.2.2 Analysis of Malcolm criteria measurement

Malcolm measures are included seven criteria in management perspective. In this study it identified each because Excellence issue is diverse from management angle and to see further correlation between each viewpoint. Quality improvement is the basic for any organization.

*Table 5.6 Bivariate Correlation in between Malcolm criteria measurement*

		Correlations						
Malcolm criteria measurement		Leadership system strength	Strategic planning improvement	Customer and market focus management.	Information and data analysis efficiency	Human resource focus	Process Management	Business results capability
Leadership system strength	Pearson Correlation	1	.896**	.960**	.845**	.855**	.926**	.929**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000
Strategic planning improvement	Pearson Correlation	.896**	1	.922**	.820**	.921**	.861**	.884**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000
Customer and market focus management.	Pearson Correlation	.960**	.922**	1	.877**	.882**	.927**	.958**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000
Information and data analysis efficiency	Pearson Correlation	.845**	.820**	.877**	1	.856**	.843**	.904**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000
Human resource focus	Pearson Correlation	.855**	.921**	.882**	.856**	1	.837**	.881**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000
Process Management	Pearson Correlation	.926**	.861**	.927**	.843**	.837**	1	.923**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000
Business results capability	Pearson Correlation	.929**	.884**	.958**	.904**	.881**	.923**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	

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

b. Listwise N=100

When we see the above relationship of each variables in management perspective they have strong relation with significance level of 0.01 and the causal Pearson Correlation of most variable has a strong positive relation and their value is greater than 0.9 whereas the leadership vs. customer and market their value is 0.960 and it has highest value than the others which shows strong positive relationship.

### 5.2.3 Analysis of waste minimization tools measurement

Waste minimization tools measures are included six perspectives in this study. It identified each because waste issue is different from process angle and to see further correlation between each viewpoint. Waste minimization is the basic for any organization; the company does not adopt any particular standardized approach to larger improvement projects.

*Table 5.7 Bivariate Correlation in between waste minimization tools*

		Correlations					
waste minimization tools		lean	Just in time	TQM	Kaizen	Work study	Six sigma
lean	Pearson Correlation	1	.960**	-.042	.858**	.866**	-.335**
	Sig. (2-tailed)		.000	.677	.000	.000	.001
Just in time	Pearson Correlation	.960**	1	-.034	.858**	.833**	-.370**
	Sig. (2-tailed)	.000		.739	.000	.000	.000
TQM	Pearson Correlation	-.042	-.034	1	.114	.244*	.717**
	Sig. (2-tailed)	.677	.739		.257	.015	.000
Kaizen	Pearson Correlation	.858**	.858**	.114	1	.868**	-.141
	Sig. (2-tailed)	.000	.000	.257		.000	.162
Work study	Pearson Correlation	.866**	.833**	.244*	.868**	1	.019
	Sig. (2-tailed)	.000	.000	.015	.000		.848
Six sigma	Pearson Correlation	-.335**	-.370**	.717**	-.141	.019	1
	Sig. (2-tailed)	.001	.000	.000	.162	.848	
**. Correlation is significant at the 0.01 level (2-tailed).							
*. Correlation is significant at the 0.05 level (2-tailed).							
c. Listwise N=100							

When we see the above relationship of each variables in waste minimization tool perspective they have strong relation with significance level at 0.01 and 0.05 whereas the causal Pearson Correlation of JIT vs. Six sigma their value is -0.370 which show negative relationship and the highest Pearson correlation in waste minimization tool perspective is between lean vs. JIT its value is 0.920 which mean that JIT in NAS food is highest factor in Lean analysis.

#### 5.2.4 Analysis of competitiveness measurement

Competitiveness measurements are included five perspectives that help evaluation and decision making within organizations that occupy in waste issue. It identified the correlation between quality, price, time, customer satisfaction and environmental views.

**Table 5.8 Bivariate Correlation in between competitiveness measurement**

Correlations <sup>b</sup>						
competitiveness measurement		Price	Quality	Time	Customer satisfaction	Environment
Do price affect the competitiveness of biscuit product	Pearson Correlation	1	.898**	.869**	.803**	.833**
	Sig. (2-tailed)		.000	.000	.000	.000
Do quality affect the competitiveness of biscuit product	Pearson Correlation	.898**	1	.914**	.895**	.912**
	Sig. (2-tailed)	.000		.000	.000	.000
Do time affect the competitiveness of biscuit product	Pearson Correlation	.869**	.914**	1	.934**	.940**
	Sig. (2-tailed)	.000	.000		.000	.000
Does customer satisfaction affect the competitiveness of biscuit product	Pearson Correlation	.803**	.895**	.934**	1	.913**
	Sig. (2-tailed)	.000	.000	.000		.000
Does environment affect the competitiveness of biscuit product	Pearson Correlation	.833**	.912**	.940**	.913**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
**. Correlation is significant at the 0.01 level (2-tailed).						
b. Listwise N=100						

When we see the above relationship of each variables in competitiveness measurement perspective they have strong relation with significance level of 0.01 and the causal Pearson Correlation of most variable has a strong positive relation and their value is greater than 0.9 whereas the time vs. customer satisfaction and environment their value is 0.934 & 0.940 respectively and it has highest value than the others which shows strong positive relationship it mean that time affect the competitiveness of biscuit product in NAS food is highest factor in customer satisfaction and environment analysis.

### 5.3. Regression analysis

Here in the regression analysis help to show quantitatively how much is the effect of one variable over other variable is required. In regression analysis the study further examined the effect of the independent variables on the dependent variables. Therefore, additional analysis that allows us to make better inferences was conducted.

Regression equation of business performance is:

$$Y_i = \alpha + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + \beta_6x_6 + \beta_7x_7 + \epsilon \dots \dots \dots \text{(Antony \& Sanghamitra, 2010), (Syum, 2010), (Fentahun \& Alemu, 2013); (Hermela, 2016).}$$

Where:  $Y_i$  = dependent variables;  $x_1 \dots \dots \dots x_3$  = independent Variables

$\alpha$  = intercept;

$\beta_1 \dots \beta_3$  = coefficients

$\epsilon$  = error term

There are a lot of alternatives to make the independent variables with dependent variables. The variables in this study case are waste minimization metrics which are strong and linear correlated with those selected waste measures.

#### *Awareness of waste perspective*

Dependent variable: AOW1=Excessive transport

Independent variables: AOW2, AOW3, AOW4, AOW5, AOW6 and AOW7

In this awareness of waste perspective there are excessive transportation independent variables and six selective independent variable in order to get the optimal equation the study feed the data on SPSS software linear regression and randomly vary the independent variables to get optimal coefficient value of independent variables consequence up on dependent variable. See on table 5.9 below.

**Table 5.9 regression analysis result between waste measurements.**

Eqn.	Equations	R2
Eqn. 1	$AOW1 = -0.947 + 1.433UI - 0.738UM - 0.772IP + 0.930OVP + 0.071W - 0.093D$	0.745
Eqn. 2	$AOW2 = 1.387 + 0.227ET + 0.370UM - 0.060IP - 0.160OVP + 0.288W + 0.041D$	0.924
Eqn. 3	$AOW3 = -0.594 - 0.206ET + 0.653UI - 0.160IP + 0.580OVP + 0.420W - 0.247D$	0.931
Eqn. 4	$AOW4 = 0.597 - 0.125ET - 0.062UI - 0.093UM + 0.423OVP + 0.267W + 0.090D$	0.898
Eqn. 5	$AOW5 = -0.085 + 0.291ET - 0.315UI + 0.650UM + 0.814IP - 0.567W + 0.487D$	0.943
Eqn. 6	$AOW6 = -0.756 + 0.022ET + 0.553UI + 0.458UM + 0.499IP - 0.552OVP + 0.434D$	0.931
Eqn. 7	$AOW7 = 0.568 - 0.035ET + 0.097UI - 0.333UM + 0.208IP + 0.585OVP + 0.536W$	0.913

In the above table the coefficient of independent variables are positive and negative. This shows that correlation coefficient value indicating that those variables have positive and negative relation. Which means as the independent variable increases the dependent variable decreases (inverse relationship). The conclusion from the multiple regression model confirms that the results of the cross tabulations for the type and directions of the relationship of most of the independent variables with dependent variables. The good regression results of equation five is selected (see Table 5.9) which is explained R2 value about 0.943 or 94% with statistically significant ( $P < 0.01$ )

### *Malcolm criteria perspective*

Dependent variable: MFW1= Leadership system strength

Independent variables: MFW2, MFW3, MFW4, MFW5, MFW6 and MFW7

In this Malcolm criteria perspective there are leadership independent variables and six selective independent variable in order to get the optimal equation the study feed the data on SPSS software linear regression and randomly vary the independent variables to get optimal coefficient value of independent variables consequence up on dependent variable. See on table 5.10 below.

*Table 5.10 regression analysis result between Malcolm criteria measurement.*

Eqn.	Equations	R2
Eqn. 1	$MFW1 = -0.026 + 0.120SPI + 0.631CAMF - 0.039IADA - 0.019HRF + 0.301PM - 0.04BRC$	0.931
Eqn. 2	$MFW2 = 0.336 + 0.076LSS + 0.389CAMF - 0.111IADA + 0.320HRF + 0.003PM - 0.116BRC$	0.909
Eqn. 3	$MFW3 = -0.132 + 0.377LSS + 0.369SPI + 0.064IADA - 0.055HRF + 0.076PM - 0.378BRC$	0.962
Eqn. 4	$MFW4 = 0.588 - 0.035LSS + 0.1565SPI + 0.095CAMF + 0.185HRF + 0.023PM + 0.373BRC$	0.837
Eqn. 5	$MFW5 = -0.840 - 0.045LSS + 1.192SPI - 0.214CAMF + 0.488IADA + 0.008PM + 0.280BRC$	0.883
Eqn. 6	$MFW6 = 0.490 + 0.340LSS + 0.005SPI + 0.133CAMF + 0.029IADA + 0.004HRF + 0.290BRC$	0.887
Eqn. 7	$MFW7 = -0.221 + 0.0350LSS - 0.160SPI + 0.547CAMF + 0.363IADA + 0.103HRF + 0.22PM$	0.942

In the above Table 5.10 the coefficient of independent variables are positive and negative. This shows that correlation coefficient value indicating that those variables have positive and negative relation. Which means as the independent variable increases the dependent variable decreases (inverse relationship). The conclusion from the multiple regression model confirms that the results of the cross tabulations for the type and directions of the relationship of most of the independent variables with dependent variables. The good regression results of equation three is selected (Table 5.10) which is explained R<sup>2</sup> value about 0.962 or 96% with statistically significant (P<0.01).

### ***Waste minimization tools***

Dependent variable: WMT1= Lean

Independent variables: WMT2, WMT3, WMT4, WMT5, WMT6 and WMT7

In this waste minimization tools perspective there are lean independent variables and five selective independent variable in order to get the optimal equation the study feed the data on SPSS software linear regression and randomly vary the independent variables to get optimal coefficient value of independent variables consequence up on dependent variable. See on table 5.11 below.

***Table 5.11 regression analysis result between waste minimization tools.***

<b>Eqn.</b>	<b>Equations</b>	<b>R<sup>2</sup></b>
<b>Eqn. 1</b>	$WMT1 = 0.368 + 0.680JIT - 0.050TQM + 0.016K + 0.308WS - 0.035SS$	<b>0.943</b>
<b>Eqn. 2</b>	$WMT2 = 0.257 + 0.734L + 0.066TQM + 0.186K + 0.024WS - 0.110SS$	0.935
<b>Eqn. 3</b>	$WMT3 = -0.123 - 0.603L + 0.733JIT - 0.014K + 0.226WS + 0.702SS$	0.589
<b>Eqn. 4</b>	$WMT4 = 0.207 + 0.034L + 0.373JIT - 0.003TQM + 0.360WS + 0.019SS$	0.813
<b>Eqn. 5</b>	$WMT5 = -1.038 + 0.691L + 0.049JIT + 0.042TQM + 0.372K + 0.195SS$	0.882
<b>Eqn. 6</b>	$WMT6 = 2.323 - 0.336L - 0.919JIT + 0.568TQM + 0.083K + 0.846WS$	0.716

In the above table the coefficient of independent variables are positive and negative. This shows that correlation coefficient value indicating that those variables have positive and negative relation. Which means as the independent variable increases the dependent variable decreases (inverse relationship). The conclusion from the multiple regression model confirms that the results of the cross tabulations for the type and directions of the relationship of most of the independent variables with dependent

variables. The good regression results of equation one is selected (see Table 5.11) which is explained R2 value about 0.943 or 94% with statistically significant ( $P < 0.01$ ) and ( $p < 0.05$ ) level.

***Competitiveness measurement.***

Dependent variable: CM1= price

Independent variables: CM2, CM3, CM4, CM5, CM6 and CM7

In this competitiveness measurements perspective there are price independent variables and four selective independent variable in order to get the optimal equation the study feed the data on SPSS software linear regression and randomly vary the independent variables to get optimal coefficient value of independent variables consequence up on dependent variable. See on table 5.12 below.

***Table 5.12 regression analysis result between competitiveness measurements.***

<b>Eqn.</b>	<b>Equations</b>	<b>R2</b>
<b>Eqn. 1</b>	$CM1 = 1.505 + 0.569QA + 0.348TA - 0.207CSA - 0.065EA$	0.832
<b>Eqn. 2</b>	$CM2 = -0.177 + 0.531PA + 0.011TA - 0.254CSA - 0.249EA$	0.906
<b>Eqn. 3</b>	$CM3 = -1.305 + 0.357PA + 0.12QA + 0.471CSA + 0.379EA$	<b>0.933</b>
<b>Eqn. 4</b>	$CM4 = 1.415 - 0.239PA + 0.315QA + 0.532TA + 0.159EA$	0.893
<b>Eqn. 5</b>	$CM5 = -0.245 - 0.096PA + 0.397QA + 0.551TA + 0.204CS$	0.905

In the above table the coefficient of independent variables are positive and negative. This shows that correlation coefficient value indicating that those variables have positive and negative relation. Which means as the independent variable increases the dependent variable decreases (inverse relationship). The conclusion from the multiple regression model confirms that the results of the cross tabulations for the type and directions of the relationship of most of the independent variables with dependent variables. The good regression results of equation three is selected (see Table 5.12) which is explained R2 value about 0.933 or 93% with statistically significant ( $P < 0.01$ ) level.

**Table 5.13 Correlation between waste measurement and Malcom criteria measures**

Correlations <sup>b</sup>					
		AOW5	MFW3	WMT1	CM3
AOW5	Pearson Correlation	1	.888**	.856**	.832**
	Sig. (2-tailed)		.000	.000	.000
MFW3	Pearson Correlation	.888**	1	.963**	.951**
	Sig. (2-tailed)	.000		.000	.000
WMT1	Pearson Correlation	.856**	.963**	1	.952**
	Sig. (2-tailed)	.000	.000		.000
CM3	Pearson Correlation	.832**	.951**	.952**	1
	Sig. (2-tailed)	.000	.000	.000	
**. Correlation is significant at the 0.01 level (2-tailed).					
b. Listwise N=100					

The relationship between each waste minimization perspective while they are strong/weak. In this study Malcom criteria measures are strong relation with all measures and the r value show more strong correlation with waste minimization tool And competitiveness measure 0.963 and 0.951 respectively. Also waste minimization tool and competitiveness measure has strong r value 0.952 and show it has a strong correlation. Hereafter the finding result of this study is how to minimize waste and enhance quality of the company and the value of each indicators to the perspective in equation form have been discussed in the above section. In order to identify easily the improvement sector using beta value by considering each perspective and total mark as independent and dependent variables, regression analysis is conducted to determine the effect and impact of each measurement perspective on the overall result of a company (See table 5.13).

## Analysis on Waste Level using the 7 Waste approach and Value Added (VA)/Non Value Added Activities (NVA)



Define



Measure



Analyze



Improve



Control

1) **Defining Stage:** The biscuit production process and determination of VA/NVA activities NAS manufactures various biscuits in its production lines. The production process of line is run fulltime Asmah (2011).value adding activities are Preparation of flour material, oil material, packaging material, Weighing of other materials, Mixing process, Cutting & forming process, Baking process, Cooling process, Stacking process, Cream mixing process and Packing process. While non-value adding activities are lay time and QC product check. Each process has a certain design and layout in order to obtain quality, process capability and good capacity in order to meet the needs of consumers.

2) **Measure Stage:** Waste Identification

Based on the observation on the biscuit production process in NAS, several waste resources have been identified i.e. non-standard process, Fail on the ground ,Crimean machine waste area , Rapper wastage, Packaging scrap product drops, error metal detector detection, broken, oval, overweight or small products, imperfect shape, non-standard water content, malfunction process, and engine breakdown. According to (Womack, 2003), Toyota identifies seven types of waste, and they include 1.Overproduction, 2.waiting time, 3. Unnecessary transportation, 4. Excessive or erroneous processing, 5. Excessive inventory, 6. Unnecessary movement and 7.Defective product to identifies the observed. The results of this identification were illustrated by a value stream mapping diagram, to determine the actual condition of the observed objects in several indicators, including value added and non-value added time. The value of Process Cycle Efficiency (PCE) was calculated to determine the value of Lean application level at NAS. This was then followed by measuring stage in which the process of measuring and identification of waste occurring at every stage of production process was conducted. The occurrence of each waste was measured and classified using the approach of 7-waste classification and finally calculated by Pareto analysis.

**Table 5.14. The value added process in the biscuit manufacturing for 3 month**

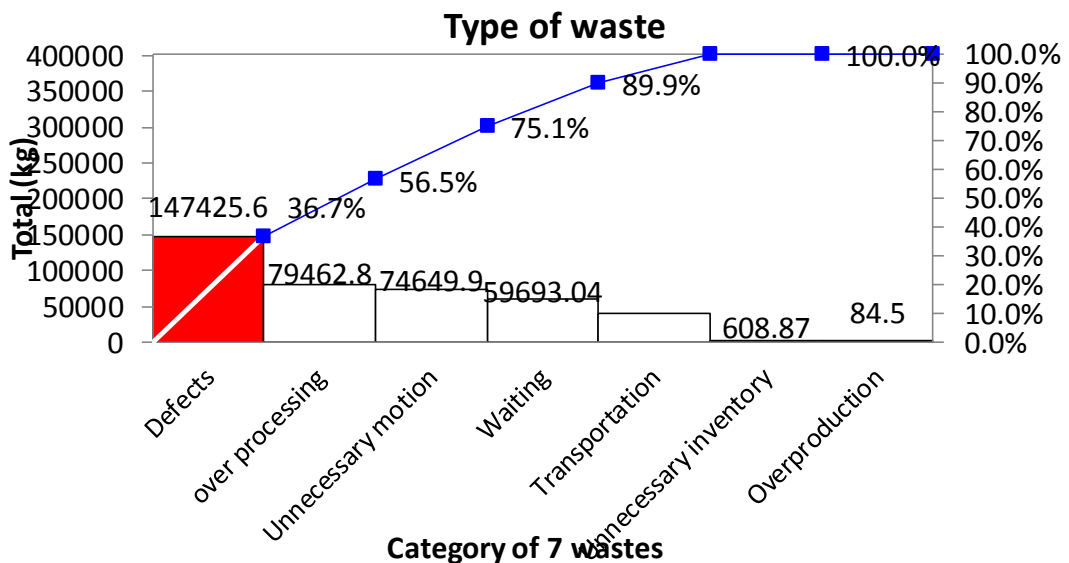
Activity	Time(minute)
Preparation of flour material	5.0
Preparation of oil material	4.5
Preparation of packaging material	3.05
Weighing of other materials	11
Mixing process	20
Cutting & forming process	6
Baking process	4.5
Cooling process	5
Stacking process	7.8
Cream mixing process	10
Packing process	7.03
Cartoons process	4.8
<b>Total</b>	<b>78.88</b>

Analysis on the mapping process of the whole series of biscuit production is illustrated by some activities that are classified as non-value-added activities and some value-added activities (Tables 5.14 and 5.15). Based on the time measure of the VA and NVA activities, the value of Process Cycle Efficiency (PCE) of 49.64% was obtained. The value of PCE is the result of division between Value Added Time and Total Cycle Time.

**Table 5.15. Non value added process in the biscuit manufacturing for 3 month**

Activity	Time(Minute)
Lay time-dough	50.0
QC product check	30.0
<b>Total</b>	<b>80.0</b>

A company can be considered Lean if the ratio of value-to-waste ratio has reached a minimum of 30%; therefore, if the company is not lean and can be categorized as a traditional company (George, 2002). Because the value of waste ratio is 36.7%.



**Figure 5.1. Pareto diagrams of seven wastes**

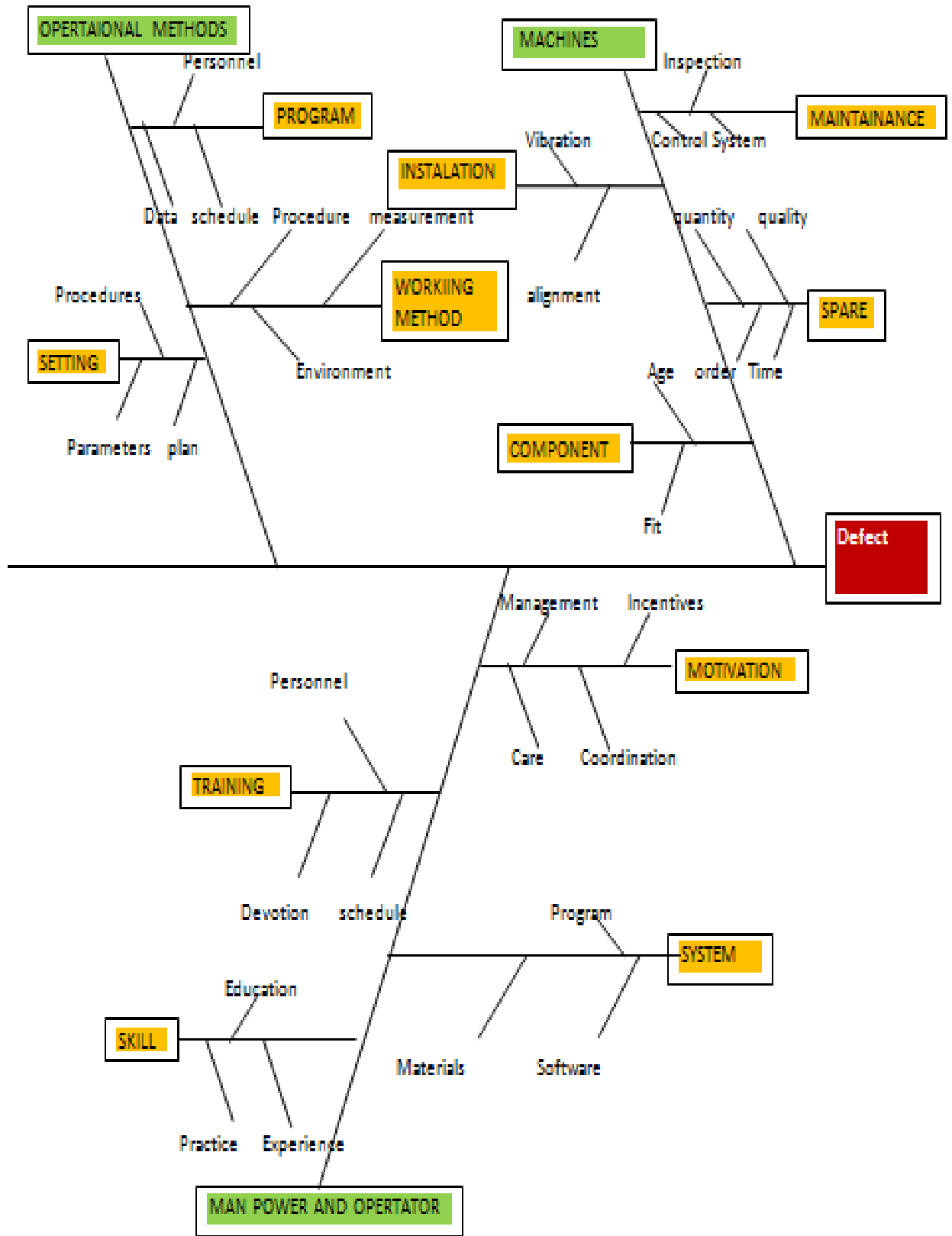


Figure: 5.2. Cause and effect diagram for under defect

### 3). **Analysis Stage:** Determination of Critical to Quality (CTQ) and Cpm value

Critical to Quality or CTQ is a standardized or critical measure at every stage of production processes in order to produce quality products that meet the consumers' expectation in accordance with the capabilities of process technology available. In relation to the measurement of this CTQ, Gazperzs (2011) suggests that the characteristics of quality that will satisfy customers should be identified first. Following this, the quality characteristics considered as critical and that should be controlled are classified, and each quality characteristic that has been classified should be determined to see whether it can be controlled through material control, machines, work processes, and others. At CTQ, a maximum tolerance limit (USL= Upper Specification Limit) and a minimum tolerance limit (LSL: Lower Specification Limit) were set up. The values of USL and LSL are determining the process variation for each classified quality characteristic, and they can also be used as signposts for product and process developments. The range of USL and LSL values is determined by the value of  $\pm n$  sigma, and the Six-sigma approach (DMAIC method) is used as a reference in order to decrease waste or loss (Hasan, 2013).

*Table 5.16 CTQ of Biscuit Production Process in one line in NAS food Plc*

Process stage	Critical to quality (CTQ)	Measurement	LSL	Target	USL
Preparation of raw materials	Process 1	Kg	6	6.5	7.1
	Process 2	Kg	10	10.5	11.3
	Process 3	Kg	12	12.5	13.2
Mixing	Process 4	Kg	31.5	32	32.7
	Process 5	Kg	199.5	200	200.8
	Process 6	Kg	89.5	90	90.7
Forming	Process 7	Gr	19.5	20	20.7
	Process 8	Gr	17.5	18	18.8
Oven	Process 9	Mm	49.5	50	50.6
	Process 10	Mm	44.5	45	45.7
	Process 11	%	2.5	3	3.8
	Process 12	PH	8.5	9	9.7
Cooling	Process 13	Wt.	39.5	40	40.6
	Process 14	Wt.	9.5	10	10.6
Stacking	Process 15	Gr	29.5	30	30.6
	Process 16	Mm	34.5	35	35.8
Packing	Process 17	Gr	139.5	140	140.7
	Process 18	Gr	29.5	30	30.8

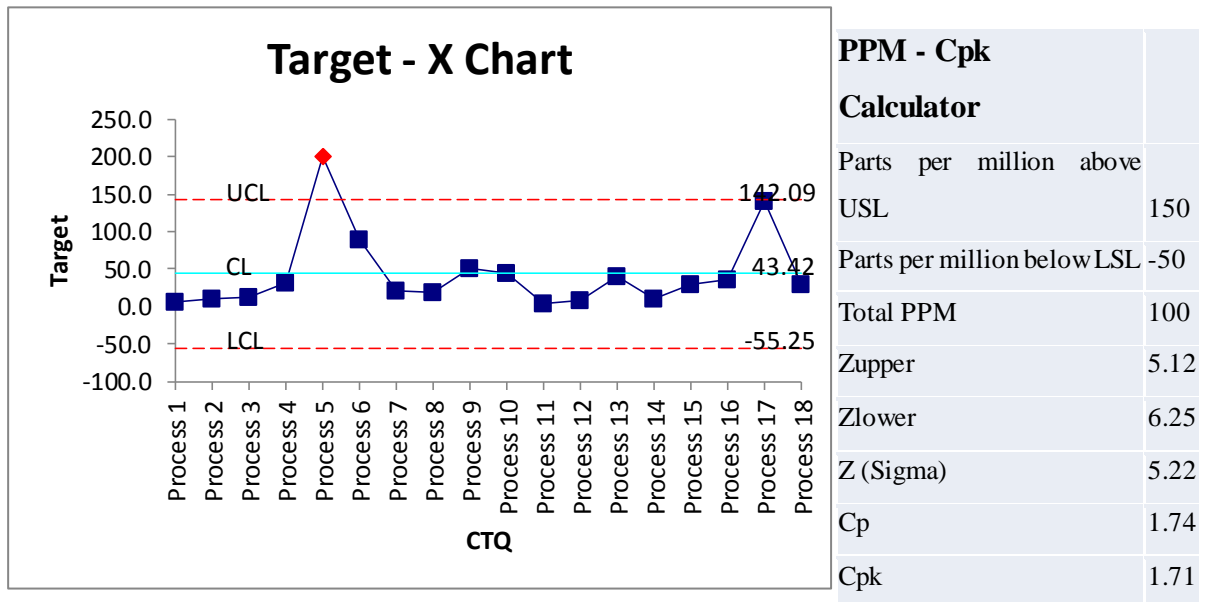


Figure: 5.3 control chart for UCL and LCL.

The research found the values of six sigma calculation and enter the number defect observed is 5.25, enter the size of the sample are 78 and the defects per million (DPMO) of 67308, and sigma of 3. This shows that the biscuit production of has a production capability with a failure of 67308 every 1,000,000 productions, or equivalent to 6.73% loss, and this indicates the production process still has a high failure rate.

### Process Sigma Calculator

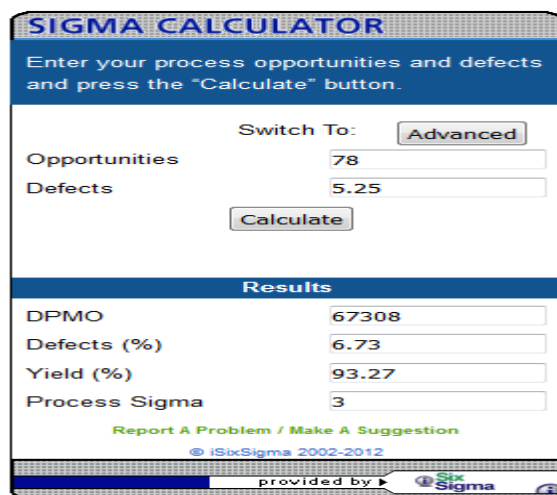


Figure 5.4 process sigma calculators.

Also the research calculates DPOM, percentage of defect, percentage of yield, process sigma by process sigma calculator with inserting the number of defect observed and opportunities then automatically it calculates and gives result as we see above in the picture.

#### 4) Improvement Stages (Determination of FMEA)

In regards to improvement, a number of improvement steps at each stage of the existing processes from the preparation of materials, mixing, forming, baking, cooling, stacking and packing were established and then tabulation on FMEA analysis was carried out. The FMEA method is also used to determine the failure of the process and to analyze and improve the production quality Puspitasari and Martanto, (2014); Ahmed Mukti, (2017).

Processes	Steps/Inputs	Failure mode	Failure Effects	SEV	Causes of failure mode	OCC	Current control	DET	RPN
Biscuit making									
Material preparation	Material weighing	Wrong ingredient	Inconsistent quality	10	Substandard material supplied by supplier	5	Undetectable	10	500
		No electricity power	Damaged dough	8	Main Distributor Panel Trip	6	No monitoring	10	480
		Blocking wheat at hopper	Line stop	7	Damaged Filter	6	No monitoring	10	420
Mixing Process	Mixing	Different usage of water between shifts	Unstable dough and waste	6	Differences in methods by operators	10	Controlling only after mixing is finished	6	360
		Frequently error sensor	Down time and safety issue	6	Unstable socket pad	10	Alarm system of mixer is on	5	300
Forming Process	Forming	Product Tailing	Product jam	10	Uneven surface of blades	10	Checklist of forming	6	600
		Product Tailing	Product Jam	10	Loose molder Teflon	10	Visual control	5	500

Oven Process	Baking Process	Irregular thickness of biscuit	Unbalanced thickness of biscuits	10	Uneven weight among rows	10	Check list of intense monitoring	5	500
		Product Jam	One side of Wire mesh is loose	10	One side of Wire mesh is loose	10	Visual control	7	700
Cooling process	Cooler	Product is Excess Calm	More rejected products	10	Scrap was taken accidentally	10	Only Visual	5	500
Stacking process	Sandwich	Thin or thick biscuits	packing machine often starts or stops	10	Cream texture is different since the icing weight is different	10	No control/monitor	10	1000
	Mixing cream	Unbalanced Cream	Waste/ thin or thick	10	Inaccurate balance or weighing scale	10	Inappropriate display	8	800
Packing Process	Product packaging	Broken Products	Dead machine,, quality potential	10	No sorting tool of sandwich since taken accidentally to packing	10	Visual	10	1000
		Poor packaging material	Inconsistent quality	10	Substandard material supplied by supplier	6	No control	10	600

**5) Control Stage:** plan to continue measuring the success of the updated process is usually created and any documentation, process or training material is updated.

## 5.4 Qualitative result

**Analysis on Baldrige model with six sigma methodology they state that “Baldrige provides the framework, Six Sigma the methodology.”**

The experience of Motorola with Six Sigma helped the company to win the baldrige award in 1988. According to Sumberg (2005); Mahour M.Parast,(2006) the Six Sigma quality laid the foundation for Motorola to be the first company to win the baldrige award. Such a link between the Six Sigma methodology and the baldrige model exists in practice.

The MBNQA framework today has extended its application to beyond businesses and has specific guides for Education and Health Care organizations (Badri et al., 2006; Goldstein & Schweikhart, 2002). The fundamentals remain the same, with seven key categories guiding the success of an organization. These seven categories are Leadership, Strategic Planning, Customer and Market Focus, Measurement, Analysis and Knowledge Management; Human Resource Focus; Process Management; and Business Results (Png, 2015)

**Leadership:** how upper management leads the organization, and how the organization leads within the community.

**Strategic Planning:** how the organization establishes and plans to implement strategic directions.

**Customer and Market Focus:** how the organization builds and maintains strong, lasting relationships with customers.

**Measurement, Analysis and Knowledge Management:** how the organization uses data to support key processes and manage performance.

**Human Resource Focus:** Outlining the importance of human resources, Around 349 employees work round the clock to assure the highest standards in quality due to precise and undeviating guidance given through the human resource. According to him the key aspects of its success is their skilled and motivated workforce backed by a superior image of the company. With the focus of achieving further sustainable development, the company has implemented several initiatives within the past few years including projects focused on employee skills development, local and international training and identifying the gaps to be competitive in HR. The approach on training and skill development has enhanced the employee motivation and their engagement to the company, where the company gains a long term achievement in HR sustainability which enhances the employee productivity.

**Process Management:** it uses powerful tools like Continuous improvement program, Zero Defect, and Re-engineering. Continuous improvement recognizes that, even when no errors occur, there are opportunities to improve the design of the process or product. All the time, the competitors are seeking to gain an advantage by making their products better. If the companies don't seek to improve, it will get left behind. Company should expect to receive no complaints from customers. This goes beyond the idea of keeping complaints to a minimum. It indicates that the company should adopt a new approach, perhaps checking that each customer is satisfied with his purchase (Dr. H. Nagaprasad, 2008).

**Business Results:** how the organization improve in terms of customer satisfaction, finances, human resources, supplier and partner performance, operations, governance and social responsibility and how the organization compares to its competitors.

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## CHAPTER SIX

### 6.1. PROPOSED CONTINUOUS QUALITY IMPROVEMENT MODEL

The integration of lean, six sigma and baldrige model understand separately and define similarity and dissimilarity in each alignment some criteria are considered based on the literature review. These include: focus on work condition in addition to process, easily understandable and having proper metrics; addressing the possible root cause of continuous quality improvement problems; being continuous improvement tool; having clearly defined improvement goal; flexibility to apply from operation to firm level and involving all, including top management to low.

#### **Likeness between Lean and Six sigma**

The similarity between lean manufacturing and six sigma below:

1. They are origin the quality evolution in Japan.
2. They require high level of management commitment.
3. They represent a culture change of the organization.
4. They implemented as part of a strategic plan.
5. They require input from all level of the organization.
6. They have systematic structures.
7. They work toward the same ultimate goal elimination waste.
8. They create efficient processes.
9. They have demonstrated that it is possible to dramatically improve the quality of products and customer experience by improving processes.

#### **Difference between Lean and Six sigma**

The difference between lean manufacturing and six sigma below:

1. Whereas six sigma is focused on reducing process variations and improving process output by following a problem solving approach using statistical metrics, lean is primarily concerned with elimination of wastes and improving the in house work flow.
2. Six sigma focused not only on manufacturing operations, but also on all possible processes including R&D or design process which is cover in DMADV roadmap and service and areas while lean focuses on improving manufacturing operations in variation, quality and productivity.

3. Lean looks at ways to increase flow while six sigma focuses on achieving consistent result.
4. Lean is used primarily in production whereas six sigma can be used to reduce errors in production as well as nonproduction environments.
5. Lean strives to maximize value to the customer though using a few resources as possible. Six sigma strives for near perfect results that will reduce costs and achieve higher levels of customer satisfaction.
6. Lean uses tools like 5S, VSM, kaizen etc...while six sigma uses tools like flow chart, control chart, graphical chart etc...
7. Lean criticizes system interaction not considered processes improved independently while six sigma criticism statistical or system analysis not valued.
8. However Lean emphasizes standardization and productivity, Six Sigma can be more effective at tackling process noise and cost of poor quality. Breyfogle (Martin P. R.)(2003); Ahmed (2013).

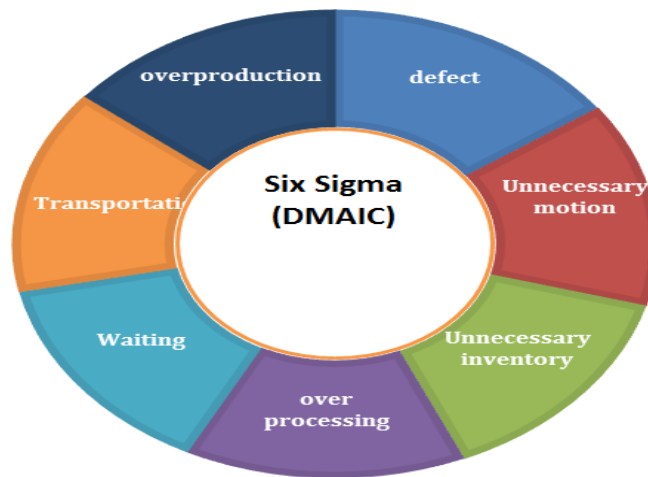


Figure 6.1 integration of lean with six sigma

Table 6.1 Interactions between lean Six Sigma (Source: Adapted from Pyzdek (2000))

Interaction Between Lean And Six Sigma	Lean	Six Sigma
	Focus on customer value stream	Customer requirements measurement, cross functional management
	Use a project-based implementation	Project management skills
	Understand current conditions	Knowledge discovery
	Collect product and production data	Data collection and analysis tools
	Document current layout and flow	Process mapping and flowcharting

Time the process	Data collection tools and techniques, SPC
Calculate process capacity and Take time	Data collection tools and techniques, SPC
Create standard work combination sheets	Process control planning
Evaluate the options	Cause-and-effect, FMEA
Plan new layouts	Team skills, project management
Test to confirm improvement	Statistical methods for valid comparison, SPC
Reduce cycle times, product defects, changeover time, equipment failures, etc.	Seven management tools, seven quality control tools, design of experiments

### **Likeness Six sigma and Malcolm Baldrige national quality award**

The similarity between six sigma and MBNQA below:

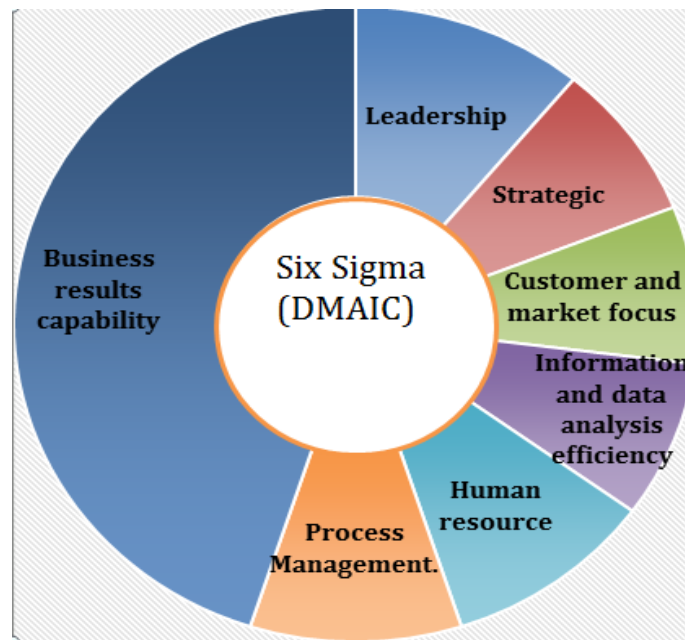
1. However six sigma emphasizes on outcomes, baldrige emphasis on outcomes can be more effective at tackling process noise and cost of poor quality.
2. They require high level of management commitment.
3. They represent a culture change of the organization.
4. They implemented as part of a strategic plan
5. They require input from all level of the organization.
6. They have systematic structures.

### **Difference between Six sigma and Malcolm Baldrige national quality award**

The difference between six sigma and MBNQA below:

1. Six sigma origin in Japan whereas Malcolm baldrige national quality award origin in USA.
2. Whereas six sigma is focused on reducing process fluctuations and improving process output by following a problem solving approach using statistical metrics, baldrige focus on quality on the future and analysis and knowledge transfer and organization performance.
3. Six sigma Criticisms the system interaction not considered processes improved independently while baldrige Criticisms unfairness, superficiality and publicity the inherent value of the continuously improving award program far outweighs organizational performance.

4. Six sigma use tool flow chart, control chart, graphical chart etc... while baldrige use questioner, ABC tools
5. However six sigma emphasizes on processes while baldrige emphasis on structure best for practice- wide problem assessment and goal setting.



*Figure 6.2 Integration between six sigma and MBNQA*

Recognized from linking six sigma methodologies with MBNQA the proposed integrative based on the principles.

- ✳ When six sigma integrated with baldrige model. In fact, it becomes part of baldrige model for achieving performance excellence. Such a performance requirement is set by the top management. Afterward aligned with the requirement of the baldrige model six sigma methodologies become used for improve the process and meet quality objective.
- ✳ The baldrige self-assessment includes both the assessment of each seven categories in the baldrige model as well as the efficiency and effectiveness of the six sigma projects. Such an approach toward six sigma projects ensures that the company is gaining benefit from implementing the six sigma methodology. (Mahour M.Parast, 2006)
- ✳ The proposed model for the integration six sigma-baldrige is capable of addressing the core value of the baldrige model. Area such as leadership competencies, strategic development and human resource management can be address by six sigma methodology (Mahour M.Parast, 2006).

### **Similarity between lean-six sigma (LSS) and MBNQA**

1. They require high level of management commitment.
2. They represent a culture change of the organization.
3. They implemented as part of a strategic plan.
4. They require input from all level of the organization.
5. They have systematic structures.
6. The main ultimate goal for both model are continuous quality improvement.

### **Difference between lean-six sigma (LSS) and MBNQA**

The difference between lean-six sigma (LSS) and MBNQA below:

1. Lean-six sigma usage of scientific data to guide decision and improvement in an organization whereas MBNQA quality comparison of an organization's performance against an optimum benchmark.
2. Lean-six sigma focus action and actual improvement while MBNQA focus on assessment and compliance.
3. The purpose of lean-six sigma that to improve specific outcomes within an organization however MBNQA purpose is national recognition and holistic view of company performance.
4. Lean-six sigma not recognized award whereas MBNQA recognized award.
5. Whereas related to organization culture influence lean-six sigma is continuous improvement mindset, customer centricity, process and data centricity, MBNQA influence not specific it depend on the outcome of the management's reflection.

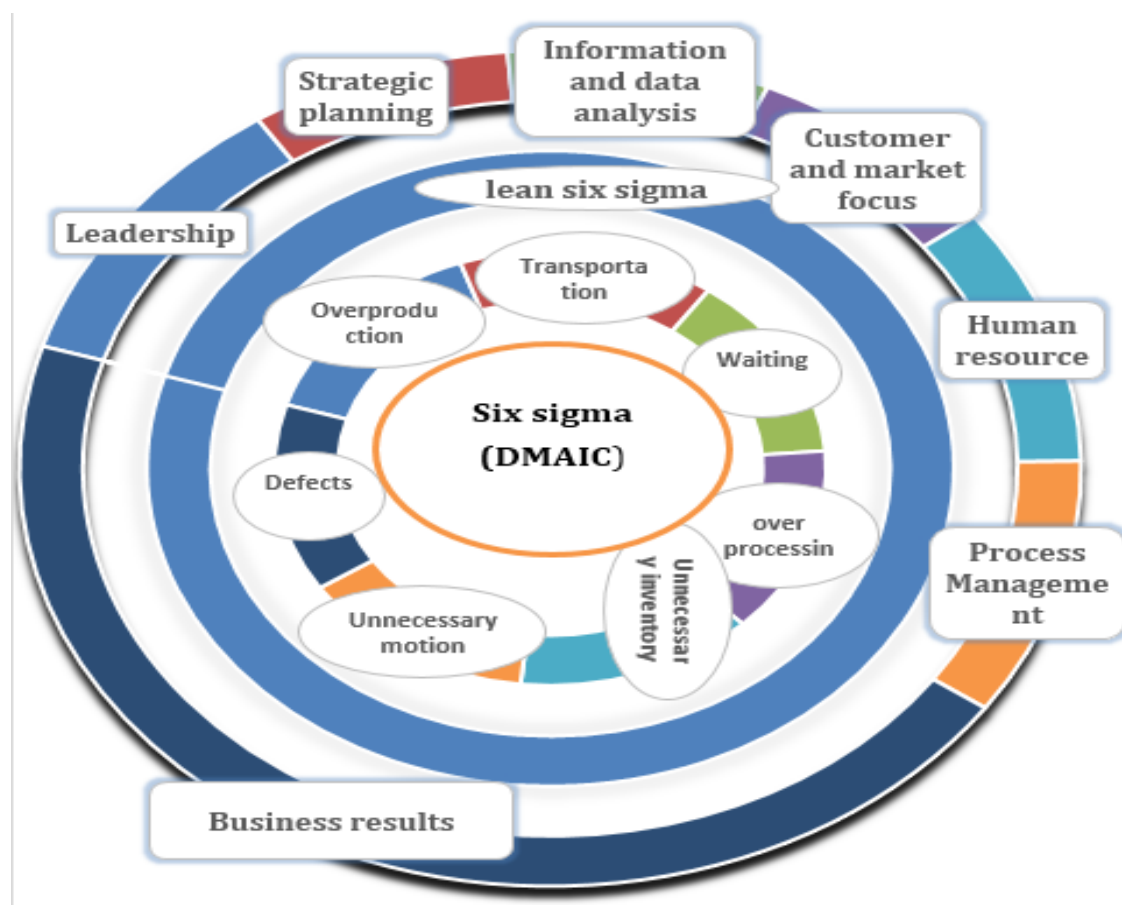
Recognized from linking lean six sigma methodology with MBNQA the proposed integrative based on the principles

- ✦ When lean, six sigma integrated with baldrige model. In fact, it becomes part of baldrige model for achieving excellence. Afterward aligned with the requirement of the baldrige model, lean and six sigma methodologies become used for improve the process and meet quality objective.
- ✦ The baldrige self-assessment includes both the assessment of each seven categories in the baldrige model as well as the efficiency and effectiveness of the six sigma projects. Such an approach toward six sigma and lean projects

ensures that the company is gaining benefit from implementing the lean- six sigma methodologies.

- ✦ The proposed models for the integration lean six sigma-baldrige is capable of addressing the core value of the baldrige model and identify the seven waste of lean. Area such as leadership competencies, strategic development and human resource management can be address by six sigma methodology.

The success of Six Sigma and Lean Thinking that can be enhanced by a presentation that is characterized by the Malcolm Baldrige Criteria help Excellence. An integrated lean system is one of the best analysts of a successful Six Sigma initiative (figure 6.1) whereas An integrated Baldrige management system is one of the best predictors of a successful Six Sigma initiative (figure 6.2) and this research final proposed conceptual model for continuous quality improvement model integrated lean manufacturing, six sigma and MBNQA in one demonstrated on (figure 6.3) below.



**Figure 6.3 Integration between lean six sigma (LSS) and MBNQA**

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## Feature of the proposed model

### 6.1.1 Preparation;-

#### Applying Six Sigma in the lean philosophy

I established a link between Six Sigma methodology and the lean manufacturing. The proposed integrative six sigma and lean manufacturing are based on the following principles:

- ✦ The Six Sigma methodology is linked with the lean. In fact, it becomes part of the Lean six sigma (LSS) for achieving waste and defect reduction.
- ✦ The lean self-assessment includes the assessment of each seven waste in the six sigma (DMAIC).
- ✦ The proposed model for the integrative lean Six Sigma is capable of addressing the core values of the lean. Areas such as overproduction, waiting time, unnecessary transportation, excessive or erroneous processing, excessive inventory, unnecessary movement and defect can be addressed by Six Sigma methodology.

#### Applying Six Sigma in the Baldrige Model

I established a link between six sigma methodology and the baldrige model. The proposed integrative six sigma and baldrige model is based on the following principles:

- ✦ The Six Sigma methodology is linked with the baldrige model. In fact, it becomes part of the baldrige model (and not separate from it) for achieving performance excellence. Such a performance requirement is set by the top management. After the establishment of such goals (which need to be aligned with the requirements of the baldrige model) Six Sigma methodologies is used to improve the processes and meet quality objectives.
- ✦ Six Sigma projects can be applied to all types of the projects, processes, and products. The selection, administration, and control mechanisms are directed by the top management.
- ✦ The proposed model for the integrative six sigma-baldrige is capable of addressing the core values of the baldrige model. Areas such as leadership competencies, strategic development and deployment, and human resource management can be addressed by six sigma methodology.

### Applying Six Sigma in the Baldrige Model and Lean

I established a link between six sigma methodology and the baldrige model also six sigma and lean. The proposed integrative lean Six Sigma and baldrige model is based on the following principles:

- ✦ When lean, six sigma integrated with baldrige model. In fact, it becomes part of baldrige model for achieving excellence. Such a performance requirement is set by the top management. Afterward aligned with the requirement of the baldrige model, lean and six sigma methodologies become used for improve the process and meet quality objective.
- ✦ The baldrige self-assessment includes both the assessment of each seven categories in the baldrige model as well as the efficiency and effectiveness of the six sigma projects. Such an approach toward six sigma and lean projects ensures that the company is gaining benefit from implementing the lean- six sigma methodologies.
- ✦ The proposed models for the integration lean six sigma-baldrige is capable of addressing the core value of the baldrige model and identify the seven waste of lean. Area such as leadership competencies, strategic development and human resource management can be addressed by six sigma methodology whereas for the integrative lean Six Sigma identifies such area overproduction, waiting time, unnecessary transportation, excessive or erroneous processing, excessive inventory, unnecessary movement and defect can be addressed by Six Sigma (DMAIC) methodology.

**Note:** The systematic method by which the baldrige-based culture of excellence is established, waste is eliminated from processes through Lean Thinking, processes are moved toward perfection using Six Sigma, and progress is measured using assess results. The baldrige criteria require waste reduction, process improvement, and results that are aligned with business strategies and goals. Six sigma and lean thinking tools demonstrate how some organizations have chosen to carry out these requirements. The goal of this effectively aligned process is to drive beyond incremental improvement to breakthrough improvement and breakthrough improvement is where significant competitive advantage is gained.

## CHAPTER SEVEN

### 7. Conclusion and Recommendation

#### 7.1. Conclusion

The conclusion of this research is that the waste minimization at NAS food Plc. as production process applying the lean process. In such cases, the standard DMAIC cycle may provide structure and ensure that each step is improved thoroughly, thereby helping the success of the project. Lean can contribute to these projects by staking out the direction; that is, indicating where to start, for example through the use of value stream mapping where the process is reviewed in order to find waste. Analysis on the mapping process of the whole series of biscuit production is illustrated by some activities that are classified as non-value-added activities and some value-added activities.

In this paper both qualitative and quantitative analysis are applied and the result of qualitative by using (DMAIC) based on the time measure of the VA and NVA activities, the value of Process Cycle Efficiency (PCE) of 49.64% was obtained. And the research found the value of waste ratio is 36.7%, this show non lean in the company and the values of six sigma calculation and insert the number defect observed is 5.25, the size of the sample are 78 and the result defects per million (DPMO) is 67308 and sigma of 3. This shows that the biscuit production of has a production capability with a failure of 67308 every 1,000,000 productions, or equivalent to 6.73% loss, and this indicates the production process still has a high failure rate. And improvement by using FMEA analysis was carried out each stage of the existing process used to determine the failure of the process and to analyze and improve the production quality and the result of highest RPN on Stacking and packaging process so they should take action for waste minimization and continuous quality improvement. In additional Organizations try to implement the baldrige model as a means for achieving excellence. The seven categories within the baldrige model is integrated and related with the purpose of addressing quality challenges so that companies can be competitive in the dynamic business environment.

In quantitative analysis used SPSS software and the Correlation and regression analysis is used to quantify the association between two continuous variables (between an independent and a dependent variable or between two independent variables). The result of this shown relationship of each variables in waste measurement perspective they have strong relation with significance level of 0.01 and

the causal Pearson Correlation of most variable has a strong positive relation and their value is greater than 0.8, likewise The good regression results of equation is selected in each section which is explained  $R^2$  value about 0.9 or 90% with statistically significant ( $P < 0.01$ ) level.

However, this paper relying on a review of the national and international literature, 25 key indicators was selected based on the correlation having strong 'r' value under four improvement perspectives were identified to assess measurement system of the organization. The Lean Six Sigma & baldrige application studied here does not point towards one well-defined Lean Six Sigma approach; the company does not adopt any particular standardized approach to larger improvement projects. Instead, the company supports the integration at this level by ensuring that their improvement specialists are widely trained in Lean, Six Sigma and baldrige model.

## **7.2. Recommendation**

Further research is required for biscuit manufacturing in terms of waste minimization at each process stage using this DMAIC methodology. This study needs to be continued in terms of FMEA usage along with the development selection model for waste minimization and improving the production process. Instead, the company supports the integration at this level by ensuring that their improvement specialists are widely trained in Lean, Six Sigma and Baldrige model.

The study should be continued with a further discuss in the integration of lean six sigma with quality award criteria for continuous quality improvement in the perspective of process and management in manufacturing. Similar research also should be conducted in order to provide added value in the fields of food or agriculture with the application of lean six-sigma and Baldrige model.

### **7.3 Future research**

The study should be continued with a combination of other methodologies such as TPM approach and other methods of improvement. Similar research also should be conducted in order to provide added value in the fields of food or agriculture with the application of Lean Six-sigma and Malcolm model.

This study has focused on the NAS food plc. It would be interesting to apply the research question to other types of industries, both service and manufacturing oriented. Similar studies could also be performed on larger companies. The present study could for such purposes be used in a broader meta-analysis.

The statistical analysis could be refined. A longer observation period and an increased sample size may increase the accuracy of the results. For a more extensive analysis, additional categories regarding financial performance and continuous improvement work could be included. Finally, other statistical methods could be used to answer the research question.

## References

- Addae-Korankye. (2013). *Total quality management (tqm): a source of competitive advantage. A comparative study of manufacturing and service firms in ghana. International Journal of Asian Social Science*, 3(6), 1293-1305.
- Ahmed, M. (2013). Lean, six sigma and lean six sigma. *International Journal of Scientific & Engineering Research*, 6(2), 1137-1153.
- Ahmed M, s. a. (2017). PT kraft ultrajaya indonesia. *indonesian journal of business and entrepreneur*, 77-89.
- Akbar Javadian Kootanaee1, D. K. (2013). Just-in-Time Manufacturing System:From Introduction to Implement. *International Journal of Economics, Business and Finance*, 1(2), 07-25.
- Alie Wube Dametew, D. K. (2017). The Roles of TQM and JIT for Basic Metal Industries Global Competitiveness. *Industrial Engineering & Management*, 6(2).
- Alie Wube Dametew, F. E. (2016). Supply Chain Integration for Improving Performance on Manufacturing Industries. *Global Journal of Researches in Engineering:J.General Engineering*, 16(4).
- Areview. (2013). INTRODUCTION TO JIT:. *International Journal of Latest Research in Science and Technology*, 2(6), PP 97-101.
- Atkinson, R. D. (2013). *Competitiveness, innovation and productivity:clearing up the confusion*. The Information Technology& Innovation Foundation.
- Cindy, v. a. (2017). state programs based on baldrige criteria help organization innovate &continuously improve their performance excellence and quality. *feature baldrige award*, 6(2).
- Coskun Dalgıç, H. V. (2011). *Improvement of Food Safety and Quality by Statistical Process Control (SPC) in Food Processing Systems: A Case Study of Traditional Sucuk (Sausage) Processing*. InTech, Available from: <http://www.intechopen.com/books>.
- CSA,s. (2014/15). Agricultural sample survey.crop and liverstock utilization.
- Dagne Birhanu, D.-I. D. (2009). *Small Scale Metalworking Industries Cluster (Case Study on Towns of Oromia Special Zone)*. Addis Ababa: Un-published work.
- Dametew, A. W. (2015). Problems of Solid Waste Management in Small and Medium Enterprises. *International Journal of Environmental Monitoring and Analysis*, 50-66.
- Dametew, A. W. (2016). Design and Analysis of Small Hydro Power for Rural Electrification. *Global Journal of Researches in Engineering: F Electrical and Electronics Engineering*, 16(6).
- Daniel, O. A. (2016). Proposal for a conceptual model for evaluating lean production development performance .volume 6.
- Dave, N. (2002). how to compare six-sigma,lean and the theory of constraints. Volume 6.

- Dr. H. Nagaprasad, I. B. (2008). Making World Class Product Through Quality Process Management.
- Effah-Kesse, D. (2017). *Implementation Of Lean In The Public Sector: Investigating The Benefits And Drawbacks.(A Case Study of Molde Municipality)*. Molde University College.
- EIAR,. I. (2006). success in value chain;durum wheat commercialization and adoption improve technology in bale zone,Ethiopia.
- Eshetu, B. (2017). *Integrated Model for Continuous Productivity Improvement in Footwear Industry:(A Case of Anbessa Shoe S.C.)*. AAiT.
- FAO, A. (2012). Addressing marketing and processing constrains that inhibit Agri-food exports. 160.
- Fasika Bete Georgise<sup>1</sup>, T. K.-D. (2014). Integrating Developing Country Manufacturing Industries into Global Supply Chain. *Journal of Industrial Engineering and Management*.
- Fatemeh, H. (2011). Continuous improvement through an integrated maintenance model . volume 10.
- Fourtunne. (2016). *Metal and Engineering Industry Underperforms*. Published on Nov 15,2016 [ Vol 17 ,No 863.
- Gebre-mariam, H. (2018). *wheat production and research -Ethiopian agricultural portal*. Retrieved from [www.eap.gov.et>sites>default>files](http://www.eap.gov.et/sites/default/files).
- Hans, S. B. (2013). *Applying Lean, Six Sigma, BPM, and SOA to Drive Business Results* (Vol. 6). IBM.
- Hermela, S. (2016). Performance Measurement and Improvement System in Meat Processing Industries. *Addis Ababa University*, PP 118.
- Herndon, V. W. (1998). World Development Indicators . *International Journal of Environmental Monitoring and Analysis*, 3(2).
- Horne, J. R. (2009). *The effect on corporate performance of firms that won the*. H. Wayne Huizenga School of Business and Entrepreneurship Nova Southeastern University .
- Imam, H. (2010). *Recycling in a supply chain context - A case study regarding sorting and collection*. Melardeen University of Seweden.
- Jangwoo Lee, K. L. (2015). Supplier Partnership Strategy And Global Competitiveness:A Case Of Samsung Electronics. *Eurasian Journal of Business and Management*, 3(4), 1-12.
- Kitaw, A. M.-I. (2014). *Continuous Improvement in Global Competitiveness Arena,Conceptual framework for integrating JIT in TQM implementation program*. School of Mechanical and Industrial Engineering (SMIE).
- Kitaw, K. J. (2016). A Literature Review On Global Occupational Safety And Health Practice & Accidents Severity. *International Journal for Quality Research*, PP 279–310.

- Kitaw, Y. Y.-I. (2014). *Competitiveness and beyond the production system thought in reference to Ethiopian leather and Leather products industry*. School of Mechanical and Industrial Engineering (SMIE).
- Kongolo, M. a. (2014). Impact of Total Quality Management (TQM) on Service Delivery in Swaziland's Sugar Industry. *International Journal of Operations and Logistics Management*, 3(2), 158-169.
- Kumar, Z. Z. (2013). Manufacturing Excellence through JIT Approach. *International Journal of Application or Innovation in Engineering & Management (IJAIEM)*, 2(7).
- Kumar<sup>1</sup>, R., & Kumar<sup>2</sup>, V. (2012, October Oct 19-20). Lean manufacturing: elements and its benefits for manufacturing industry. *Trends and Advances in Mechanical Engineering, YMCA University of Science & Technology, Faridabad, Haryana*.
- Liang, P. C. (2014). *Review of lean six sigma and malcolm baldrige national quality award and a proposal for the future*. National university of singapore.
- Link, A. N. (2001). *Economic Evaluation of the Baldrige National Quality Program*. University of North Carolina at Greensboro.
- Mahdi Salehi, M. A. (2010). Impact Of JIT On Firms' Financial Performance Some Iranian Evidence. *Global Journal of Management and Business Research*, 10(4).
- Mahour M.Parast, E. C. (2006). *A Relationship Between Six Sigma And Malcom Baldrige Quality Award*.
- Malihe Manzouri 1, M. N.-R. (2014). Increasing Production and Eliminating Waste through Lean Tools and Techniques for Halal Food Companies. *Sustainability*, 6, 9179-9204.
- Martin, K. (2014). Development of collaborative green lean production system . pp 132.
- Martin, P. R. (n.d.). *A Study on the Factors of Regional Competitiveness*. University of Cambridge, Rotterdam.
- Matsui, A. C. (n.d.). *JIT Practices and Competitive Performance: Empirical Evidence from Japan*. Yokohama National University: International Graduate School of Social Sciences.
- Md. Mazedul Islam, A. M. (2013). Application of Lean Manufacturing to Higher Productivity in the Apparel Industry in Bangladesh. *International Journal of Scientific & Engineering Research*,, volume 10.
- Milovanoi, M. (2011). Just in time concept as a mean for achieving competitive advantage in the virtual economy. In b. Katalinic (Ed.). 22. DAAAM International, Vienna, Austria, EU,.
- Mohamed, K. (2013). Continuous Quality Improvement (CQI) Strategies to Optimize your Practice. Volume 20.
- Mohamood, K. (2014). *Lean approach in manufacturing and service sectors and service sectors*. Tut Faculty of Mechanical Engineering.

- Mousa, A. (2013). Lean, six sigma and lean six sigma Overview. *International Journal of Scientific & Engineering Research*,, volume 4(5).
- Nave, D. (2002). *How To Compare Six Sigma, Lean and the Theory of Constraints*. USA: American Society for Quality.
- NLC, T. N. (2013). Continuous Quality Improvement (CQI) Strategies to Optimize your Practice. volume 20.
- Pap, N., Pongrácz, E., & Myllykoski, L. (2014). Waste Minimization and Utilization in the Food Industry. *Jatindra Kumar Sahu (ed.)*.
- Paul Grizzell, B. a. (2006). Alignment of Baldrige with Six Sigma,Lean Thinking. volume 10.
- Perry R, H. c. (2004). *SPSS explained*. London and New york.
- Peter Lee, A. F. (2013). *The role of Lean thinking in increasing resource efficiency in the UK food and drink supply chain*.
- Png, C. L. (2015). A Review Of Lean Six Sigma And Malcolm Baldrige. volume 6.
- Praveen, S. (2012). Reduction of working in process inventory & production lead time in bearing industry using value stream mapping. volume 9.
- Quesada-Castro María del Rocío., A.-P. J. (2014). Study of the Application of Lean Manufacturing Techniques in Medellin Baking Industry. volume 10.
- Richard Reeda,. D. (2000). Total quality management and sustainable competitive advantage. *Journal of Quality Management*, 5(1), pp 5-26.
- Robert Huggins, H. I. (2013). Regional Competitiveness: Theories and Methodologies for Empirical Analysis. *Journal of CENTRUM Cathedra The Business and Economics Research Journal*, 6(2), 155-172.
- Robert J. Vokurka, G. L. (2000). A Comparative Analysis of national & regional quality awards.
- Roy Andersson, H. E. (2006). Similarities and differences between TQM, six sigma and lean. pp 282-296.
- Same, M. (2016). Development lean six-sigma conceptual implementation model for manufacturing organization .volume 8.
- Samuel, K. (2010). Integrated lean TQM model for global sustainability & competitiveness. volume 16.
- Shahin, A. (2010). GT & lean production a conceptual model for enhancing productivity. Volume 14.
- Sunilkumar N Chaudhari1, A. J. (2015). JIT Implements in manufacturing industry – A Review. *International Journal of Engineering Research and General Science*, 3(4).

- Talib, F. (2013). An Overview of Total Quality Management: Understanding the Fundamentals in Service Organization. *International Journal of Advanced Quality Management*, 1(1), 1-20.
- Talib, F. R. (2011 a). Total quality management and service quality: an exploratory study of management practices and barriers in service industries. *International Journal of Services and Operations Management*, 10(1), 94-118.
- Talib, F. R. (2011c). An interpretive structural modeling (ISM) approach for modeling the practices of total quality management in service sector. *International Journal of Modeling in Operations Management*, 1(3), 223-250.
- Vuppalapati, K. L. (1995). "JIT and TQM: a case for joint implementation", MCB University Press, *International Journal of Operations & Production Management*. 15(5), 84-94.
- Walder, J. (2007). Integrated Lean thinking & ergonomics utilizing material handling assist device solutions for a production work place.
- Wallberg, L. (2011). Milk production in dairy cows and goats –a case study in the Nyando district in South-Western Kenya.
- Womack, J. a. (2003). *The Machine that Changed the World*. New York.
- Workneh, H. (2010). *Analysis of Technical Efficiency of the Ethiopian Agro-Processing Industry: The Case of Biscuit and Pasta Processing Firms*. AAU School Of Economics.
- Yasin, a. (2014). *Application of lean six sigma for process improvement: the case of ethiopian paper and pulp s.c*. Addis Abab: AAiT.
- Young, B. (2001). *Waste Minimisation An Environmental Good Practice Guide for Industry*. The Environment Agency.
- AACCSA, (. A. (2017). value chain study on wheat industry in Ethiopia .
- AGP,. A. G. (2018). *Market & Agribusiness Development*. Retrieved from [ethioagp.org>wheat-3](http://ethioagp.org/wheat-3).
- NIST, N. i. (2016). Four U.S Organizations receive national highest honor for performance excellence". *department of commerce, WWW.nist.gov/news-events/news/2016/11*.

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**APPENDIX I: QUESTIONERS**

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The purpose of this question is to collect data on the factors facing the waste minimization practices in NAS food PLC. I strongly feel that this study will not be realistic without getting some information from you, so you are kindly requested to answer correctly and honestly. These questioners are prepared specifically to the employees.

I would also like to guarantee you that all responses given will be treated as strictly confidential! And used for academic purposes only. If you need further clarification, please feel free to contact through the address above.

Thank you for your kind cooperation.  
Sincerely,

Please rate below questioner to your current organization competitiveness measures, so that ensure the factors affect biscuit production measures fulfill the enlisted criteria or not 1=strong disagree 2=disagree 3=slightly agree 4=agree 5 =strong agree and please tick '√' mark in the corresponding cell.

		1	2	3	4	5
1	Do price affect the competitiveness of biscuit product					√
2	Do quality affect the competitiveness of biscuit product	√				
3	Do time affect the competitiveness of biscuit product				√	
4	Does customer satisfaction affect the competitiveness of biscuit product					√
5	Does environment affect the competitiveness of biscuit product			√		

### Waste

Please rate below questioner to your current organization awareness of waste and waste measurement system design, 1=strong disagree 2=disagree 3=slightly agree 4=agree 5 =strong agree and please tick '√' mark in the corresponding cell.

s/n	Description of performance in waste controlling	score				
		1	2	3	4	5
1	Excessive transport	√				
2	Unnecessary inventory	√				
3	Unnecessary motion				√	
4	Inappropriate processing				√	
5	Over-production		√			
6	Waiting		√			
7	Defect		√			

### Continuous improvement strategies

Please rate below questioner to your current organization regard to tools that use to minimize waste measurement system design, 1=not practice 2= unknown 3=none 4= known 5 = highly practice and please tick '√' mark in the corresponding cell.

s/n	Description of performance measures	score				
		1	2	3	4	5
1	Lean					
2	Just in time	√				
3	TQM					
4	Kaizen					
5	Work study			√		
6	Six sigma					

### Customer and market focus

Please rate below questioner to your current organization regard to customer and market focus measurement system design, 1=strong disagree 2=disagree 3=slightly agree 4=agree 5=strong agree and please tick '√' mark in the corresponding cell.

s/n	Description of performance measures	score				
		1	2	3	4	5
1	Leadership system strength				√	
2	Strategic planning performance				√	
3	Customer and market focus management.			√		
4	Information and data analysis efficiency			√		
5	Human resource focus.			√		
6	Process Management.			√		
7	Business results capability		√			



- By employee's unique knowledge: All the rest biscuit manufacturers are taking our workers from us specially operators, supervisor and even production & other managers. So I would say we are the center of excellence.
- By good company leadership: very good with evidence of less man power turn over

11. How many departments in your company? 8 (eight) departments.

12. Do you have any plan or strategy to create long term biscuit suppliers partnership?  
Or you have? Yes we do have a plan to create such kind of partnership.

13. Which operation capacity level explains your factory performance every well?

14. Your major source of wheat seed materials is from? We buy the flour from locally available flour millers.

**Thank you for your cooperation.**

APPENDIX III:

