St. Mary's University

College Of Business

School Of Graduate Studies

A RESEARCH PROJECT SUBMITTED TO ST. MARY'S UNIVERSITY SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF ART IN PROJECT MANAGEMENT.

Prepared By: Rahel Dula

Advisor: Temesgen Belayneh (PhD)

May 2024

Addis Ababa, Ethiopia

THE EFFECT OF QUALITY MANAGEMENT SYSTEM ON PRODUCTIVITY WITH REFERENCE TO PACKAGING MATERIALS, THE CASE OF HEINEKEN BREWERY SHARE COMPANY

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BY
RAHEL DULA

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Abstract

Amongst beverage industries, breweries in particular face intense competition and must constantly improve their production processes to remain competitive. One of the major determinants of competitiveness at the industrial level is rising productivity. Efficient usage of raw materials is one of the key indicators of productivity in addition to other resources like labor, capital, and energy. This study examines the effect of the packaging materials quality management system on the productivity of the Heineken Brewery. The research focuses on three independent variables: quality control, quality assurance, and supplier relationship management, and their impact on the brewery's productivity measured in terms of machine breakdown and rejection percentage of a packaging line. The study employed an explanatory research design, adopting a case study strategy. The study's population is employees with direct and indirect experience with packaging materials in three departments: packaging, quality, and procurement. The target population includes operators and technicians who work on machines fed with primary and secondary packaging materials, production team leaders, quality analysts, material specialists, and managers. the sampling method utilized non-probability purposive sampling techniques. Data collection and analysis will encompass both quantitative and qualitative analyses through surveys, observations, and interviews to examine the research problem comprehensively. The results are discussed descriptively, and linear regression analysis is performed to ascertain the relationship between the dependent and independent variables. The descriptive analysis gives a clear image of the perception of the shopfloor team on the quality management system and supplier relationship management of the brewery. The regression analysis presented a statistically substantial association between quality assurance, quality control, supplier relationship management, and productivity. The findings suggest that implementing good quality assurance, high quality control management, and also strong supplier communication management positively affects the productivity levels of packaging lines through the reduction of machine breakdowns and quality rejections because of packaging materials that don't meet the company specifications.

Keywords:- Machine breakdown, Rejection percentage, quality assurance, quality management, supplier relationship management, productivity

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CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Throughout the course of human civilization, people have utilized a range of materials to safeguard and preserve the items they have acquired. As production rates surged and consumer demands shifted with the onset of industrialization in the 18th century, packaging not only took on a more pivotal role in terms of protection and storage but also became an integral aspect of marketing. The proliferation of packaging materials and designs was influenced by factors such as the printing press, the emergence of new artistic movements, and evolving consumer habits. (Polat, B. 2022)

Bearing in mind the difference between a package (a physical unit that contains the product), packaging (the process of preparing goods for transport or delivery), and packing (the enclosure of one or more particular items in a package or a container), a distinction has to be made between various levels of packaging (Robertson, 2006). Whereas primary packages are in direct contact with the product, thus providing the primary protective barrier, secondary packages are mainly used as distribution carriers, even if used in retail outlets. Depending on the size of the transport units, tertiary or quaternary packages might help to endorse the handling of these secondary units.

Having a broad understanding of the properties of packaging material is essential in designing packaging material for specific products. The mechanical strength, gas permeability, sealing ability, and biodegradability of packaging materials determine their suitability for the intended purpose (Marsh and Bugusu, 2007). Therefore, it is necessary to evaluate the properties of the packaging material to choose the appropriate material that will maintain the safety and quality of the packaged product. Over time, food packaging products have evolved from simple preservation containers to include various aspects such as convenience, marketing issues, material reduction, safety, and the use of environmentally friendly materials (Realini, C.E, Marcos, B. 2014).

The food and beverage sector is increasingly reliant on automated flow line manufacturing systems to improve efficiency and productivity. Safety, quality, and sustainability are also key concerns in this industry. Amongst beverage industries, breweries, in particular, face intense competition and must constantly improve their production processes to remain competitive (Jeffries.M, et al. 2003).

Bottling plants are capital-intensive and require complex mass production, with multiple machines and materials involved in both the investment and production phases (Bierbooms, R. 2012).

According to Osuya Emeke great & dr. Aniekan Offiong In 2013, Packaging lines are production systems developed to meet the requirements of mankind, which tend to accomplish the demand for greater product variability and shorter life cycles these lines aim to manufacture products at production rates in the shortest time, in the most productive way, cheaply and with the quality required.

In the beverage industry, competitiveness means an ability to take the most advantageous position in a constantly changing market environment. Competitiveness is based on quality, volume of production, technical superiority, and product differentiation. In the ultimate analysis though, one of the major determinants of competitiveness, whether at national, industrial, or firm level, is raising productivity. According to Bupe.G. Mwanza and Charles Mbohwa. 2016, productivity is the efficient use of resources, labor, land, capital, materials, and energy for the production of various goods and services.

Productivity can be measured by factors such as availability, performance, quality, raw materials, and the production environment, including systems, labor, and operations (Fei He, Kang Shen, Lijing Lu, and Yifei Tong. 2018).

In Ethiopia's manufacturing industry, a few studies made on the effect of quality since it is a stumbling block for the majority of the industries. (Haben,2008; Netsanet, 2008; Mesafint, 2008; Birhan, 2008, Tessema, 2008; Dagne, 2009; Yitagesu, 2009; Amanuale,2009; Wondifraw, 2010 Asrat, 2011; Negalign, 2011)

High quality is not an added value; it is an essential basic requirement. Both Quality control and quality assurance systems together constitute the key to the quality management system. Quality control is focused on fulfilling quality requirements, it encompasses the operational techniques and activities undertaken within the quality assurance system to verify that the requirements for quality of the trial-related activities have been fulfilled. Quality assurance, on the other hand, is focused on providing confidence that quality requirements are fulfilled. It must operate independently from the operational units, and it must regularly perform quality review activities (self-inspection audits/internal audits) to ensure compliance within operational units with

Company quality standards, good working practices, current Good Manufacturing Practices, Good Laboratory Practices, and local, national, regional, and international legal, ethical, and regulatory requirements. Manghani, K. (2011)

According to studies conducted in our country's beverage industry (Getenet Entele Jote, 2020), there is a significant and positive correlation between the implementation of continuous improvement strategies on quality and overall organizational performance. These findings are in line with Jang and Lin's (2008) research, which suggests that continuous improvement can improve the quality of products and services, reduce costs, minimize defects, and increase customer satisfaction. The relationship between improvement and overall organizational performance is measured in terms of internal audits, control of non-conforming products, the practice of the Plan-Do-Check-Act (PDCA) cycle, and top management's commitment to continual improvement.

Materials play a key role in manufacturing firms as they represent the major component of manufacturing cost and profitability. The productivity of any company will be greatly affected if the management of the company does not pay special attention to material management in the company. This is because this is the lifeblood that holds the various components of manufacturing in any organization together and ensures that it will have all the necessary items needed to carry out its day-to-day activities. Successful implementation of the supplier management concept in an organization leads to a reduction in the duplication of functions and, an improvement in the quality and delivery of materials. Adamu Garba, 2020.

Discussing productivity in terms of quality based on the two quality management system approaches: quality assurance and quality control and also the kind of relationship the company builds with the suppliers to bring productivity on packaging lines is the intention behind this study. This research discusses the loss of productivity due to packaging materials on packaging line performance which is the backbone of the supply chain of the beverage industry.

1.2 Statement of the problem

97% of industrial products companies were hit particularly hard by covid 19 pandemic. The pandemic continues to offer significant challenges for supply chains globally. Even in 2022, national lockdowns slow or even temporarily stop the flow of raw materials and finished goods, disrupting the production of goods as a result. In the aftermath of severe disruption from the pandemic, most production companies plan to shake up their supply chain strategies to become more resilient and sustainable by making a shift from linear supply chains to more integrated ways of working with different suppliers, especially local ones. (Ernst & Young LLP,2022)

Starting from the end of 2021, poor packaging material quality feed on the packaging lines resulted in increased equipment downtime and product quality rejection, labor costs, rework, material replacement costs, disposal fees, and overall reduction of productivity for Heineken's brewery due to the change to multiple suppliers, local and international. the current relationship with packaging suppliers does not involve the level of collaboration necessary to identify and mitigate potential issues with new packaging materials early on. The company's quality management system is not adequate to prevent the incoming poor quality packaging materials to the brewery. Improving productivity by working through the brewery quality management system and by working on suppliers are the major gaps to be addressed.

Most studies in the international literature focus on increasing productivity by reducing production costs through mass production. In this way, they try to interpret and evaluate the competition between brewers based on technical criteria and quantitative methods and deal less with quality management issues regarding brewing companies. (Vrellas, C. G., & Tsiotras, G. 2015). Few studies concerning the examined industry focus on raw materials quality to bring productivity which is exactly what this study does.

It is important to note that a crucial aspect of packaging that requires continuous enhancement is the quality of the production process. This is because defects in the production process can lead to possible production failures, resulting in wastage of resources. (Widiaswanti, 2017). Although there is literature available that jointly determines production, quality control, and maintenance for a single-unit production system, the impact of material quality on machine performance needs specific attention to study. besides Forker's study, there has been no other significant empirical

investigation on the interplay between quality practices, quality performance, the strength of buyer-supplier relationships, and productivity which will be the output of this study.

1.3 objective

1.3.1 general objective of the study

The general objective of the study is to evaluate the Effect of a quality management system on productivity which is going to be measured in terms of performance and rejection rate regarding packaging materials.

1.3.2 Specific objectives

1. To assess the effect of a quality Assurance system in the brewery on productivity

2. To assess the effect of a quality control system of the brewery on productivity

3. To evaluate the effect of the relationship with the material suppliers on material quality delivered and packaging line productivity

1.4 Research questions

- How do you identify the packaging lines' performance loss like machine breakdowns, defective product output, and energy consumption of the machines (thermal, water, chemical) due to poor quality packaging materials?
- How is the brewery's quality assurance system in handling packaging materials?
- How is the brewery's quality control system in handling packaging materials?
- What looks like the relationship with the material suppliers? Is there a communication channel in place with the suppliers to bring quality as a continuous improvement plan?

1.5 Significance of the study

The findings of this study hold significant importance for breweries and other production-based industries that strive to reduce the costs of quality materials while maintaining high-quality standards, productivity levels, and other performance measures. The study provides a causal analysis that assists production companies in making informed decisions for the future without compromising their core values and productivity, with the aim of minimizing costs in the process. Moreover, this study serves as a reference for future management teams in the brewery industry to evaluate their performance against established benchmarks and work towards quality to bring productivity.

The suppliers can also benefit from the results of the study as it provides them with insights on how to strategize with their customers and build a work methodology that allows for regular site visits, eliminating the need for customers to enforce such visits. With the help of this study, management teams can prepare better strategies for waste management while reviewing their quality control and quality assurance systems for the future. By implementing smart and informed approaches to packaging materials, unnecessary costs resulting from rework and weekend labor can be significantly reduced. Furthermore, the study assists the quality department in Advising a sampling strategy for new material delivery, thus reducing the need for communication with the warehouse team to sort defective materials and allocate time and labor costs to dispose of or return the produced materials to the supplier.

1.6 Scope of the study

This study specifically looks into the quality of packaging materials from the packaging line machineries “meeting performance standards” point of view not marketing at the end customers aspect. The supplier relationship mentioned does not include supplier selection and any procurement contract management with them it is all about the communication and support between the company and the existing suppliers. Out of the many productivity measurement methods of a packaging line, this study measures productivity in terms of machine yield and rejection percentage starting from 2022. From all types of packaging materials, this study only discusses primary and secondary packaging materials that have been changed from the previous design, size, and supplier to minimize the cost of purchasing. the quality management system in the brewery is expressed only in terms of quality control system and quality assurance system which does not refer to the other quality management system approaches like Continuous process improvement, benchmarking, management leadership, and human resources management.

1.7 Limitations of the study

The study is limited to the Heineken brewery share company, HBSC, and the findings are only from the brewery perspective. It had been preferred to conduct the study on different types of companies to conduct cross-analysis and generate conclusive and generalized findings. The other limitation that the researcher has is the confidentiality policy related to the supplier management system due to the legal agreement between the company and the different suppliers Hence, the other limitation as in all case studies, is the generalizability of the conclusions is limited to this brewery.

1.8 definition of terms

Machine breakdown:- stoppage of the machine on the packaging line that will cause filler machine stoppage for more than 5 min

Rejection %:- number of bad production(rejected bottles) out of the total output of packaging line machines

Entrance control:- a verification procedure to determine whether a batch of packaging materials is acceptable (conforming) or not acceptable (non-conforming) through acceptance sampling in combination with supplier production data evaluation

Supplier:-; material supplier physical location where a supplier manufactures the production materials.

Audit:- any assessment in the process to approve a supplier production location for certain materials. An audit can be a traditional on-site audit, a remote audit, a paper audit, or a self-assessment

1.9 Organization of the Study

This study is organized into five chapters:

Chapter one is composed introduction, the background of the study, the problem statement, the objective clarifying the research's goals and what it aims to achieve, research questions, the significance of the study emphasizing the need for a deeper understanding of this phenomenon, the scope and limitations of the study identified, acknowledging the boundaries within which the research will be conducted.

Chapter two consists literature review relevant to the study's topic of interest. This section contains three sub-sections, the first section reviews the conceptual literature on the definition of packaging, quality management, and productivity. The second part is the theoretical literature on theories related to quality, the six big loss theories, and the theory of productivity. The last part is an empirical review of the literature findings regarding the key terminologies of the study. the researcher also develops a conceptual framework for the variables of the research.

Chapter three is about the design and methodology of the research. In this section, a description of the research area, the research design, approach, population, sampling, data collection, data analysis, validity, reliability, and ethical considerations will be defined clearly.

Chapter four will take the results and discussion. This chapter presents the results of the employed instruments including questionnaires, interviews, observation, data interpretation, and presentation of findings to address the research problem.

Chapter Five discusses about Conclusions based on researcher insights gained regarding study findings and limitations. Sets of recommendations are presented for practitioners in the field and for professionals interested in pursuing additional research to exceed the scope and findings of this study

CHAPTER TWO

LITERATURE REVIEW

2.1 conceptual literature review

2.1.1 Packaging Materials

Packaging is the name given to a material that protects the product it is in, surrounds it, facilitates its transportation, and ensures that it reaches the consumer most appropriately. In recent days, apart from this basic function, packaging, which communicates directly with the consumer by eliminating the seller, has become one of the important phenomena of the consumer society (POLAT B. Journal of History School,2022)

Packaging serves more than just a physical protection function for products; it also plays an essential role in preserving the taste and aroma of the product by guarding it against air, moisture, and other harmful gases (Risch, 2009,). For many product categories, packaging has become a crucial element of brand communication (Ambrose & Harris, 2017,). Packaging can also be strategically important for a company, as it can provide better quality presentation, reduce costs, and adapt to new distribution channels while taking into account the desires and needs of the end user (Coles v. d., 2003,). A more critical task of packaging is to attract customers' attention in the market and increase sales (Biegańska, 2018,). Packaging instills trust in the product while also providing the purchaser with valuable information such as the product's nutritional values, consumption method, content, manufacturer, production, and expiration dates (Çeken, 2018,). With industrialization and innovations, coupled with the growing global population, protecting, storing, and transporting consumer goods has become a critical concern. The increase in environmental pollution and the deterioration of the natural balance of the world have caused most conscious consumers to prefer packaging that does not harm nature and other creatures living in nature.

Azzi et al. (2012, p. 439) identify the main concepts that stand out in packaging design as comfort, portability, sustainability, security, and communication. Aside from the rapid increase in the world population, the coat of arms of production and the smooth delivery of the products produced due to the increased production to the end consumer has become a crucial process of the production and marketing process.

Beverage packaging can retard product deterioration, retain the beneficial effects of processing, extend shelf-life, and maintain or increase the quality and safety of food. Packaging protects three major classes of external influences: (a) physical protection that shields beverages from mechanical damage and includes cushioning against shock and vibration during distribution; (b) biological protection against microorganisms, insects, and other animals; and (c) chemical protection which minimizes compositional changes triggered by environmental influences, such as exposure to gases (typically oxygen), moisture (gain or loss), or light (Marsh, K.; Bugusu, B.,2007)

These days, being different and identifying new ways to differentiate has become a vital strategy for brands. With the emergence of many factors that will affect the environment such as global warming, many companies were on the hunt for new packaging designs and packaging materials. Environmentally friendly packaging products, which are mostly used for organic products, have also started to be used in many non-organic products in order to attract the attention and perception of their customers (POLAT Journal of History School (2022)

Packaging material provides several functions including protection, containment, convenience, and communication to the product (Robertson 2016). Each packaging material is different in terms of physical, chemical, and functional properties. The various properties offer different aspects as the packaging of food material is concerned. The properties of packaging material serve as a basis for the selection of material for the packing of food products. The basic material properties of packaging material that influence the quality and safety are Barrier properties, Mechanical properties, Chemical reactivity, and Migration properties. (Kim et al. 2014)

Testing the packaging materials involves determining their physical properties such as mechanical strength and permeability. It is crucial to study the chemical stability of a packaging material, particularly when it is intended for food-based applications. Additionally, determining the properties helps to predict the performance of the packaging material when it is in real environmental conditions (Arvanitoyannis and Bosnea, 2004). A series of testing methods are necessary to ensure that the packaging material possesses the required properties. The material should be tested in the same environment as the product will be used because almost all properties change as the environment around the package changes (Jayan, H., Moses, J.A., & Anandharamakrishnan, C., 2018).

Compression testing is performed on packaging materials to determine their compression strength. This strength is typically measured in order to analyze the packaging's stacking properties. When containers are stacked on top of each other, the bottom container experiences more force than the top container. Therefore, the container must be able to withstand the force during transportation, distribution, and bulk handling (Horvath et al., 2017).

Accurately measuring the thickness of packaging film is crucial to ensure that it meets certain specifications for storing specific products. The traditional method for measuring thickness is using a micrometer. However, screw gauges or vernier calipers can also be used, but they can introduce more errors. Nowadays, digital micrometers are used to provide extremely accurate measurements up to 0.001 mm. To measure the film, place it between the anvil and spindle according to ASTM F2251-13 2013 standards.

Packaging material can have imperfections or be improperly sealed, which can lead to leaks. Leaks can spoil the food inside the package by allowing unwanted gases, harmful microorganisms, or other contaminants to enter. Therefore, it is important to detect any leaks in packed food products. The heat seal strength, along with leak testing, can provide information about the integrity of the packaging material (ASTM D3580-95 2015).

Many types of food are sensitive to oxygen, and the shelf life of some foods depends on the packaging material's ability to let gas pass through it. This ability is called gas permeability, which determines if the packaging material is suitable for the job. Gas permeability depends on the gas's solubility in the polymer material and how easily the gas can pass through it. ASTM D1434 provides two methods to determine gas transmission rate (GTR), permeance, and permeability (only for homogeneous material) for polymer material (Jayan, H., Moses, J. A., & Anandharamakrishnan, C., 2018).

Researchers are currently working on developing packaging materials that can be degraded naturally due to the negative impact that synthetic polymer materials have on the environment. Biodegradable plastics are a promising alternative, as they are derived from plant- and animal-based materials or other renewable resources. It is more important to determine the extent of biodegradability of the prepared biodegradable film rather than assessing its mechanical and barrier properties (Siracusa et al. 2008). Biodegradation or composability can be indicated by

several factors such as loss of weight, carbon dioxide production, and change in tensile strength, dimensions, and chemical and physical properties (Singh and Sharma 2008).

2.1.2 productivity

Productivity is a measure of the efficiency of a company. It is calculated as the ratio of output to input. Historically, productivity was often calculated as the output ratio to the most limited or critical input, with all the other inputs held constant. In industries that require skilled labor, output per worker is considered the most appropriate measure of productivity. However, this single-factor-based measure of productivity has limitations. Firstly, in most industries or sectors, there may be several factors of production that are of almost equal importance, making it difficult to choose among them. Secondly, the relative importance of inputs may change over time. To reflect all production and costs, productivity measures should include as many outputs and inputs of the firms as possible. Output is usually measured as an aggregate of all types of production activities. The inputs are generally identified as capital, labor, energy, materials and sometimes purchased services. include as many outputs and inputs of the firms as possible in order to reflect all production and costs. (Owyong, D. T. (n.d.). *Productivity Growth: Theory and Measurement*.)

Economists may measure national productivity by comparing national outputs and national resources; managers may determine it from the ratio of firm outputs to firm resources (e.g. budget and investment); engineers may measure it in terms of output per worker, per unit of materials used or per hour of machine time. Thus, productivity rankings may vary depending on what level of outputs and inputs are being compared. (Chen, S., & Lin, N. 2020)

Productivity measurement by dividing the output by the input is incomplete if it does not consider quality elements, such as rejected or poor-quality products. Productivity improvement does not just mean the efficient production of any product or service but of products and services that are needed, demanded, and bought by discerning customers and society at large, (Ahmed Al-Dujaili 2013)

An increase in productivity usually means a higher output and production, which can lead to a reduction in production costs per unit and a decrease in the price of a commodity. This can result in increased demand for the product, higher profits and revenue for the organization, higher wages for workers, and even an increase in the demand for labor to produce more output. An increase in productivity can have a positive effect on economic growth by reducing costs per unit and

increasing the profitability of organizations. This can lead to higher dividends for shareholders, export promotion and import substitution, foreign exchange savings, and improvement in the balance of payment, as well as an increase in the country's reserve. Above all, maintaining a continuous improvement in labor productivity is essential for a nation to lead in global market competition (AuzinaEmsina, 2014)

In the production process, Productivity is closely connected to the use and availability of resources. This means in short that productivity is reduced if a company's resources are not properly used or if there is a lack of them. On the other hand, productivity is strongly linked to the creation of value. Thus, high productivity is achieved when activities and resources in the manufacturing transformation process add value to the produced products. Furthermore, the opposite of productivity is represented by waste, which must be eliminated to improve productivity. So far, the term productivity may seem rather easy to understand, however, several implications have caused much confusion. A common mistake is, for instance, to use productivity as synonymous with measures of production, which refers to the amount of a product or service produced. As a result of this confusion, people tend to believe that increased production, means increased productivity. This is not necessarily true. An important point to keep in mind is that productivity is a relative concept, which cannot be said to increase or decrease unless a comparison is made, either of variations from competitors or other standards at a certain point in time or of changes over time (Tangen n.d.)

coming to the relationship between productivity and performance, while productivity is a fairly specific concept related to the ratio between output and input, performance is a term that includes almost any objective of competition and manufacturing excellence such as cost, flexibility, speed, dependability, and quality. However, various performance objectives can have a large effect on the productivity of an operation (N. Slack, S. Chambers, R. Johnston,2001).

High-quality operations do not waste time or effort having to re-do things, nor are their internal customers inconvenienced by flawed service. Fast operations reduce the level of in-process inventory between micro-operations, as well as reducing administrative overhead. Dependable operations can be relied on to deliver exactly as planned. This eliminates wasteful disruption and allows the other micro-operations to operate efficiently.

Flexible operations adapt to changing circumstances quickly and without disrupting the rest of the operation. Flexible micro-operations can also change between tasks quickly and without wasting time and capacity.

Most researchers agree that efficiency is strongly linked to the utilization of resources, which primarily affects the input of the productivity ratio. This implies that efficiency in manufacturing can be regarded as the minimum level of resources required to operate a given system, compared to the actual number of resources utilized (D.S. Sink and T.C,1989). The efficiency ratio is quite easy to measure, regardless of whether it is based on time, money, or any other factor. However, effectiveness is a more ambiguous term and is typically quite challenging to quantify. It is often associated with creating value for the customer and impacts the output of the productivity ratio. Focusing solely on efficiency may not be an effective way to increase productivity, which unfortunately is a common practice in the industry. Nevertheless, high values of both efficiency and effectiveness in the transformation process led to high productivity (M. Jackson,2000).

The Triple P model places productivity at its core. Productivity can be defined operationally as the ratio of output quantity (i.e., the number of products produced correctly according to their specifications) to input quantity (i.e., all types of resources consumed in the transformation process). (S. Tangen, 2002).

2.1.3 Quality

There are various ways to define quality, but there is no single universal definition of it. The perception of quality differs from person to person, yet everyone understands what quality means. In a manufactured product, the customer as a user recognizes the quality of fit, finish, appearance, function, and performance. The quality of service can be rated based on the degree of satisfaction of the customer receiving the service. Some people view quality as meeting performance standards, while others view it as meeting the needs of customers or satisfying them. (Awoku, 2012). ISO defines quality as "The degree to which a set of inherent characteristics fulfills requirements." In order to meet customers' needs and regulatory requirements, it is necessary to fulfill these requirements. The difference between organizations or products is mostly determined by the product or service offered by the company.

In the context of manufacturing, the quality of a product can be best described in terms of several factors such as conformance, performance, reliability, features, durability, and serviceability (Awoku, 2012). Conformance refers to the extent to which a product meets the established standards. Performance, on the other hand, indicates how effectively the product functions. Reliability is a measure of the probability that a device will perform its intended functions under specific conditions for a certain period. It is also important for the products to have features that facilitate their efficient usage and are durable enough to withstand wear and tear. Additionally, they should be easily repairable to ensure their longevity. The concept of quality management systems has been around for many decades. In the 1930s, Walter Shewhart at Bell Laboratories inspired the use of statistics to identify "best practices" in the USA. This discovery has evolved over many years into control charts and was adopted by manufacturing industries in the US before 1950. During World War II in the 1940s, quality control charts and statistical techniques were used to monitor production processes and evaluate quality, respectively (Geoff, 2001, p. 4). In the 1950s and 1960s, W. Edwards Deming and Joseph Juran recognized the importance of pursuing perfection by applying quality principles and techniques to processes and the management of organizations. With the U.S. dominating world manufacturing, there was no practical interest in quality practices. Deming and Juran were invited to Japan to lecture on statistical quality control (Goeff, 2001). In the 1970s and 1980s, many U.S. companies lost market share to foreign competition. Foreign manufacturing companies were producing lower-priced products and better quality. As the West continued to add luxury to products in order to sell at higher prices and

increase profits, the East was busy adding quality to products in order to produce items better and cheaper (Goeff, 2001). To increase quality awareness, the ISO family standards and Malcolm Baldrige National Quality Award were established in 1987.

Total Quality Management is a system that considers the whole organization and aims to identify the reasons behind its shortcomings. According to Chitale et al (2003), it can be broken down into three parts: Total, Quality, and Management. The "total" aspect of total quality management means that it involves all activities, departments, and people within the organization, all the time. This eliminates silo thinking and encourages teamwork. Quality refers to the entirety of the shape and appearance of the goods and services provided, which validates its ability to meet the needs of customers. Juran (1989) sees quality as "fitness for use", while Manizu et al (2013) view it specifically in the context of the food and beverage industry from both user and manufacturer perspectives. From the user's point of view, quality reflects consumer preferences, and from a value-based perspective, quality is related to the price or usefulness of the product. From the manufacturer's point of view, quality is a confirmation of specifications. In the total quality management system, the management team is responsible for planning, organizing, controlling, and leading. In support of Chitale et al's (2003) view, Olcay (2014) adds that it is an organization-wide approach of continuously improving the quality of products, services, or processes by focusing on customer expectations to enhance their satisfaction and firm performance. Continuous improvement is a crucial aspect for organizations as technology and consumer preferences are constantly evolving. This means that businesses need to continuously improve their processes and proficiency.

The standards set by ISO 9000 consist of 20 quality system elements that range from evaluating management involvement to ensuring the proper use of statistical process control (Sharma 2005). ISO 9000 certification confirms that the certified company has a quality management system in place, which helps it to meet the quality standards that it has publicly announced (Elmuti and Kathawala 1997). To earn ISO 9000 certification, a company must establish procedures that ensure quality is measured, conforms to customer specifications, and that appropriate corrective actions are taken when defects occur. The most common standard for quality management systems for breweries is ISO9001:2000. This standard specifies the quality system that the brewery should implement to prove its ability to manufacture and supply products to an established specification

ISO requires top management to develop adequate skills and systems for documenting process performance and responding to process failures (Anderson et al. 1999). The ISO procedures instill a quality discipline in the certified company and reduce the cost of poor quality by identifying defects/mistakes at an early stage (Corbett et al. 2005).

There are many different approaches to quality (Walklin, 1992; Hagar, 1998), most of which are applied at the organizational level rather than that of individual modules or projects. Quality assurance is one approach, defined by (Gilbert,1992) as "the assembly of all functions and activities that bear upon the quality of a product or service so that all are treated equally, planned, controlled and implemented systematically." More specifically, a Quality Assurance system documents procedures to ensure that the overall process meets specified objectives and to demonstrate that quality is a managed outcome (Dawson and Palmer, 1995). As such it is a sub-function of the Total Quality Management system

The cost of poor quality is onset by mistakes made during the manufacturing of a product (Stanciu & Pascu, 2014). cost starts with internal or external failures, which may result in product recalls, scrapping, and expenses incurred by rework (Stanciu & Pascu, 2014; Chiarini, 2015). These costs also include litigation fees and attorney fees associated with the quality failure, and lower production rates due to the quality failure (Lu, Zhang, & Pan, 2015). it also has intangible costs such as reputation and relationship costs (Ahmad et al., 2015). Intangible costs are soft losses (Zrymiak, 2016). Poor quality costs consist of quality failures, which can affect a firm's profits due to costs associated with correcting the failure, reductions in new transactions, and reductions in repeat transactions. Business leaders should consider processes to lower bad costs occurring, so the firm's performance does not experience negative effects.

2.2 Theoretical Literature Review

2.2.1 Productivity Theory for Industrial Engineering

Usubamatov R,2017, productivity is a fundamental term in macro and microeconomics, which consider two types of productivity. In macroeconomics, the term productivity is the ratio of output to input, which can be dimensionless and represents the efficiency of the economic system according to the fundamental science. Microeconomics considers physical productivity as the number of products fabricated per observation time (ASME). The productivity theory for industrial engineering considers the design of machinery by the criterion of the physical productivity rate. This theory discovers engineering laws, regularities, and reasonable links for creating new manufacturing machines and systems. Productivity theory is based on fundamental principles of theories of technology, machine design, reliability, efficiency, optimization of machining processes and structures of automated lines, management, etc. Productivity theory for industrial engineering presents holistic mathematical models of productivity for machines and manufacturing systems and demonstrates the links between physical productivity rate, reliability, technological and technical parameters, and the structure of machines and systems with complex designs. The productivity theory is universal and can be applied to any type of industry. Nevertheless, the final criterion for the evaluation of industrial machinery remains economic efficiency, which primary and weighty component is the productivity rate of manufacturing machines and systems. The known publications that present the mathematical models for the productivity rate of machines and systems based on the partial and simple solutions that enable to derive approximate equations for productivity rate. These approaches give simplified mathematical models for the productivity rate of the manufacturing systems and results in the calculation of the approximated productivity rate can be far from the real output of machinery. Manufacturers need correct and clear mathematical models that include the main criterion for design and enable calculating with high accuracy the productivity rate of the machines and systems. This industrial demand is satisfied by the productivity theory that represents the analytical approach to the productivity rate of the manufacturing machines and systems based on parameters of technological processes, reliability of mechanisms and units with different failure rates, and management systems. The mathematical models allow for the output of manufacturing machines and systems to be modeled with results that are close to actual productivity. The accuracy of results in productivity rate depends on the accuracy of initial data of manufacturing processes only, which

are indices of technology, reliability of mechanical, electrical, electronic units and machines, and management. Any failure of such components leads to the downtime of expensive production machines and systems. Contemporary manufacturing systems with complex designs have large structural variances with serial, parallel, and mixed locations of machines and workstations arranged according to the technological process. Predicting the productivity rate of such complex and integrated production systems is a crucial problem for engineering. Productivity theory for industrial engineering enables solving problems of optimization in technological and structural solutions. This theory covers the gap between a theoretical study of productivity for industrial machines and systems and practical achievements. Practitioners and manufacturers using productivity theory will have the ability to solve optimally engineering problems of productivity for the manufacturing machines and complex systems. Conceptual principles of productivity theory for industrial machines and systems contain the following components:

1. Technological processes and balancing are the basis for structural designs of manufacturing machines and systems.

2. Mathematical models of productivity rate for a machine-to-land optimization of the multi-tooling machining process by the criterion of maximal productivity rate.

3. Mathematical models of productivity rate for manufacturing systems of serial, parallel, and mixed structures with buffers for optimal structural solutions by the criterion of maximal productivity rate.

4. Analysis of the work of industrial machines and systems in real manufacturing environments and discover the reason for productivity losses and solutions to improve the efficiency of machinery.

Productivity theory contains approaches to applying theoretical developments to engineering problems that are consistent with the philosophy of engineering progress. The purpose of productivity theory is to guide practitioners and manufacturers through the experience in the effective use of Mathematical models for solving engineering problems for manufacturing processes.

2.2.2 Six Big Loss Theory

Seiichi Nakajima, based on the experience of the practical application of maintenance best practices in Japan between 1950 and 1970 is the pioneer of Total Production Maintenance which strives to maintain optimum equipment conditions to prevent unexpected breakdowns, speed losses, and quality defects arising from process activities. According to Nakajima (1998), The generic losses that reduce the effectiveness of the equipment have been grouped and categorized as six big losses.

1. Equipment failure/breakdown losses. They may be categorized as time losses when productivity is reduced, and quantity losses caused by defective products: 2. Set-up/adjustment time losses: result from downtime and defective products that occur when production of one item ends, and the equipment is adjusted to meet the requirements of another item 3. Idling and minor stop losses: occur when the production is interrupted by a temporary malfunction or when a machine is idling. 4. Reduced speed losses refer to the difference between equipment design speed and actual operating speed 5. Reduced yield that occurs during the early stages of production from machine start-up to stabilization 6. Quality defects and rework are losses in quality caused by malfunctioning production equipment. The first two big losses are known as downtime losses and are used to help calculate a true value for the availability of a machine. The third and fourth big losses are speed losses that determine the performance efficiency of a machine, i.e. the losses that occur as a consequence of operating at less than the optimum conditions. The final two losses are losses due to defects, the larger the number of defects the lower the quality rate of parts within the factory.

2.3 Empirical literature review

2.3.1 The effect of quality management system on productivity

According to Charisis George Vrellas and George Tsiotras .2015, the Most successful companies in the beverage industry are those that manage to harmonize productivity with quality, while at the same time maintaining their market share by meeting the consumers' demands.

Heizer and Render (2004) found that quality primarily affects companies in four areas: 1) cost and market share: an improved quality can lead to increased market share and cost savings, they can also affect profitability, 2) corporate reputation: reputation company follows a quality reputation produced. Quality will appear along with the perception of the company's new product, employee management practices, and relationship with suppliers; 3) product liability: organizations have a great responsibility for all resulting from the use of goods or services, and 4) the international implications: in the age of technology, the quality is a concern of international operations.

Organizations that have implemented quality management systems gain advantages in various aspects of organizational performance. Some of the benefits are improved financial performance (Augustyn et al., 2019), established knowledge management (Honarpour et al., 2018), increased profitability (Hailu et al., 2018), improved labor productivity (Belay et al., 2014), improved open innovation (Rold et al., 2017), green innovation (Li et al., 2018), improved job satisfaction (Addis et al., 2019), etc. The total quality management system can, therefore, be seen as a way to gain a competitive advantage in the world market.TQM has been widely implemented throughout the world. Many firms have concluded that effective TQM implementation can improve their competitive abilities and provide strategic advantages in the marketplace. Several studies have shown that the adoption of TQM practices can allow firms to compete globally (Mahanti, and Antony, 2005; Hart and Horsthemke, 2007). Several researchers also reported that TQM implementation has led to improvements in quality, productivity, and competitiveness in only 20-30% of the firms that have implemented it (Yusuff, 2004). According to a survey of manufacturing firms in Georgia, the benefits of TQM are improved quality, employee participation, teamwork, working relationships, customer satisfaction, employee satisfaction, productivity, communication, profitability, and market share (Islam and Karim, 2010). A study conducted by Becker (2001) indicated that a 90% improvement rate in employee relations, operating procedures, customer satisfaction, and financial performance is achieved due to TQM implementation. However, Islam

and Karim (2010) reported a 95% failure rate for initiating TQM implementation programs; Coronado and Antony, (2002) reported that TQM implementation has uncertain or even negative effects on performance. Coronado and Antony (2002) indicated that achieving high product quality and pursuing successful TQM implementation is highly dependent on top management support. However, Al Falah, Zairi, and Ahmed, (2003) reported that there is no association between top management support for quality and the level of product quality achieved. Thus, conflicting research findings have been reported surrounding the effects of TQM implementation on overall business performance.

Duffuaa, S. O., & Khan, M. (2005), In the case of critical components, the cost of false acceptance is much higher than the cost of false rejection, because falsely accepted components may result in system failure, which may involve human losses. Therefore, it is perceived and shown that repeat inspections are likely to reduce the costs of the errors and increase the cost of inspection.

In the world of business, quality, and productivity have long been considered crucial indicators of a company's performance, particularly within the realm of manufacturing. However, these two factors have traditionally been evaluated separately. This is largely due to the fact that quality management and productivity management have often been seen as contradictory objectives (Deming, 1986; Belcher, 1987)

Deming (1986) argued that improvements in quality do create corresponding improvements in productivity by reducing costs, errors, rework, and delays. Niraj Goyal (2011) conducted a case study entitled ‘Brewing better beer with TQM’ about how a quality management system helped a brewing company reduce variation in beer bitterness levels. The results of Lean Six Sigma implementation were translated into a major cost savings of $150,000 annually.

The study conducted by (Iyer et al. in 2013) on the Indian auto component industry found that the implementation of an Effective quality management system typically takes around 7-8 years for a company. The actual deployment of the system takes place over the next 5 years through the establishment of infrastructure elements like quality check circles, cross-functional teams, and supervisory improvement teams, along with core elements like quality assurance systems, scientific methods, process management, and statistical process controls. Regarding the operational and conceptual learning outcomes of the quality management system, During the initial stages of total quality management implementation, as shop floor workers try out the new

techniques learned during the training programs on smaller projects, the resultant know-how (operational learning) from these projects helps them bring the processes under control and improve the process efficiency levels. Over some time, this newfound understanding of processes coupled with the scientific inquiries into cause-and-effect relationships as advocated by the quality management system core practices resulted in conceptual learning about various process dynamics and the impact of critical process variables on output quality. Armed with this conceptual knowledge, the quality check circles try to improve the quality assurance system by redesigning processes and modifying standard operational procedures in a bid to reduce common causes of variation, which will ultimately improve the process capability. This exercise results in the growth of a firm's technical knowledge which pushes its production frontier farther ahead.

Hauck et al. 2022 studied one of the major approaches of quality management systems, quality control, in such a way that many manufacturing processes have a point where defects are more likely to occur. To prevent this, it is common for manufacturing companies to have screening processes early on in production, in addition to quality checks at the end. By catching defects early, the remaining production steps can be completed more efficiently and at a lower cost. This saves time and money by reducing the workload and inventory of defective items at subsequent stations. There are still more choices to be made on this matter. One of them concerns how much to invest in early inspection operations. It's important to avoid excessively long inspections as it could cause a bottleneck in production and may not catch all defects. Therefore, the decision about inspection time should factor in both the costs involved and the effectiveness of the detection method. Understanding the relationship between screening decisions, related costs, and the outcome of inspection (i.e., defect detection rate) is crucial.

Another finding from Iyer et al. 2013 on the other approach of the quality management system, the quality assurance approach, there is a better understanding of process performance by shop floor workers coupled with lower work in process material levels, which helps them identify production problems such as machine failures, production defects, time-consuming machine setups, unbalanced lines, lack of coordination, etc. Once the problem becomes visible, different improvement methodologies like Plan-Do-Check-Act (PDCA) enable workers to determine the root causes of the problem and design, test, and implement a solution that ultimately reduces waste.

Conformance and non-conformance costs decline with time while quality improves with time (Ittner et al. 2001). The reduction in quality costs and improvement in product quality result in higher productivity

According to (Mandal et al. 2000) on the adoption of quality management systems by Indian manufacturing firms, many managers may not fully understand the benefits of quality management systems. Only a small percentage of firms (39%) were able to reduce customer complaints, and even fewer (23%) were able to lower manufacturing costs increasing productivity. However, the fact that many firms in the industry are pursuing quality certification suggests that best practices may have become more widely available after certification. This may have led to productivity gains driven by two different approaches: some innovative firms continued to prioritize learning and development, while others focused on executing documented processes to catch up with the leaders. Meanwhile, some firms may have followed inefficient documented processes after certification, leading to a decline in technical change. Others with efficient processes may have simply maintained the status quo, resulting in declining efficiencies compared to more innovative firms. Variance was observed in technical and relative efficiency changes across firms after certification, but no significant trends were found. The observed combined significant effect on overall productivity change shows a lower variance across all firms and suggests that firms gained due to either technical change or relative efficiency, but not both.

Egwuatu felix ikechukwu. 2010 described the wide available techniques of quality control for product or process quality Benue Breweries. Among them are statistical process control tools, acceptance sampling, fail mode, effects analysis, Six Sigma, and design of experiments. Acceptance sampling is the major statistical technique to decide whether to accept or reject a lot based on the information from the sample. The application of acceptance sampling allows industries to minimize product destruction during inspection and testing and to increase inspection quality and effectiveness. Thus, the philosophy underlying the implementation of a quality control strategy is that companies with quality control concepts see their (corporate performance and productivity) through the eyes of their customers and clients and then measure them against customer/client expectations.

2.3.2 supplier relationship for material quality

The quality of purchased materials is critical to the quality of a company's finished products. Writers such as Deming and Ishikawa- agree as to the culpability of purchasing organizations in allowing defects to happen Ishikawa argues that purchasing organizations are responsible for at least 70% of defects in purchased materials., According to Deming, buyers now have additional duties to discharge, including the cessation of the practice of granting business exclusively based on price. Louis Dekose- notes that many buyers have recognized this and are experimenting with various new approaches, such as supplier base reduction, single or limited sourcing arrangements, and tighter integration with supplier planning and scheduling systems. While the requirements outlined in a buyer's quality system standard can assist a supplier in improving its quality, the fact remains that a supplier bears full responsibility for the quality of its products and services. Hart believes that suppliers are responsible for examining their customers' production processes to understand how the supplied material is utilized and how it contributes to the end product. It's worth noting that Debruicker, Sumrnes, and Roberts emphasize the importance of suppliers being proactive in expanding their customer base as a competitive strategy, rather than simply reacting to their customers' quality improvement initiatives.

The term "co-maker ship" was first introduced by the Philips Group to describe the evolving relationship between customers and suppliers, which suggests that changes are happening in this area. To ensure conformance, it is the buyer's responsibility to provide a clear specification that outlines the exact requirements. However, simply providing a specification is not enough. The supplier should be allowed to comprehend the function of the part that they are supposed to supply and to discuss design details, particularly regarding the manufacturability of parts, before finalizing them.

communicating quality requirements clearly and accurately to suppliers is the biggest single breakthrough an organization could make in improving supplier quality performance. Some purchasing managers and quality engineers seem to think that the quality performance of their suppliers can be achieved almost by remote control and often are surprised and disappointed when they receive nonconforming items. In certain organizations, the act of receiving feedback from suppliers was discouraged. In other cases, it was either ignored or taken informally, while in some,

it was never even sought in the first place. This resulted in quality planning being largely one-sided since suppliers were not given a voice in product specification or design. After the initial vendor assessment, some purchasing organizations did not even take the trouble to follow up and ensure that their suppliers' manufacturing processes continued to meet the required level of quality conformance.

Developing a strong buyer-supplier interface involves two crucial factors: the primary responsibility of the purchasing department and the establishment of a single point of contact for handling supplier communications. The communication channels between buyers and suppliers are often unclear, leading to a disorganized flow of information. This can result in misunderstandings and leave some stakeholders uninformed. Unfortunately, the allocation of responsibilities among various departments, such as purchasing, quality assurance, and production is often ambiguous when it comes to supplier activities. For instance, a major corporation looking to initiate a supplier development program found that while procurement, design, production, and quality assurance engineers were all in touch with suppliers, no one function assumed overall accountability for supplier performance regarding price, delivery, and quality. This was a crucial discovery, for a company that had traditionally defined the role of the purchasing function as "obtaining the right parts, at the right time, at the right price." The purchasing function was not achieving this objective, and the company's organizational structure was not adequate for coping with the requirements of effective supply management. To improve supplier performance, the company had to get back to the basic

a purchaser's influence on its suppliers varies with its purchasing. the greater a buyer's purchasing power, the more effective are its suppliers' quality assurance activities but purchasing power alone is not a surefire guarantee of supplier improvement. Companies with considerable purchasing power may well improve the quality of purchased items but will not necessarily achieve lasting benefits or motivate their suppliers to internalize the benefits of cost-effective quality management to satisfy all customers. There is a tendency for some suppliers to treat powerful customers as sacred cows, leading in effect to "stratified quality control."

Cost reduction is a major element in the purchasing strategies of most customers. When they are under pressure, quality appears to assume a lower priority than price and other commercial considerations. This has a negative effect on a company's image and its credibility with suppliers

and while price is negotiable, product and service quality are not. Many suppliers do not appear to realize that total quality management can provide them with the essential organizational capacity to satisfy all their customer requirements.

In the US automotive and electronics industries, Krause et al. (2007) discovered that when a buying firm is committed to long-term relationships with its major suppliers, shares common goals and values with its suppliers, and is involved in supplier development initiatives, it is more likely to achieve competitive success.De Toni and Nassimbeni (2000) suggest that the way to eliminate inspections of incoming materials is to significantly improve the quality of the suppliers. This can be achieved by certifying suppliers on quality, providing technical assistance, and offering incentives such as long-term relationships, contracts, and commitments. Improving supplier quality leads to better quality and productivity, improved design of the parts, and lower costs (Lee & Ansari, 1985). According to Lyons et al. (1990), De Toni and Nassimbeni (2000), and Burton (1988), as suppliers are responsible for nearly 30% of quality-related issues, encouraging them to improve the quality of their products is crucial.

Successful supplier development involves a joint effort to enhance supplier capabilities in areas such as technology, quality, delivery, and cost. It fosters a culture of continuous improvement (Watts and Hahn, 1993). Burnes and Whittle (1995) identified key components of effective supplier development, including but not limited to the integration and enhancement of activities and processes, ongoing collaboration and long-term relationships, shared benefits resulting from improvement efforts, and clear structures for both companies concerning cost, price, and profit. The provision of technical assistance to suppliers can lead to improvements in quality, reliability, and delivery, according to Langfield-Smith and Greenwood (1998) and Carr and Pearson (1999). Additionally, providing technical assistance to suppliers can enhance the cost, quality, productivity, and design performance dimensions of the buying firm (Lee and Ansari, 1985). Supplier development can result in reduced costs, better communication, risk sharing, and improved problem-solving capabilities (Quayle, 2000). Cooper and Gardner (1993) discovered that supplier partnerships are linked to higher competitive performance in terms of cost, quality, innovation, and flexibility. Furthermore, partnership relations between buyers and suppliers have been shown to have a positive impact on the financial performance of the buyer firm, as demonstrated by Martine and Grbac (2003) and Johnston et al. (2004).

improved supplier relationship enhances process management, which may provide inputs about product or component simplification and standardization and the capabilities of prospective materials and parts (Forza and Filippini, 1998, Kaynak, 2003). Successful customer and supplier cooperation can create inventory reduction benefits (Naor et al., 2008).

According to the study in Egypt manufacturing industries, Suppliers can enhance and maintain quality assessment and delivery performance by prioritizing quality. The relevance of this approach to quality performance is highlighted in the SRM practices introduced in this research. Precise quality and availability of products are crucial for both the firm and suppliers. In today's business landscape, quality is an essential prerequisite for delivering superior products to consumers. Risk assessment and auditing can help evaluate suppliers' overall risk to the business. The outcome of the risk assessment can determine which suppliers pose higher risks to the business and how frequently the firm should review or audit them for gaps or risks in their business. With an increasing focus on supplier audits assessing all aspects of the supplier's capacity to consistently provide high-quality materials, it is essential to control quality through suppliers' usual audit and assessment methods to ensure products are correct the first time, without requiring extensive physical trials, repeated testing, and associated expenses. Real-time visibility, early and continuous tracking, and systematic resolution of issues ensure timely delivery and faster time-to-market. Constant supplier feedback leads to continuous improvements and frees up the firm's ability to concentrate more on innovation and drive increased market share and revenue. (Maram Roushdy, Merihan Mohamed, Sarah Hesham, Sara Elzarka, and Lobna Hafez,2015)

The companies that were visited had differing opinions on whether it was worth implementing supplier relationship management due to the potential risks. Some companies chose not to adopt certain practices, like using software to connect with suppliers, because they believed that building long-term relationships with key suppliers could create obstacles to exiting. This is because these relationships could lead to dependency, such as investing in shared IT systems, and make it difficult to switch suppliers. As a result, new players in the market may be discouraged and miss out on innovation from other suppliers. Additionally, implementing the software and training employees would require a significant investment. One of the least common practices among the companies was rewarding suppliers with incentives from the firm. This was mainly due to the high costs involved, especially if the firm had multiple suppliers, which could increase expenses.

suppliers selected based on cost only would not necessarily lead to an improvement in the buying firm's improvement in revenue condition. (Jogendra Kr. Nayak Gautam Sinha Kalyan K. Guin,2011)

According to Levi (2011), most buyers who assess their suppliers claim that the practice encourages a smaller number of defects inside the supply chain. This is a result of the fact that improved communication between the buyer and the supplier enables the latter to understand precisely what the buyer requires and that which successfully works and that does not materialize in practice so that activities can be enhanced to minimize the possibility of defects. A good evaluation of your supplier can help minimize uneconomical costs and activities, normally used by dishonest suppliers, such as extra inspections, added contents charges, overtime, security of stocks, obsolete inventory, and purchasing from several sources which cut down price leveraging.

According to (Ochieng, 2014), The buying firm, or manufacturer, may engage in supplier development as a means to improve the supplier's performance and capabilities, ultimately satisfying the manufacturer's supply requirements and specifications. Supplier development strategies involve ensuring that there is competitiveness among suppliers, assessing supplier performance, feedback communication, creating supplier certification programs, laying down the promised current and future benefits, and carrying out site visits and training programs. The buying firm is normally involved in supplier development programs to ensure that the firm attains the company's objectives. Several studies support the positive results of supplier development strategies on buyer and supplier performance improvements (Krause, 2000)

2.4 conceptual framework

Kumelachew Gebeyehu and Maru Shete,2020 The conceptual framework is the blueprint of the research work that guides the researcher to conceptually understand the research and outline and operationalize the dependent and independent variables so that the measurement, processing, analysis of the data, and interpretation of the result are easy and meaningful. through excessive literature reviews, the researcher needed to show the relationship between the independent variables and the dependent variable.

The dependent variable productivity is expressed by two KPIs packaging line performance out put. a high yield of the production line. Productivity is also expressed by rejection rate to imply a smaller number of rejections on a packaging line is a larger number of good products for delivery and less cost for waste and rework which increases productivity.

The two fundamental approaches for a quality management system are **quality assurance system** which is about demonstrating confidence in ways of preventing the quality of the product and process from becoming inadequate in the first place with the practice of checks, tests, and audits used to make sure the required standards are consistently met or exceeded. and **quality control system,** a system of controlling quality by inspecting a sample and comparing it to a specification to take corrective action. Process checks in the packaging department on critical machines are also how quality control systems are measured. The third dimension of the quality management system is **supplier handling** which is measured by the effective communication between supply chain departments and also relationship with material suppliers

Coming to the relationship between the independent variables and the dependent variable, productivity, it’s crucial to note that any changes in the quality of packaging materials can significantly impact productivity. Improving quality management systems reduces losses related to rejections and re-work, resulting in lower costs, and substantially increasing productivity.

there is a significant increase in the company's productivity as a result of efficient management of packaging materials suppliers which is practiced by inter-departmental coordination among materials-related departments, planning, procurement, production, technical, and quality (communication in the supply chain), and effective communication with the suppliers.

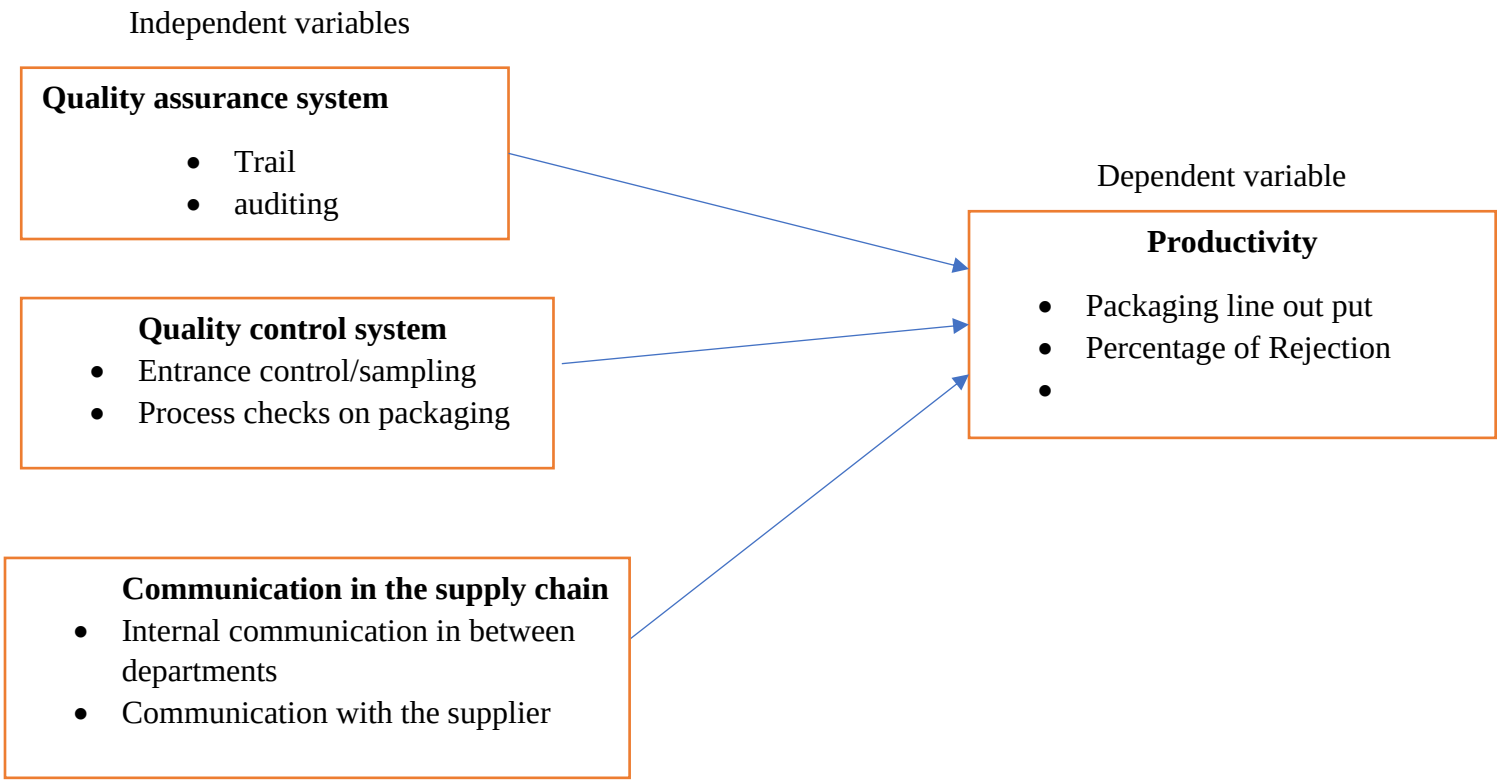


Figure 1. conceptual framework derived by the researcher

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

The selection of research methodology elements is heavily influenced by the specific research question that needs to be answered and the desired research objectives.

This section of the chapter delves into various aspects of the research. It explores the research design, approach, target population, sampling methods, and the actual sample size. Furthermore, it discusses the different sampling methods and techniques employed. Additionally, it will cover the data aspects, including data types, data sources, data collection methods, and data analysis methods.

3.1 Description of study area

The decision to conduct research at Heineken Ethiopia stems from a well-justified rationale based on the research question at hand. As a global company, Heineken is constantly striving to enhance quality, productivity, and cost management. The research aimed to identify any gaps within the supply chain systems that may lead to a decline in the productivity of packaging lines related to the quality management system of packaging materials.

The primary purpose of the supply chain function is to ensure customer satisfaction by delivering the right product, at the right price, to the right place, at the right time, and of the right quality. In this context, the term "customer" encompasses not only the end consumer but also every supplier involved in the chain. Consequently, every link in the supply chain, including planning, sourcing, production, delivery, and returns, acts as a customer to one another. Therefore, the research question takes into account the various components of the supply chain system, with a specific focus on production (packaging lines) and the quality department which is the owner of changes on packaging materials.

The study is carried out within the packaging department, quality department, and procurement department. This comprehensive analysis of the supply chain system provides a deeper understanding of areas where improvements can be made. The research outcomes will greatly benefit Heineken Ethiopia in its pursuit of enhancing quality, productivity, and cost management.

The packaging department's objective is to uphold beer quality to the greatest extent possible. By implementing well-controlled packaging processes and utilizing high-quality primary, secondary,

and tertiary packaging, the department ensures that the beer reaches consumers in optimal condition.

The quality department makes quality control checks on the packaging line on different critical control points and approves the continuity of production if it only adheres to Heineken standards. this department leads the quality assurance system of the brewery and is where the different standards and ways of working get approval. The department also works closely with the procurement team regarding packaging material suppliers by monitoring and measuring their quality and performance over time. The procurement department is majorly in charge of business agreements with suppliers and facilitation for transportation of packaging materials.

3.2 Research design and approach of the study

A research design is the specific methods and procedures employed to gather and analyze data about the variables identified in the research problem. In this particular study, an explanatory research design is utilized. Explanatory research, also known as analytical research, is a type of cross-sectional study that aims to identify causal relationships between factors or variables relevant to the research problem.

According to Suryabrata (2003), the explanatory research method involves a systematic, factual, and accurate approach to describing the study, utilizing facts, behaviors, and relationships between the phenomena under investigation.

The study uses a combination of qualitative and quantitative research approaches to get a more complete understanding of a research problem. To achieve the objective of this study, a case study research strategy is employed. A case study thoroughly explains how and why certain phenomena occur by revealing the mechanisms behind causal relationships (Wabwoba & Ikoha, 2011). A case study aims to determine the factors and relationships contributing to the behavior being studied. It offers detailed information about the specific unit of analysis. It requires gathering a substantial amount of information, thereby enabling conclusions to be based on a comprehensive and detailed dataset (Marczyk et al., 2005)

3.3 Population of the study

A population is the entire collection of a carefully defined set of people, objects, or events(Celine, 2017). The population of this study encompasses all individuals involved in the brewery packaging material input and output. The quality department's focus on quality standards ensures that packaging materials meet the requirements for production and consumer satisfaction. The packaging department's direct interaction with packaging materials on the bottling lines offers practical insights into the performance and potential issues on the line yield associated with packaging materials. The procurement department's expertise in sourcing packaging materials by creating a relationship with suppliers, The warehouse's role in storing and managing packaging materials contributes to understanding the impact of low-cost materials on storage requirements. From the packaging materials side, it consists of the primary and also secondary packaging materials used on the packaging line.

Target population:- the target population refers to a specific subset or segment within the larger population that is the primary focus of a study. This selection ensures that the study captures the perspectives of those who have firsthand experience with packaging materials and their quality impact on productivity. The wet area machine operators and technicians, the warehouse store team only related to keeping the packaging materials, and the quality team only assigned to follow packaging operations are the target individuals for this study along with team leaders and managers of the three departments. The study focuses on crown corks, labels, and glue from the packaging material side due to their impact on quality, performance, and cost on a packaging line as well as each being brought to the line from different suppliers.

3.4 sampling

The research questions, objectives, and choice of research strategy are the major factors to dictate the type of sampling method for use. This research used a Non-probability purposive sampling technique (or non-random sampling). It is often associated with case study research design because case studies tend to focus on small samples and are intended to examine a real-life phenomenon (Yin, 2003). Purposive or judgmental sampling is a strategy in which particular persons or events are selected deliberately in order to provide important information that cannot be obtained from other choices (Maxwell, 1996). It allows to take target individuals who possess the most relevant insights and knowledge like operators, technicians, team leaders, quality manager, packaging manager, and procurement representatives.

Extreme case or deviant sampling will help us to focus on special cases on the basis that the data collected about these unusual or extreme outcomes will enable the researcher to learn the most, answer the research questions, and meet the objectives most effectively. so this method is used to select the bottling lines that are highly influenced by the packaging raw materials other than the others due to the machine technology difference they have from others and also the type of brand they are assigned to produce.

There are five bottling lines with different capacities and brand production. From the failure deployment history and the number of brands they produce three of them are taken as a sample to collect data and generalize regarding the research questions

3.5 Data Collection Tools / Instruments

According to Hurrel. 2005, data is The embodied information in terms of figures or facts used to analyze for different calculations and finally gain a result to address the research study question. The case study will employ various data collection procedures and tools to gather detailed information over an extended period. This comprehensive approach will provide in-depth insights aligned with the research objectives through both qualitative and quantitative approaches (Yin, 2012). To obtain data from relevant sources, this study employed primary data collection methods for the case study. Observation (human actions, physical environments, or real-world events), and semi-structured interviews, to provide reliable, comparable qualitative data and questionnaires. The questionnaire used in this research consists of two parts. The first part is designed to collect demographic information from each respondent, while the second part contains information to assess variables. The responses are recorded on a five-point Likert scale ranging from '1=Strongly Disagree' to '5=Strongly Agree. The availability of data from different sources creates an important opportunity during case study data collection to constantly check and recheck the consistency of the findings (Duneier, 1999). In so doing, the researcher triangulated or established converging lines of evidence which will make the findings as robust as possible.

Several data quality issues can be identified with the use of semi-structured and in-depth interviews, related to bias like the interviewer and interviewee bias and also reliability but a necessary preparation is made to reduce any uncertainty on it.

The findings derived from this study using non-standardized research methods are not necessarily intended to be repeatable since they reflect reality at the time they are going to be collected, in a

situation that may be subject to change. Marshall and Rossman (1999) suggest that researchers using a qualitative, non-standardized approach need to make this clear – perhaps to transform an aspect perceived to be a weakness by some into a strength based on realistic assumptions about the ability to replicate research findings. This will shape the perception regarding data reliability.

3.6 Data analysis

Before selecting a data analysis method, the type of data that is required for the study should be determined (Kabir, 2016). The study will employ both quantitative and qualitative analyses to examine the research problem. As to Kothari (2004) data analysis includes a comparison of the outcomes of the various treatments upon the several data collection methods and the making of a decision as to the achievement of the goals of research. The analysis, irrespective of whether the data is qualitative or quantitative, may describe and summarize the data, identify relationships between dependent and independent variables, and forecast outcomes. this research will follow inductive analysis.

According to Cohen, et.al. (2007), Qualitative data analysis is the range of processes and procedures whereby we move from the qualitative data(non-numeric information) that have been collected, into some form of explanation, understanding, or interpretation of the people and situations we are investigating.

Tilahun Nigatu (MPH),(2009) lists the Points of focus in analyzing qualitative data, The primary message content, The evaluative attitude of the speaker toward the message, Whether the content of the message is meant to represent individual or group-shared ideas, The degree to which the speaker is representing actual Vs hypothetical experience.

quantitative data analysis, Weiss (1999) explained that descriptive statistical analysis focuses on the exhaustive measurement of population characteristics. It is concerned with the numerical description of a particular group observed. such as frequency, percentage, tables, and bar charts which are utilized to examine the demographic profiles of the target respondents. These measures provide a comprehensive understanding of the characteristics of the respondents whereas Central tendencies such as the mean, mode, and standard deviation (SD) will be employed to assess the variability of the collected data, allowing for an examination of the dispersion of data points around the average values for the study of independent variables and dependent variables.

Findings from observation and interview as a qualitative analysis are put along with each descriptive analysis to support the results

Multiple linear regression can be used to express the causal relationship between one dependent variable and two or more independent variables. Importantly, the independent variables could be quantitative or qualitative (O'Brien and Scott, 2012).

Data is gathered from respondents using a questionnaire, and the software tool SPSS version 27.0 is used for data analysis. The collected information is presented in tables, including averages and standard deviations.

3.7 Reliability and Validity

Before distributing a questionnaire or undertaking research, the study checked its validity and reliability. Validity measures the credibility of study results, ensuring that the research design accurately answers research questions and minimizes bias and error. Content validity evaluates whether the research survey adequately captures the concepts being studied. In this study, validity is checked by employing content validity through expert reviews. The result shows that the questionaries of the survey, interview, and the areas of observation properly align with the research objective and answer the research questions.

In this study, reliability is a measure of stability, equivalence, and internal consistency. It refers to how consistent and stable the research results are, and how well they can be replicated by other researchers. The reliability test is measured using Cronbach's alpha, and the result becomes 0.82 which shows a very good level of repetition of values that gives confidence to make decisions on the packaging materials incoming to the brewery.

3.8 Ethical Considerations

Ethical considerations are crucial in research to ensure the protection and well-being of participants and to maintain the integrity and validity of the research process. Here are some key ethical considerations for this study:

Informed Consent: This study must obtain informed consent from participants, ensuring they fully understand the purpose, procedures, risks, and benefits of the study. Participants should be given the freedom to voluntarily participate or withdraw without any negative consequences.

Privacy and Confidentiality: Researchers should respect the privacy of participants and ensure that their personal information remains confidential. Data should be anonymized or de-identified to protect participants' identities.

Beneficence and Non-maleficence: this study strived to maximize the benefits of the study while minimizing any potential harm to participants. The potential risks and benefits of the research are carefully assessed, and steps are taken to minimize any adverse effects.

CHAPTER FOUR

RESULT AND DISCUSSION

The response rate of the study is 100%, which gives a full view of what the target respondents contribute to the study. In this study, 24 operators, 6 technicians, 5 quality analysts, 6 team leaders, 3 managers, and 2 material specialists participated. 36 of them are from the packaging department, 8 from the quality department 2 from the warehouse department.

- Background information of the respondents

employees work experience in their current role and their educational background will indicate how they understand the subject matter and are capable of contributing important information for the case under study. their position in the organization also indicates their responsibility in the company to manage the quality of production.

Table 1 demographic representation of respondents

For 46 respondent		frequency	Percent
Work experience in the company	<2 years	10	22%
	2-5 years	20	43%
	>5years	16	35%
Educational background	General certificate	10	22%
	University Degree	25	54%
	Masters	11	24%
role in the company	Non-management	35	76%
	Team leader	7	15%
	manager	4	9%

From the above information, the majority of respondents (54% degree holders +24% masters) make them capable of understanding the subject matter very well. The experience those respondents have in Heineken also shows that almost 78% of them are well experienced to adapt the Heineken way of working and understand how Heineken values quality in its inputs, processes, and final products. The management team, managers, and team leaders have a lower representation than the non-management team and their experience on the subject matter might be different so

interview and observation will summarize their standpoint on the quality management and productivity of the packaging lines. Except for the managers and the material specialists, 41 respondents participated in the survey question. The former are eligible for an interview

4.1 Quality control management in the brewery

The following table summarizes the 41 respondent's views on each question regarding the quality control management of the brewery

Table 2 quality control survey questions

how satisfied are you with the quality of the packaging materials used by the brewery?	1. Very dissatisfied	2. Dissatisfied	3. Neutral	4. Satisfied	5. Very satisfied
	5 (12.2%)	28 (68.3%)	0	8 (19.5%)	0
How often do you encounter issues with the quality of packaging materials (e.g., defects, damage) in our brewery's products?	Rarely	Occasionally	sometimes	Frequently	always
	0	0	10 (24.39%)	31 (75.61%)	0
How would you rate the consistency of packaging material quality across different batches of production?	very poor	Poor	fair	good	excellent
	5 (12.2%)	20 (48.8%)	10 (24.4%)	6 (14.6%)	0
How satisfied are you with the current entrance control system for packaging materials in preventing the entry of defective or substandard materials into our brewery's production process?	Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied
	0	20 (48.78%)	15 (36.59%)	6 (14.63%)	0
To what extent do you agree that the sampling procedures accurately represent the overall quality of the products?	Strongly disagree	Dis agree	neutral	agree	Strongly agree
	0	25 (60.98%)	10 (24.39%)	6 (14.63%)	0
How important do you consider the quality of packaging materials in maintaining the packaging line performance?	Not important at all	Slightly important	Moderately important	Very important	Extremely important
	0	0	0	11 (26.83%)	30 (73.17%)

The first question to understand what is happening on the shop floor is whether the employees in the packaging hall are satisfied with the quality of packaging materials coming to the line

- The satisfaction level of the brewery team with the quality of the packaging materials used on the line is asked of the employees

No employee is very satisfied with the quality of the packaging materials used by the brewery and none of the samples shows neutrality. The rest of the ratings for The satisfaction level of the employees on the quality of packaging materials is found to be leaned to dissatisfaction as per the mean value of 2.07 which shows on average what respondents feel about the quality of packaging materials.

Both the mode and median for this question are "Dissatisfied", indicating that the most common response and the middle response fall within this category. This suggests a prevailing sentiment of dissatisfaction with the quality of packaging materials among respondents.

From the observation made on the packaging line performance data and quality rejection data machines have huge downtime and rejections due to packaging materials. The machine stops repeatedly due to the crown cork stuck on the chute, the Crown stuck at the hopper, the Crown stuck at the lower chute, and the Crown stuck inside the twist/magic tube negatively impacting the yield per 24-hr and operators are needed to remove the damaged crowns or oversized crowns or a crown stuck on the mentioned areas very frequently making them assist the machine to operate instead of doing other operational controls on the machine.

- The frequency of defects and damage observed by the employees on the line whenever a packaging material is fed to the machines is brought into question.

A mean value of 3.71 indicates on average, respondents encounter issues with the quality of packaging materials "Frequently". This reflects a notable concern about the frequency of defects or damage in the brewery's products. The data on the frequency of the defects and damage the shopfloor people observed on the packaging materials used in packaging shows a lower standard deviation, 0.46 which shows little variation in the responses or indicates high agreement among respondents. we can infer that most respondents either favor "Sometimes" or "Frequently" in encountering issues with packaging materials. This suggests a consistent perception among the

respondents, potentially indicating a recurring problem or consistent experiences with defective packaging materials.

- The employee's insight regarding the consistency of packaging material quality across different batches of production,

Most respondents favor “poor” supporting the weighted mean of 2.41 which suggests that on average, respondents perceive the consistency of packaging material quality to be slightly closer to "Poor". the standard deviation of the weighted responses is approximately 0.89 indicating a moderate level of variability in respondents' ratings. The results highlight there are inconsistencies in packaging material quality across different batches.

- The satisfaction level of the packaging shopfloor employees and the quality analysts through the Entrance control system in the brewery which prevents the entry of defective or substandard materials into the brewery's production process

The mode "Dissatisfied" shows the highest frequency. the median is "Neutral" which suggests that there is a sizable subgroup of respondents who neither strongly support nor strongly oppose the system. 2.66 mean value reflects respondents are neutral to slightly dissatisfied with the current entrance control system for packaging materials. This indicates a perceived need for improvements in preventing defective or substandard materials from entering the production process. The dissatisfaction expressed by a significant portion of respondents indicates potential areas for improvement in the current entrance control system. The mixed sentiment observed in the responses highlights the complexity of the issue and the need for further investigation by observation and interview.

Document observation is made on the standards for entrance control of different packaging materials. Though the Heineken standard for different packaging materials specification suggests raw materials specifications, converting specifications, final product specifications, storage, and handling, the standard made by Heineken Ethiopia does not contain parameters to achieve all. Raw material specifications and converting specifications are not included and the standard focuses on the final product specifications which is why the certificate of analysis from suppliers also does not focus on the raw material composition and the converting process. The repeated complaints from the packaging operators and technicians as well as the performance loss due to missed labels

on bottles or label scattering problems on the magazine of the labeler, forced the quality team to make a physical visit to the supplier and then found out the supplier use inefficient cutting operation to prepare the dimension. They were not die cutting which is more accurate than other cutting operations. This indicates raw material composition and converting process should be included in the Heineken entrance control standard.

Heineken should enforce suppliers regarding their material processing techniques in addition to the specification of raw material they used and the final product specification they produced. The particular finding regarding this process parameters is the way the suppliers are making labels. Since the supplier does not make varnishing and embossing to the required level while making the labels it becomes too difficult for the label to be penetrated with the available caustic solution strength and conductivity in the bottle washer. The major problem of the packaging lines in 2023 for four months was bottles leaving the bottle washer without being cleaned and rejected by the empty bottle inspection machine continuously which highly affects the production volume per hour. It is recommended to include the material processing methods specification on the certificate of analysis that suppliers are sending like the printing technique used, the Varnishing technique, the Cutting operation, the coating used, the Metallization operation, and metalized layer thickness (µm), Perforation density (holes/cm^2), Embossing depth (µm).

The interview question about the availability of standard operating procedures for all quality inspections done as an entrance control of packaging materials is answered yes by the quality manager except for glue inspection. But as far as the current standards are concerned it need to be updated on the standard first to include all the necessary parameters based on the packaging material standard.

- the sampling procedure accuracy to represent the quality of the whole product is also asked if employees agree on it

With Mean= 2.54, the central tendency (mean, median, mode) all indicate a prevailing sentiment of disagreement while there is some variability in opinions according to Standard Deviation: 2.02 The results align with the prevailing sentiment observed in the previous related questions where dissatisfaction was prevalent among respondents, particularly regarding aspects related to the quality of packaging materials and entrance control systems. Similarly, in this question about the

accuracy of sampling procedures in representing overall product quality, the majority of respondents expressed disagreement with the statement.

Observation is made on how sampling is done before doing the entrance control The Heineken standard specifies the sample size and Acceptable Quality Level (AQL), which determines whether a Lot is acceptable or not through acceptance sampling. However, the implementation of these standards on the shop floor is inadequate. From some of the no-acceptance procedures, it is indicated that empty shell, bend, and oval shape crown, any non-conformity resulting in 1% performance loss, or leakage due to missed or wrong liner application should be discarded. But this is not the case since more than 1% performance loss is happening on average daily Because there are too many bends and damaged crowns. The extract loss percentage due to leakage through the missed liners reflects the sampling method used is not as per the ISO standard and also the entrance control system needs improvement.

The quality manager's response to the interview question related to following standards for sampling and the availability of trained personnel with enough amount to do it is that Some packaging materials come in large quantities as a bundle and it is difficult to inspect the appropriate amount of sample. e.g. paper labels and crown cork so following strictly the ISO tables often results in large sampling quantities, which are not practical regarding the time it takes and the manpower it needs. For this reason, a minimum quantity sample size can be used for full inspection. However, this implies that the probability of accepting non-conforming lots is increasing, as is the probability of rejecting conforming lots.

- To realize the level of understanding of the respondents about the importance of packaging materials quality and their relation with maintaining high performance of machines

No respondent believes it is irrelevant to have quality packaging materials to perform well on packaging lines. With a mean of 4.73, it indicates that, on average, respondents rated the importance of packaging material quality very highly, leaning towards "Extremely important". This suggests a strong consensus among respondents that packaging material quality plays a crucial role in maintaining packaging line performance.

The grand mean provides an overall average assessment across all survey questions related to packaging materials quality control system in the brewery. With a value slightly above neutral 3.03, it indicates that overall perceptions of the employee are not to the satisfied level with current

quality and control measures, as well as the perceived consistency and effectiveness, leaning towards areas needing improvement.

4.2 Quality assurance system of the brewery

Employees perception on the quality assurance system of the brewery is assessed based on some critical questions presented below

Table 3 survey questions on quality assurance system

How much do you agree that all necessary inspection standards are available for all packaging materials to assure quality in the brewery?	Strongly disagree	Dis agree	Neutral	agree	Strongly agree
	0	7 (17.07%)	4 (9.76%)	18 (43.9%)	12 (29.27%)
How frequently are inspection standards reviewed and updated to ensure relevance and effectiveness?	Rarely	Occasionally	Sometimes	Often	Always
	4 (9.76%)	6 (14.63%)	31 (75.61%)	0	0
How much do you agree that auditing processes are in place to assess the packaging material suppliers?	Strongly disagree	Dis agree	Neutral	agree	Strongly agree
	22 (53.66%)	10 (24.39%)	5 (12.20%)	4 (9.76%)	0
How frequently are packaging material suppliers audited for quality assurance purposes?	Rarely	Occasionally	Sometimes	Often	Always
	20 (48.78%)	15 (36.59%)	6 (14.63%)	0	0
To what extent do you believe the auditing processes contribute to the quality and consistency of packaging materials in the brewery's current working situation?	Not at all	Slightly	Moderately	Significantly	Extremely
	16 (39%)	22 (53.6%)	3 (7.3%)	0	0
Do you agree the quality assurance system is well implemented in the warehouse to store the packaging material well?	Strongly disagree	Dis agree	Neutral	agree	Strongly agree
	0	10 (24.4%)	0	23 (56.1%)	8 (19.5%)

- To start with the backbone of the quality assurance system, it is asked if employees agree on the availability of standards and procedures to inspect all packaging materials

The mean score of 3.85 indicates that, on average, respondents lean towards agreement regarding the availability of inspection standards for quality assurance in the brewery. This suggests that most respondents perceive that inspection standards are indeed available. The mode and the median "agree" reinforce the notion that a significant portion of respondents perceive that most or all necessary inspection standards are available. the standard deviation, 2.1, suggests that there is some degree of dispersion or diversity in the opinions expressed. In practical terms, this means that while the majority of respondents tend to agree that inspection standards are available, there are still some who disagree or are uncertain. The spread of responses indicates that this question needs further investigation through interviews with the packaging material specialist and quality manager to explain if some packaging materials are excluded from the entrance control system.

It is stated that Heineken applies the ISO 2859 and 3951 standards for the quality assessment of incoming packaging materials but the difficulty of the nature of the material highly affects effective entrance control systems for example for glue since it is fluid. From the quality department side, there is no entrance control standard prepared for the glue because glue comes with a 25 kg barrel and the analysis does not justify the whole barrel content, so they are dependent on the trial system.

A lack of standards and procedures for trials of some packaging materials is also observed on the line. The trial is only made with a low number of buckets like 3 or 4 which is insufficient as it is only for 24 hr of production, this has to be increased for 3-4 days due to the following reasons.

- There might be differences in composition from barrel to barrel even if within the same batch, so we need to make the trial system for the batch.
- We need to consider any change over on the labels because metallic-based labels consume more glue than paper ones so the glue effect for different label types is different even with the metallic one the consumption needs to be optimized considering the environmental hazard it has.
- Glue quality depends on the machine speed so since there are different lines with different speeds on the labeler, we need to try on the high-speed machines first.

- The trial system should include the planned maintenance days on the machine to see the effect of the glue on the machine since Water resistance characteristics come with very bad cleanability of machines.

- In addition to the availability of the standards and procedures to assure quality on the packaging line, employees are asked how frequently the standards are reviewed and updated since standards that do not fit the current working scenario are not going to be considered valuable.

A mean value of 3.3 indicates that while the majority of respondents perceive that inspection standards are reviewed and updated sometimes, some perceive it to occur occasionally or rarely which means there is a range of opinions, with some variation in how frequently individuals perceive this process to occur according to the standard deviation 1.2.

To elaborate on this question, observation is made on the line on crowner machine standards where packaging material in terms of design is frequently made. there is a huge gap in updating the quality control checklists after significant changes in the raw material design. After the change from the crown thickness from 0.22mm to 0.2mm the quality control checklist is not changed. One of the major quality controls made on the crowner machine is testing the crimping quality of the machine. The previous thickness of the crown should be applied to the bottle with a diameter of 28.6 to 28.8mm; meaning the crown should not pass with the lower range and the crown should freely pass the gauge on the maximum value. But this scenario completely doesn't work for the thinner crown. For the 0.20 mm thickness, the Go No Go Control Range should be 28.5 to 28.7 mm; meaning that 28.7 mm must be freely passed, and 28.5 mm is not passed. For this to happen the height adjustment of the machine should also be changed otherwise the previous height for the thicker crown will make the new thinner crown highly pressed to the extent of cracking the bottle while capping. This quality control checklist was introduced after too many problems happened on the line like a high percentage of leakage rejection due to cracks on the bottlenecks for several months and doing the root cause analysis lately not as part of the change management system on the raw material quality control.

- The other major approach for the quality assurance system is Auditing suppliers as well as packaging line quality performances. Here employees are asked if they agree that auditing processes are in place to assess the packaging material suppliers

An average of 1.78 indicates respondents strongly lean towards disagreement or strong disagreement regarding the presence of auditing processes to assess packaging material suppliers. This suggests a prevailing sentiment among respondents that such processes are lacking or inadequate. The mode and median, strongly disagree, further underscores the prevalent perception among respondents that auditing processes for assessing packaging material suppliers are not in a visible state. The standard deviation 0.98, indicates that while the majority of respondents strongly disagree or disagree with the presence of auditing processes, there is some diversity in the strength of disagreement among respondents.

From the interview with the packaging material specialist when he once visited the supplier, The type of instrument used to measure the crown dimension used by the supplier and the company quality department is different this is a huge misalignment between supplier and customer and also without a common instrument, the supplier will not accept the gap in its products and act upon them and this indicates the company is not auditing the suppliers for the quality control system they are using for their products to much with the quality control te company use on the entrance control system to accept or reject a batch.

- The frequency of auditing is also questioned to employees to align with the previous question that emphasizes the visibility of the supplier audit.

The mean, 1.66 indicates that on average respondents lean towards "Rarely" or "Occasionally" in terms of the frequency of auditing. the standard deviation, 0.7 suggests a small degree of divergence in individual responses. By comparing the responses with the previous question, we can gain insights into respondents' perceptions of the effectiveness and frequency of auditing processes for quality assurance of packaging material suppliers. There is a consistency that would suggest a shared perception among respondents that auditing processes are lacking or insufficient both in terms of frequency and effectiveness.

This question is further brought to the quality manager and the material specialist. They are asked about the frequency of supplier visits and the standard to follow to make supplier audits. According

to the Heineken standard, Various events can trigger the initiation of an audit and audit-related supplier visits. One is insufficient quality of material deliveries, complaints, and recalls. auditing frequency is based on the supplier performance management score and also the number of major and high non-conformity batches

- To the question pointing out the extent the employees believe the auditing processes contribute to the quality and consistency of packaging materials in the brewery's current working situation

The mean score of approximately 1.68 indicates that, on average, respondents believe that the auditing processes have a low contribution, leaning towards "Slightly," to the quality and consistency of packaging materials in the brewery's current working situation. The mode and median “slightly” give a lack of confidence in auditing processes, which may correlate with the reported complaints on the packaging line caused by the supplied packaging materials.

The dissatisfaction with the effectiveness of the auditing system on packaging material suppliers by the shopfloor people is also revealed by the low standard deviation, 0.6. the employee dissatisfaction could indeed be linked to the brewery's failure to adhere to global standards, such as the Heineken global standard. Global standards often serve as benchmarks for quality assurance practices. they are developed based on best practices, industry expertise, and regulatory requirements.

From the observation made on the certificate of analysis (COA) provided by different suppliers. Almost all suppliers use their own standard not Heineken's standard on the COA, certificate of analysis, which could have been corrected if proper auditing as per the Heineken standard had been made because even though the quality analyst compares every parameter from Heineken's standard point of view for the entrance control, Heineken should enforce the mandatory parameters to be included on the COA as per the Heineken standard to make the entrance control less time taking.

Global standards provide a consistent framework for auditing so Without such standards, there may be inconsistencies, gaps, or inefficiencies in the auditing process, leading to dissatisfaction by the operators and technicians working with machines that struggle to perform well due to the poor packaging materials being fed to them. Adhering to global standards can also confer a

competitive advantage by signaling to customers and suppliers(partners) that the brewery is committed to quality and compliance.

- The level of agreement about the implementation of the quality assurance system in the warehouse and transportation department to store the packaging material well is also asked.

According to the mean 3.9, mode and median “agree” a significant portion of respondents leans towards "Agree" and "Strongly Agree" options, indicating a notable level of confidence in the effectiveness of the quality assurance system implemented in the warehouse for storing packaging materials. The standard deviation, 0.56 indicates a relatively low variability in responses around the mean. however, there is also a notable portion of respondents who express disagreement with the effectiveness of the system. though this sentiment is not dominant, it highlights potential areas for improvement in the quality management process within the brewery, particularly in addressing the concerns of those who disagree with the current system's effectiveness.

The interview with the quality manager also indicates there are areas of improvement in how packaging materials are being handled through transportation as well as warehousing. One source for deformed and damaged packaging materials is not the material supplier rather it is a transportation issue. Driving during the rainy season causes water to enter the container and make the packaging materials rust by the time they are delivered to the brewery. This makes the unacceptable packaging material to be fed to bottling lines which is the fault of the brewery procurement team, not the supplier. The loading and unloading on the port is also one of the major issues raised by the material suppliers as a defense for the complaint regarding damaged packaging materials here it is crucial to align with the procurement team the end-to-end process of material ordering and receiving. Training drivers on how to make quality control on the port and how to deliver it to the brewery.

The Grand Mean, 2.52 indicates an overall average assessment across all survey questions related to inspection standards, auditing processes, and quality assurance in the brewery. It reflects a slightly “dissatisfied” perception overall, suggesting there may be room for improvement in the areas of inspection standards availability, frequency of audits, and perceived effectiveness of auditing processes.

4.3 Supplier Relationship Management

The following table summarizes the survey questions that indicate how supplier relation ship management is perceived by the employees in the packaging, quality, and warehouse department

Table 4 survey questions about the relationship between the brewery and its suppliers

How responsive are packaging material suppliers to corrective actions or recommendations identified as quality issues raised by the brewery team?	Very unresponsive	Unresponsive	Neutral	Responsive	Very responsive
	5 (12.2%)	23 (56.1%)	5 (12.2%)	8 (19.51%)	0
To what extent do you feel our suppliers understand the specific needs and requirements of our brewery team?	Not Understanding at All	Slightly Understanding	Neutral	Understanding	Completely Understanding
	0	28 (68.3%)	5 (12.2%)	8 (19.5%)	0
Please rate the quality of communication with the brewery packaging material suppliers:	Very Poor	Poor	Neutral	Good	Excellent
	0	23 (56.1%)	10 (24.4%)	8 (19.5%)	0
How satisfied are you with the level of flexibility and adaptability our suppliers demonstrate in meeting changing demands or requests?	Very dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied
	0	23 (46%)	9 (18%)	9 (18%)	0

- For the question that asks about the responsiveness of packaging material suppliers to corrective actions or recommendations identified as quality issues raised by the brewery team,

on average, respondents perceive packaging material suppliers as leaning towards being unresponsive according to the mean, 2.3. The median and the mode, “unresponsive” reinforce the perception that the majority of respondents view suppliers as unresponsive as well. This aligns with the previous discussion about the gap indicated by supplier auditing as one of the quality assurance systems for the brewery but the response from the quality manager during an interview

about how the communication between the company and the supplier is going also gives insight into the challenges in achieving supplier responsiveness despite the auditing efforts.

1. Communication breakdown: The lack of effective communication channels between the brewery and the suppliers. Poor communication can lead to misunderstandings, delays in response, or even missed communication about corrective actions or recommendations.

2. Resource constraints: Suppliers have limited resources, such as manpower or technology, to promptly address corrective actions or quality issues raised by the brewery team specifically during the sorting of a batch after it is announced non-conforming. This resulted in delayed responses or inadequate resolution of issues.

3. Quality control challenges: Suppliers have faced internal challenges in maintaining quality standards or resolving quality issues due to gaps within their own production processes or supply chains. These challenges could hinder their ability to respond effectively to the brewery's concerns.

4. Contractual agreements: The terms of the contract between the brewery and the suppliers do not sufficiently incentivize or mandate timely responsiveness to corrective actions or quality issues. Suppliers feel less compelled to act promptly if contractual obligations are vague or lenient.

6. Organizational culture: The organizational culture of the suppliers prioritizes efficiency or cost-cutting over responsiveness to customer concerns which led to a lack of urgency in addressing brewery-related issues.

The next several questionaries about the brewery-supplier relationship support these points to understand where the supplier is standing in terms of doing business with such a huge company Heineken Ethiopia.

- When discussing understanding the needs and expectations of Heineken Brewery from the supplier side since the level of responsiveness relates to their level of understanding the brewery's priority in this particular case, is quality,

statistics reveal that the majority of respondents feel that suppliers only slightly understand the specific needs and requirements of the brewery team. The mode and median fall under “slightly understanding” while the mean is 2.3 leaning towards slightly understanding as well. This

suggests a significant communication gap or lack of alignment between the brewery team and suppliers. The standard deviation of approximately 0.62 indicates a moderate spread of responses around the mean, reflecting little variability in respondents' perceptions. The survey results highlight potential challenges in supplier collaboration and alignment with the brewery team's objectives.

The observation made on the packaging line clearly supports the idea that the brewery quality and production team fails to explain the need and expectations to the supplier properly and challenge them whenever there comes a problem immediately with the figure of key performance indicators the line missed to achieve like the extract loss and performance versus the target. Based on the observation of contract agreements between Heineken and suppliers, The supplier must ensure the final product inspection that each Lot is conforming to the Heineken Standard based on ISO 2859 and 3951 but lack of doing audits of the supplier whether they are performing it or not results in the low understanding of what Heineken demands from the suppliers.

This question is supported by the interview with procurement and quality managers about knowledge share between the brewery quality team and the supplier including a reward and recognition system available to make them align with Heineken's expectations. Unfortunately, no reward and recognition system is prepared to encourage those working effectively, and also the knowledge share program is mostly reactive after noticing repeated quality complaints from the shop floor and non-conforming materials encountered on entrance control instead of a planned and systematic approach to share quality assurance and quality control best practices.

- Coming to the employee's perception regarding the quality of communication the brewery have with the suppliers

While few respondents may find the communication good, there is a consistent perception of poor communication among respondents, according to the mean, 2.6, median, and mode, “poor” with limited variation in their assessments, as the standard deviation of 0.6 confirms.

From the discussion with the packaging technologist, the difficulty for not challenging the packaging material suppliers based on the performance loss is that the performance loss of packaging machinery due to packaging materials is not brought from the packaging team daily with performance loss percentage and batch number of material fed on that day. There is no

consistency in using the complaint format used in Heineken Global to make a documented history. all the downtime registered on the daily performance logbook seems the machine's fault, not the material induced to it so it needs an alignment on how to investigate issues related to packaging materials on a machine with the machine operators and technicians. Immediate communications help the company to stop Further supplies of the relevant Lot from the supplier to Heineken.

The brewery may need to evaluate its communication strategies, identify areas for improvement, and implement measures to enhance collaboration and understanding with its packaging suppliers. This could include clearer communication channels, more transparent feedback mechanisms, and proactive efforts to address any concerns or issues raised by both parties.

- Regarding the general perception of the employees on suppliers being flexible and adaptable to the brewery's change in demand

overall, respondents perceive the suppliers' flexibility and adaptability to be inadequate. This dissatisfaction is reflected in the lower mean rating, 2.6. The survey suggests that suppliers may struggle to adapt to changing demands or requests from the brewery. This inflexibility can pose challenges in responding promptly to market dynamics, customer preferences, or unforeseen disruptions leading to operational inefficiencies, compromised product quality, missed opportunities, and ultimately, a negative impact on customer satisfaction and loyalty. The survey responses underscore the importance of ongoing monitoring and follow-up to ensure that suppliers continuously strive to understand and meet the brewery team's evolving needs and requirements. Regular communication channels and feedback mechanisms can help address any discrepancies and foster a more collaborative supplier relationship.

According to the observation made on the packaging line, there are different suppliers for certain packaging materials, and not all will send with a similar range of specifications some of them might produce these materials on the lower side of the required range of parameters whereas others might produce them on the higher side of the range of the specification Seeing the average crown height from different suppliers, one is delivering crowns within range but to the lowest side of the specification range and whenever this crown is used it needs its adjustment on the machine in order to prevent crowns from overlapping one another while moving downward on the machine crown chute In a similar manner, the higher value from the range of crown specification needs its own adjustment which indicates the need to select one crown for a single production line instead of

using all because the crowner machine has no handling parts to accommodate change over on the material. the supplier's physical visit to the brewery is not followed by the report request the supplier should prepare about what he/she observed and the cause for any abnormalities listed with the possible countermeasure. Usually, the supplier comes to the brewery to look visually then they will do what they assume for the solution of the problem. This is highly not a systematic approach to handling suppliers. That is why the traceability of problems and their solution falls under different employees who were part of the production or part of the quality approval system.

- **The Grand Mean 2.55** indicates an overall assessment across all survey questions related to supplier responsiveness, understanding of brewery needs, communication quality, and flexibility/adaptability. It suggests a slightly "unsatisfied" perception overall, with some aspects of supplier relationships showing areas for potential improvement in responsiveness, understanding, and communication.

Relationship in the supply chain regarding packaging materials quality

From the interview made with the packaging manager and the quality personnel about how the brewery packaging team is handling quality control issues and how the continuous improvement plan in quality is going? Their response shows a low focus given to the continuous improvement plan and most actions are reactive rather than proactive. The culture on the shop floor is more of giving temporary solutions or indirect solutions for the quality problem and not documenting everything to make a detailed root cause analysis which could've led to improving the quality control system in the brewery

Complains on the packaging line from packaging line team leaders are major goes to the technical team regarding the machine's basic condition but after several attempts of problem-solving and no visible change is noticed, it should have been seen differently from the packaging material aspect instead of letting it goes to the machine supplier. There were so many situations where the machine supplier came physically to the brewery and tried to eradicate the problem even though they could not. the production and quality departments were too reluctant not to challenge the material suppliers due to three major reasons

- they already accepted the material without proper entrance control and trial system so they don’t have enough reason to challenge the material supplier after all these times
- they failed to communicate with the technical department before making any trial and get feedback about the machine constraints, the kind of machine component to be affected by the new material usage and the type of operational or maintenance standard change to be applied after using it
- some production and quality managers failed to say NO to the planning team or the supply chain management team since the cost minimization approach is not from the bottom up but vice versa so they tend to accept working with low-cost materials risking the production effectiveness and quality standards

for machines with different packaging materials processing systems, quality problems are concluded on one material supplier without justified root cause analysis that is why continuous improvement in quality control and quality assurance is not happening to challenge back the standards being used on entrance control, the methods to execute them and finally the skilled manpower to implement packaging inspections perfectly.

Observation of the primary data on 2023 a packaging line empty bottle inspection machine rejection percentage for 6 months shows the countermeasures used to reduce the rejection because of uncleaned bottles after bottle washer are totally wrong and they were corrective, not preventive actions. Creating a suitable moment for the suppliers to challenge each other only happened after several hectic months with a loss in performance and loss in terms of rework and rejection. The cause for the label carryover at washer discharge was quickly judged to the chemical dosage amount and the bottle washer's basic condition. even if the former was correct but after all these adjustments, there were still labeled bottles continuously rejected on different lines and after wasting too much time and performance capacity it came to the hand of the label supplier since they didn’t use appropriate varnishing on the surface of the label to make it easy for washing. This clearly shows the need to bring different packaging raw material suppliers to the table and challenge each other as part of investigations into the quality problem instead of fully blaming the machine's condition.

4.4 Productivity of Packaging Lines

Employee's views towards productivity are also assessed to see what they perceive about this issue

Table 5 survey questions about productivity

How often do equipment breakdowns or malfunctions occur because of packaging materials defects on the packaging line?	Never	Rarely	Sometimes	Often	Very often
	0	4 9.76%	8 19.51%	12 29.27%	17 41.46%
How often do packaging material issues affect the packaging line's rejection percentage?	0	0	4 9.76%	8 (19.51%)	29 (70.73%)
To what extent do you think improved communication with suppliers can enhance productivity on the packaging line?	Not at all	Slightly	Moderately	Significantly	Extremely
	0	4 (9.76%)	6 (14.63%)	15 (36.59%)	16 (39.02%)
To what extent do you think a robust quality assurance system reduces downtime and increases productivity?	0	0	4 (9.76%)	15 (36.59%)	22 (53.66%)
To what extent do you believe continuous improvement initiatives within the quality control system enhance productivity by preventing defects, rework, and waste	0	0	7 (17.07%)	22 (53.66%)	12 (29.27%)

- Regarding the frequency of equipment breakdowns due to packaging materials,

Having Mean: 4.02 (Often), Median: 4 (Often), Mode: 5 (Very Often), Standard Deviation: 0.98. The majority of respondents indicated a high frequency of equipment breakdowns or malfunctions due to packaging material defects on the packaging line. Specifically, 41.46% reported these issues occurring "Very Often," and 29.27% reported them happening "Often." This suggests a significant operational challenge where packaging materials contribute to frequent disruptions in production. The mean, median, and mode all indicate that respondents perceive these issues as predominantly occurring either "Often" or "Very Often," reinforcing the consistency of this perception across the

surveyed group. Standard Deviation: The relatively low standard deviation (0.988) suggests that responses were clustered around the mean, indicating a general agreement among respondents regarding the frequency of equipment issues related to packaging materials.

These findings underscore the critical importance of addressing packaging material quality and its impact on operational efficiency. Businesses may benefit from enhancing quality control measures for packaging materials and improving maintenance protocols to minimize disruptions and optimize productivity on the packaging line. Addressing these concerns could lead to smoother operations and improved overall productivity in the brewery's packaging processes

- The question that requires the agreement to the frequency of material issues resulting in a high packaging line rejection rate

With a mean of 4.61, it suggests that, on average, respondents strongly agree or agree that extract loss is influenced by poor packaging materials usage. The standard deviation of the weighted responses, considering a distribution favoring "Strongly Agree", "Agree", and "Neutral", is approximately 1.380. The high mean coupled with the low standard deviation signifies a robust agreement among respondents regarding the impact of poor packaging materials on extract loss. Overall, in this scenario, the mean, median, and mode collectively provide a clear picture of respondents' perceptions regarding the importance of packaging material quality.

- The employee's perception regarding the relationship between productivity and supplier relationship looks like

Mean (4.05): The average response leans towards "Strongly," indicating a predominant belief in significant productivity gains through improved communication. Median (4): The middle response (median) is also "Strongly," confirming that a typical respondent holds a strong positive view. Mode (5 - Very Strongly: reinforcing that a large number of respondents strongly believe in the positive impact of improved communication. Standard Deviation (0.96): The moderate standard deviation suggests some variability in responses due to A significant portion of respondents viewed improved communication as moderately enhancing productivity. While not as strong as the majority view, this indicates that some respondents recognize a positive impact, albeit to a lesser degree. A smaller group felt that improved communication slightly enhances productivity. This suggests that a few respondents perceive only a minor positive effect from improved communication with suppliers.

- Regarding the correlation between quality assurance and productivity

The mean response of 4.44 shows a strong tendency towards significant to extreme enhancement, suggesting overall very positive perceptions of the quality assurance system's impact on productivity. The median value of 5 confirms that the central tendency of responses leans towards an extremely positive impact, aligning with the mean. The mode being 5 indicates that the most common response is that the quality assurance system extremely enhances productivity, reinforcing the dominant opinion among respondents. Overall, the data reflects a strong belief that a robust quality assurance system reduces downtime and increases productivity, with a substantial portion of respondents viewing the impact as extremely positive.

- Relationship between continuous improvement in quality control and productivity

Most respondents believe that continuous improvement initiatives within the quality control system significantly enhance productivity by preventing defects, rework, and waste. A notable portion feels these initiatives extremely enhance productivity, while a smaller group sees them as moderately enhancing productivity. The mean response of 4.12 indicates a strong consensus towards significant enhancement, and the relatively low standard deviation of 0.67 shows that the responses are closely clustered around this view. This suggests that there is a general agreement among respondents on the positive impact of continuous improvement initiatives on productivity.

- **The Grand Mean of 4.25** indicates an overall assessment across all survey questions related to productivity and the employee's perception to wards the link between productivity and its relation with quality control, quality assurance, and supplier relationships to be “significantly” noticeable It highlights areas where improvements can enhance productivity, such as reducing equipment breakdowns due to packaging materials, minimizing rejection rates due to poor packaging material usage, and strengthening communication with suppliers.

4.5 Multiple Linear regression analysis

Regression analysis, a mathematical tool that helps to predict the values of a dependent variable based on one or more independent variables, is performed using SPSS V27 to see how each independent variables affect the dependent variable, productivity

$Y = \beta_0 + \beta_1 X1 + \beta_2 X2 + \beta_3 X3 + \varepsilon$ Where Y is the dependent variable productivity;

β0, β1, β2, and β3 are parameters to be estimated or regression line coefficients or slops;

X1 and X2 are X3 are independent variables (quality assurance system of the brewery, quality control, and supplier relationship

the following assumptions are made before doing the regression analysis

Linearity: The relationship between the independent variables (quality control, quality assurance, supplier relationship) and the dependent variable (productivity) should be approximately linear. This assumption can be checked using scatter plots of each independent variable against the dependent variable.

Independence of Errors: The errors (residuals) should be independent. This assumption can be assessed through the Durbin-Watson test (Durbin-Watson value > 2) or by examining residual plots.

Homoscedasticity (Constant Variance of Errors): The variance of the errors should be constant across all levels of the independent variables. This can be checked using residual plots or statistical tests like the Breusch-Pagan test. a low p-value < 0.05 indicates evidence of heteroscedasticity

Normality of Errors: The errors should be normally distributed. This can be evaluated using a normal probability plot of residuals or statistical tests such as the Shapiro-Wilk test.

No Multicollinearity: The independent variables should not be highly correlated with each other. This can be assessed using correlation matrices or variance inflation factors (VIF).

The regression analysis is made for two lines which are highly exposed for different types of packaging materials with brands and suppliers than the others due to their annual production plan. The dependent variable, productivity is expressed in terms of the production percentage of the machines for the first regression analysis and then as bottle rejection percentage of the line for the second. the data is taken from the weekly average data observation for 100 weeks.

The three independent variables are categorized as below. The three levels are considered as predictors of the independent variable

- Quality Control: Low, Medium, High
- Quality Assurance: Poor, Fair, Good
- Supplier Relationship Management: Weak, Moderate, Strong

Since there are three qualitative categories for each variable, two dummy variables are created for each to avoid multicollinearity, where one dummy variable can be perfectly predicted from the others. For all independent variables, the lowest value is coded as 0. It is the reference category, so it does not appear in the one-hot encoded variables.

Table 6 dummy variables coding

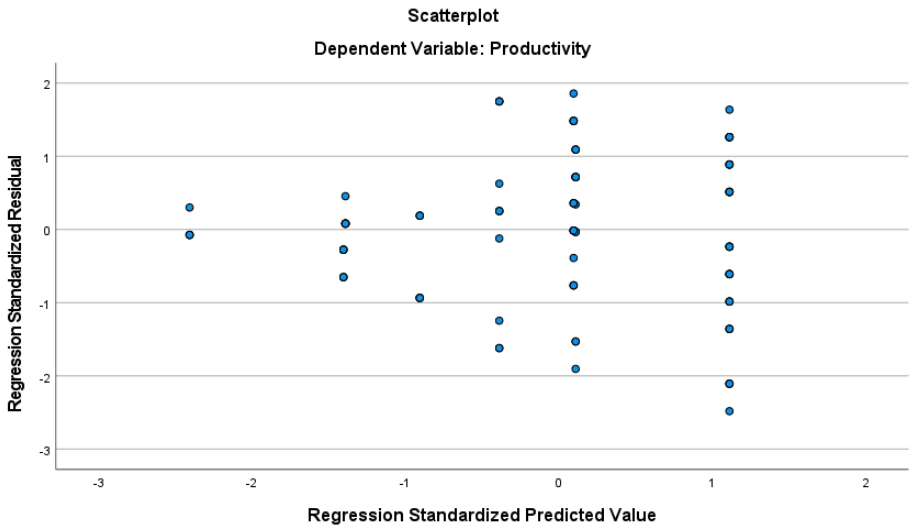
Original Data	**Encoded Data**
QC=Low, QA=Poor, SRM=Weak	QC_Medium=0, QC_High=0, QA_Fair=0, QA_Good=0, SRM_Moderate=0, SRM_Strong=0
QC=Medium, QA=Fair, SRM=Moderate	QC_Medium=1, QC_High=0, QA_Fair=1, QA_Good=0, SRM_Moderate=1, SRM_Strong=0
QC=High, QA=Good, SRM=Strong	QC_Medium=0, QC_High=1, QA_Fair=0, QA_Good=1, SRM_Moderate=0, SRM_Strong=1

4.5.1 Multiple linear Regression for productivity in terms of production performance %

Assumption test

The residuals vs. fitted (predicted) values plot is used to check the assumption of homoscedasticity (constant variance of residuals) and linearity (random scatter around zero line).

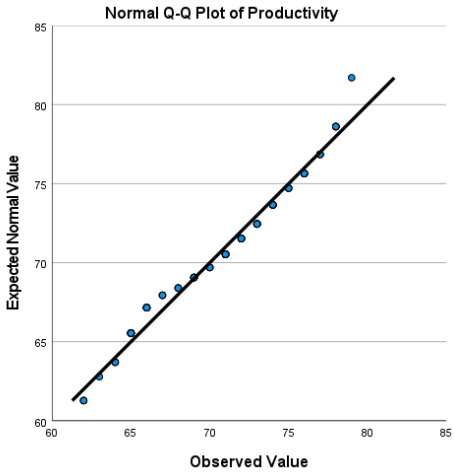
Figure 2 standardized residuals versus the standardized predicted values 1



From the plot above, the residuals appear to be randomly scattered around the horizontal line at 0, suggesting homoscedasticity and linearity assumptions are satisfied.

- The Q-Q (quantile-quantile) plot is used to check the normality of the residuals.

Figure 3 Q-Q plot of regression analysis 1



- From the Q-Q plot above, the residuals lie approximately along a straight line, indicating that the residuals are approximately normally distributed.

The SPSS data summary is presented below,

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.802[a]	.644	.633	2.67039	.644	57.796	3	96	.000	2.354

a. Predictors: (Constant), SR_mean, QC_mean, QA_Mean

b. Dependent Variable: Productivity

Table 7 Regression Model Summary 1

The model Summary indicates a strong and statistically significant relationship between the predictors (SR_mean, QC_mean, QA_Mean) and the dependent variable (Productivity). according to R^2 value, The model explains a substantial portion (about 64.4%) of the variance in Productivity, with all predictors contributing significantly to the model's predictive power. Durbin-Watson = 2.354: A value close to 2 suggests no significant autocorrelation in the residuals. The low value of the Standard Error of the Estimate suggests that the model's predictions are relatively precise.

Table 8 Anova table 1

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1236.427	3	412.142	57.796	.000[b]
	Residual	684.573	96	7.131		
	Total	1921.000	99			

Table 9 coefficients table for regression analysis 1

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	62.195	.705		88.234	.000		
	QA_Mean	7.084	1.138	.580	6.224	.000	.995	1.005
	QC_mean	10.602	1.181	.749	8.974	.000	.993	1.007
	SR_mean	4.178	1.129	.388	3.700	.000	.997	1.003

The coefficients table indicates that all predictors (QA_Mean, QC_mean, SR_mean) have significant positive effects on the dependent variable (Productivity). QC_mean shows the strongest effect, followed by QA_Mean and SR_mean. The low values of Tolerance and VIF close to 1 suggest no significant multicollinearity issues among the predictors, enhancing the reliability of the regression model's coefficients.

The regression analysis becomes,

$Productivity = 62.195 + 7.084 \cdot Q_A\_Mean + 10.602 \cdot Q_C\_Mean + 4.178 S_R\_Mean + \epsilon$

- Intercept (Constant) = 62.19): This is the expected performance when all predictor variables (QC_Mean, QA_Mean, and SR_Mean) are zero.
- QA_Mean: For every unit increase in QA_Mean, productivity is predicted to increase by 7.084 units, assuming QC_Mean and SR_Mean remain constant.
- QC_Mean: For every unit increase in QC_Mean, productivity is predicted to increase by 10.602 units, assuming QA_Mean and SR_Mean remain constant.
- SR_Mean: For every unit increase in SR_Mean, productivity is predicted to increase by 4.178 units, assuming QA_Mean and QC_Mean remain constant.

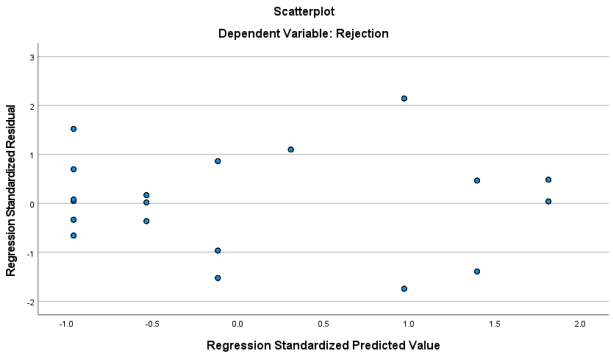
These findings support the conclusion that improving quality control (QC_mean), quality assurance (QA_Mean), and supplier relationship management (SR_mean) are all positively associated with increased productivity which is indicated as production output.

4.5.2 Multiple linear regression for productivity in terms of packaging line rejection %

Assumption test

The scatter plot of standardized residuals versus standardized predicted values indicates that the residuals are randomly distributed with no clear patterns, suggesting that the assumptions of linear regression (linearity, independence, homoscedasticity, and normality of residuals) are reasonably met.

Figure 4 standardized residuals versus the standardized predicted values 2



The Normal Q-Q plot indicates that the rejection values are approximately normally distributed, with most data points lying close to the straight line. Minor deviations at the tails suggest slight departures from normality, but overall, the data appears to meet the assumption of normality reasonably well

Figure 5 Q-Q plot of regression analysis 2

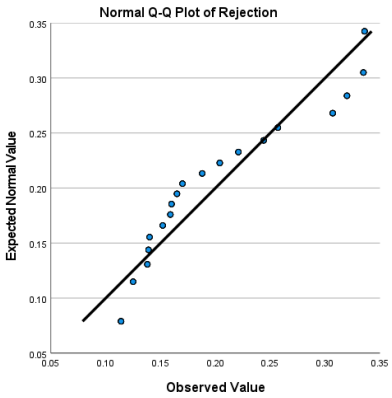


Table 10 regression Model summary 2

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.891[a]	.795	.788	.03392	.795	123.887	3	96	.000	2.774

This Model Summary indicates a highly significant and strong relationship between the predictors (SR_mean, QC_mean, QA_Mean) and the dependent variable (likely Productivity). The R^2 value explains a substantial portion (approximately 79.5%) of the variance in the dependent variable, with a very low standard error of the estimate indicating precise predictions. The F Change statistic reinforces the model's significance. The Durbin-Watson statistic suggests no significant autocorrelation issues in the residuals, further validating the model's reliability.

Table 11 Anova table 2

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.428	3	.143	123.887	.000[b]
	Residual	.110	96	.001		
	Total	.538	99			

Table 12 coefficient table for regression model 2

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.347	.010		34.854	.000		
	QC_Mean	-.254	.015	-.793	-17.092	.000	.994	1.006
	QA_Mean	-.111	.015	-.346	-7.332	.000	.960	1.041
	SR_Mean	-.056	.015	-.175	-3.705	.000	.960	1.041

All predictor variables (QC_Mean, QA_Mean, and SR_Mean) have p-values less than 0.05, indicating they all significantly impact the dependent variable (rejection percentage)The tolerance values are close to 1, and the VIF values are close to 1, indicating no multicollinearity issues. This means the independent variables are not highly correlated with each other and do not inflate the variances of the estimated coefficients.

The regression equation becomes:-

Rejection Percentage=0.347−0.254×Q_C_Mean−0.111×Q_A_Mean−0.056×S_R_Mean

The interpretation will look like,

- Intercept (Constant) = 0.347: This is the expected rejection percentage when all predictor variables (QC_Mean, QA_Mean, and SR_Mean) are zero.

- QC_Mean (Coefficient = -0.254)**:** For each unit increase in QC_Mean, the rejection percentage is expected to decrease by 0.254 units, assuming QA_Mean and SR_Mean remain constant.

- QA_Mean (Coefficient = -0.111)**:** For each unit increase in QA_Mean, the rejection percentage is expected to decrease by 0.111 units, assuming QC_Mean and SR_Mean remain constant.

- SR_Mean (Coefficient = -0.056)**:** For each unit increase in SR_Mean, the rejection percentage is expected to decrease by 0.056 units, assuming QC_Mean and QA_Mean remain constant
- The negative coefficient indicates that higher values of these variables correspond to better operational outcomes—specifically, lower rejection percentages—which ultimately signify higher productivity(more good products) in brewery packaging lines.

This relationship aligns intending to optimize processes to enhance productivity through quality control, quality assurance, and supplier relationship management to reduce waste and rework by reducing the rejection percentage on a packaging line

Regression Results vs Literature Review Outputs:-

The results for the above two regression analysis models highly align with what other researchers on quality control and productivity found out like Islam and Karim, 2010, Hauck et al. 2022, Egwuatu felix ikechukwu. 2010, Becker 2001.

It also aligns with what other researchers concluded on quality assurance and productivity Islam and Karim, 2010, Hauck et al. 2022, Egwuatu felix ikechukwu. 2010, Becker 2001,

The regression analysis is also supportive of other researcher's beliefs on the relationship between supplier relationship and productivity like Krause et al. (2007), De Toni and Nassimbeni (2000), (Quayle, 2000), Martine and Grbac (2003) and Johnston et al. (2004).

In general, Working intensely on quality assurance and quality control systems as well as building strong relationships with packaging material suppliers will positively impact productivity which can be expressed in terms of losses in performance due to breakdown or losses on resources, and quality rejections.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary Of Findings

This research revealed that packaging line machines have huge downtime and rejections due to the quality of packaging materials. These frequent machine stoppages make operators assist the machine to operate instead of doing other operational controls.

The survey on the packaging lines with people who are related to the packaging material performance indicates the employees agree high quality rejections and some frequent breakdowns are highly influenced by using poor-quality packaging materials. There is a very good understanding in the brewery production team that packaging material quality plays a crucial role in maintaining packaging line performance.

The entrance control standard does not include raw materials specifications, converting specifications, storage, and handling specifications of the final packaging materials brought by suppliers. This made the company accept packaging materials with the existing standard which mostly focuses on the final product specification and later on challenges on the packaging lines started to occur when these packaging materials did not align with the working conditions and parameters of most machines. The Certificate of Analysis, COA, from the glue supplier only contains three parameters, PH, viscosity, and brix amount which is unsatisfactory from the experience on the packaging line and also the effect it has on the environment so it should include the raw material % or Adhesive base And consumption to consider the environment and its effect on bottle washers. The particular finding regarding this process parameters is the way the suppliers are making labels. Since the supplier does not make varnishing and embossing to the required level while making the labels it becomes too difficult for the label to be penetrated with the available caustic solution strength and conductivity in the bottle washer so the bottles were leaving the bottle washer without being cleaned

ISO standards and Heineken standards are followed by the brewery team to make quality control on the entrance of packaging materials sampling techniques and the types of decisions to make when non-conformities are above the tolerance range but the implementation of these standards on the brewery is inadequate since what is observed on the shopfloor is highly deviate from what is expected. E.g. From some of the no-acceptance procedures, it is indicated that empty shell, bend,

and oval shape crown, any non-conformity resulting in 1% performance loss, or leakage due to missed or wrong liner application should be discarded. However, this is not the case since more than 1% performance loss is happening on average daily production.

Challenges are brought by the quality department team for not strictly following these standards as Some packaging materials come in large quantities as a bundle and it is difficult to inspect the appropriate amount of samples with the limitation on time and also Lack of trained quality analysts and insufficient focus given to classroom and on-the-job training in the people development pillar. The way sorting is made whenever there is a non-conforming packaging material found on the entrance inspection and also the challenge of doing sorting make the impact of packaging materials on the quality rejections even worse.

unavailability of some instruments and measuring tools make the standard operating procedures not to be fulfilled making the quality assurance system need critical attention and support the entrance control system to achieve its expectations. Updating of quality control standards on the packaging lines is done after visible loss in quality rejections whenever there is a material specification change.

the trial methodology for some packaging materials is not satisfactory due to the lack of consideration of the trial number of dates, the machine speed where the trial is made, the different SKUs to be produced, and the different properties of different batches. E.g when a glue trial is made, differences in composition from barrel to barrel are observed so it is difficult to pass or fail based on different batch usage in one trial system. metallic-based labels consume more glue than paper ones so the glue effect for different label types is different which makes it mandatory to try one glue batch on different label types. High-speed machines are also the critical ones where glue trials should happen.

According to the Heineken standard, Various events can trigger the initiation of an audit and audit-related supplier visits. One is insufficient quality of material deliveries, complaints, and recalls. auditing frequency is based on the supplier performance management score and also the number of major and high non-conformity batches but the supplier visits frequency is perceived by the packaging team members as very low regarding the different issues encountered daily. One of the findings during the visit was the type of instrument used to measure the crown dimension by the

supplier and the company quality department is different this is a huge misalignment between supplier and customer.

There is a positive perception from the brewery team on the effectiveness of the quality assurance system implemented in the warehouse for storing packaging materials. but there are areas of improvement in how packaging materials are being handled through transportation as well as warehousing. One source for deformed and damaged packaging materials is not the material supplier rather it is a transportation issue. Driving during the rainy season causes water to enter the container and make the packaging materials rust by the time they are delivered to the brewery. This makes the unacceptable packaging material to be fed to bottling lines. The loading and unloading on the port is also one of the major issues raised by the material suppliers as a defense for the complaint regarding damaged packaging materials

There are times when packaging material suppliers lean towards being unresponsive to the brewery quality complaints and it is because of several reasons, The lack of effective communication channels between the brewery and the suppliers, Suppliers having limited resources, such as manpower or technology, to promptly address corrective actions or quality issues raised by the brewery team, Suppliers have faced internal challenges in maintaining quality standards or resolving quality issues due to gaps within their own production processes or supply chains hindering their ability to respond effectively to the brewery's concerns, The organizational culture of the suppliers prioritizes efficiency or cost-cutting over responsiveness to customer concerns which led to a lack of urgency in addressing brewery-related issues.

Currently, suppliers seem to struggle to adapt to changing demands or requests from the brewery. This inflexibility can pose challenges in responding promptly to market dynamics, customer preferences, or unforeseen disruptions leading to operational inefficiencies, compromised product quality, missed opportunities, and ultimately, a negative impact on customer satisfaction and loyalty. the brewery quality and production team fails to explain the need and expectations to the supplier properly and challenges them whenever there comes a problem immediately with the figure of key performance indicators the line missed to achieve like the extract loss and performance versus the target set. The performance loss of packaging machinery due to packaging materials is not brought from the packaging team daily with performance loss percentage and batch number of material fed on that day. Unfortunately, no reward and recognition system is prepared

to encourage those working effectively, and also the knowledge share program is mostly reactive after noticing repeated quality complaints from the shop floor and non-conforming materials encountered on entrance control instead of a planned and systematic approach to share quality assurance and quality control best practices.

In general, The culture on the shop floor is more of giving temporary solutions or indirect solutions for problems that happen because of poor quality packaging materials and not documenting everything to make a detailed root cause analysis which could've led to improving the quality control system in the brewery. The research shows a low focus given to the continuous improvement plan.

5.2 conclusion

Heineken is a well-known company with its achievements in the quality of its products. It also gives priority to the quality of raw materials used on the production by different local and global suppliers but the satisfaction level on the shopfloor with these packaging materials quality is low due to the repeated experience with machine breakdowns and quality rejections due to poor packaging materials on the line. Continuous improvement is the way of working in the brewery, related to packaging materials quality there is a gap in the implementation of the standards and also handling suppliers to make them eligible for delivering products that meet the brewery specifications needs expertise and attention. There is a positive relationship between packaging materials quality management systems, supplier communication management, and the productivity of packaging lines.

5.3 Recommendation

Even though the motive behind changes in packaging materials is cost minimization, their effect on the production line performance and their environmental hazard should be taken into consideration by the supply chain management before approving the material purchasing.

The brewery needs to work on the supplier quality control and quality assurance system to reduce the burden of inspections and batch sorting from the brewery. Providing training and support with standards will help suppliers conduct inspections during the packaging material production and for their finished product. This will significantly decrease the number of non-conformities found in samples and reduce the need for repeated inspections by the brewery quality team for different batches."

The quality department should collect all the entrance control results and performance reports of the packaging materials. These should be sent for evaluating suppliers. There have to be clearer communication channels, more transparent feedback mechanisms, and proactive efforts to address any concerns or issues raised by both parties.

Entrance control checklists should include parameters for raw material usage, converting process, and finished product attributes to catch any process changes from the supplier side. The certificate of analysis from the supplier should verify all required parameters by the brewery and should be similar for different suppliers of a specific packaging material.

Some issues with packaging materials may not cause performance loss or quality rejection if they are used on certain packaging lines with low speed or less technologically advanced machines. Effective communication between the quality and production teams is necessary to determine which lines these materials should be used on without any loss in performance. To make such a decision the way the performance loss is brought to the meetings is crucial and also the packaging team should sense its criticality and decide right after seeing the loss to prevent any more loss in production.

In general, it is recommended that The change management practice in the brewery should align with the quality management system so that packaging materials changes in design, supplier, and material composition are going to be communicated to the shop floor team at an early stage to make any necessary preparations from the machine side or standards preparation.

Appendix one

QUESTIONNAIRE

ST. MARY UNIVERSITY

DEPARTMENT OF PROJECT MANAGEMENT

Dear respondent, I am a graduate student in the department of project management, at Saint Mary University. Currently, I am undertaking research entitled 'The Effect of Packaging Materials Quality Management on the Productivity of Production Companies, in the Case of Heineken Brewery'

You are one of the respondents selected to participate in this study. Please assist me in giving correct and complete information to present a representative finding on the current status of the quality management system in the brewery. Your participation is entirely voluntary and the questionnaire is completely anonymous.

Finally, I confirm that the information that you share with me will be kept confidential and only used for academic purposes. No individual's responses will be identified as such and the identity of persons responding will not be published or released to anyone. All information will be used for academic purposes only. Thank you in advance for your kind cooperation and dedicating your time.

Sincerely

Rahel Dula

Section A:- Demographic profile

1. What is your work experience?

A) <2 B) 2-5 years C) >5 years

2. What is your educational background?

A) General certificate B) University degree C) Masters

3. What is your role in the company?

A) Non-management B) team leader C) manager

Section B:- survey questions on quality control, quality assurance, and supplier relationship management

The following questions discuss how the quality assurance system is running in your working area evaluate them in relation to their applicability observed in the brewery and then put a tick mark (√) under the choices below. Where, 5= strongly agree, 4= agree, 3=neutral 2 = disagree and 1= strongly disagree OR 5= extremely satisfied, 4=satisfied, 3= neutral, 2= dissatisfied, 2= extremely dissatisfied

- quality control system

1. On a scale of 1 to 5, how satisfied are you with the quality of the packaging materials used by the brewery

1: Very dissatisfied

2: Dissatisfied

3: Neutral

4: Satisfied

5: Very satisfied

2. How often do you encounter issues with the quality of packaging materials (e.g., defects, damage) in our brewery's products?

1: Rarely

2: Occasionally

3: Sometimes

4: Frequently

5: Almost always

3. How would you rate the consistency of packaging material quality across different batches of production

1: Very poor

2: Poor

3: Fair

4: Good

5: Excellent

4. Do you agree that extract loss on a packaging line is highly influenced by poor packaging materials usage?

1: Strongly disagree

2: Disagree

3: Neutral

4: Agree

5: Strongly agree

5. How important do you consider the quality of packaging materials in maintaining the packaging line performance

1: Not important at all

2: Slightly important

3: Moderately important

4: Very important

5: Extremely important

6. How satisfied are you with the current entrance control system for packaging materials in preventing the entry of defective or substandard materials into our brewery's production process?

1: Very dissatisfied

2: Dissatisfied

3: Neutral

4: Satisfied

5: Very satisfied

8 To what extent do you agree that the sampling procedures accurately represent the overall quality of the products?

1: Strongly Disagree

2: Disagree

3: Neutral

4: Agree

5: Strongly Agree

- Quality assurance system

1. How much do you agree that all necessary inspection standards are available for all packaging materials to assure quality in the brewery?

1: Strongly Disagree - Not all inspection standards are available

2: Disagree - Few inspection standards are available

3: Neutral - Unsure about the availability of inspection standards

4: Agree - Most inspection standards are available

5: Strongly Agree - All necessary inspection standards are available

2. How frequently are inspection standards reviewed and updated to ensure relevance and effectiveness?

1: Always

2: Often

3: Sometimes

4: Occasionally

5: Rarely

3. How much do you agree that auditing processes are in place to assess the packaging material suppliers?

1: Strongly Disagree - No auditing processes in place

2: Disagree - Few auditing processes in place

3: Neutral - Unsure about the auditing processes

4: Agree - Some auditing processes in place

5: Strongly Agree - Comprehensive auditing processes in place

4. How frequently are packaging material suppliers audited for quality assurance purposes?

1: Rarely

2: Occasionally

3: Sometimes

4: Frequently

5: Always

5. To what extent do you believe the auditing processes contribute to the quality and consistency of packaging materials in the brewery's current working situation?

1: Not at all

2: Slightly

3: Moderately

4: Significantly

5: Extremely

6. Do you agree the quality assurance system is well implemented in the warehouse to store the packaging material well?

1: Strongly Disagree

2: Disagree

3: Neutral

4: Agree

5: Strongly Agree

- Supplier relationship management of the company

1. How responsive are packaging material suppliers to corrective actions or recommendations identified as quality issues raised by the brewery team?

1: Very unresponsive

2: Unresponsive

3: Neutral

4: Responsive

5: Very responsive

2. To what extent do you feel our suppliers understand the specific needs and requirements of our brewery team?

1: Not Understanding at All

2: Slightly Understanding

3: Neutral

4: Understanding

5: Completely Understanding

3. Please rate the quality of communication with the brewery packaging material suppliers:

1: Very Poor

2: Poor

3: Neutral

4: Good

5: Excellent

4. How satisfied are you with the level of flexibility and adaptability our suppliers demonstrate in meeting changing demands or requests?

1: Very Dissatisfied

2: Dissatisfied

3: Neutral

4: Satisfied

5: Very Satisfied

- Productivity
    1. How often do equipment breakdowns or malfunctions occur because of packaging materials defects on the packaging line?

- 1: Never
- 2: Rarely
- 3: Sometimes
- 4: Often
- 5: Very Often

    2. How often do issues with packaging materials affect the rejection percentage of the packaging line?

- 1: Never
- 2: Rarely
- 3: Sometimes
- 4: Often
- 5: Very Often

To what extent do you think improved communication with suppliers can enhance productivity on the packaging line?

- 1: Not at All
- 2: Slightly
- 3: Moderately
- 4: Strongly
- 5: Very Strongly

To what extent do you think a robust quality assurance system reduces downtime and increases productivity?

- 1: Not at All
- 2: Slightly
- 3: Moderately
- 4: Significantly
- 5: Extremely

To what extent do you believe continuous improvement initiatives within the quality control system enhance productivity by preventing defects, rework, and waste

- 1: Not at All
- 2: Slightly
- 3: Moderately
- 4: Significantly
- 5: Extremely

Section C:- Interview Questions

Quality control quality assurance system

1. Are we using the entrance control for all packaging materials?
2. Are all the quality inspection activities supported by standard operating procedures?
3. Do you believe all the needed tools and equipment are available to conduct the quality inspection?
4. Are there enough trained personnel to do the inspection?
5. Are changes reported by the packaging supplier in materials, processes, and machinery followed by entrance control? If yes, how is that going?
6. Do you follow Heineken's procedure to select a sample size regarding the quantity in a lot?
7. Do you follow the standard for the conditions for NO acceptance and how are you managing it?
8. What are the challenges of sorting on a batch in case of non-conformity?
9. Is there a culture of updating the quality control checklist as per the new packaging material used on the machine?
10. Do all changes on packaging material communicate to the shopfloor team with the updated quality control checklist?
11. How does the brewery approach continuous improvement in quality control processes?
12. How does the brewery handle quality control issues or deviations from standards?
13. How are packaging materials stored to maintain their quality and integrity?

Supplier relationship management

1. How frequently does the brewery quality team visit the supplier?
2. Is there a standard to follow while making the supplier audit?
3. Is there a communication platform with the suppliers related to not accepting a batch or problem on the packaging lines due to packaging material? How is that handled?
4. How does the brewery address any quality issues or concerns with suppliers?
5. Is there a knowledge share between the brewery quality team and the supplier?
6. Do you use a reward and recognition system to appreciate those who produce as per the Heineken standard

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