EFFECT OF GREEN MANUFACTURING ON OPERATIONAL PERFORMANCE OF MANUFACTURING FIRMS IN MOMBASA COUNTY, KENYA

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DECLARATION

This research project is my original work and has not been submitted for examination in in any university for the award of degree.

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DEDICATION

To my mother Beth Nduku Musila and brother Mathew Musau for their continuous and tireless support.

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ABSTRACT

The study focused on the effect of green manufacturing on operational performance of manufacturing firms in Mombasa County. Green manufacturing is new manufacturing model adopted by manufacturing firms with a goal of enhancing their competitiveness by meeting the need of green customers effectively, reducing production, increasing flexibility and speed while enhancing environmental and sustainability performance. The concern is whether implementing green manufacturing leads to improvement in operational performance. Main objective of the study was to determine the effect of green manufacturing on operational performance of manufacturing firms. The study adopted Natural Resource Based View, Informational Theory and Ecological Modernization Theory as its theoretical foundations. The study adopted green design and development, efficient processes, GSCM and end-of-life management as independent variables. Green manufacturing is a comparatively new manufacturing model and there is a need to develop conceptual framework for the concept. Literature reviewed revealed that there is a conceptual and contextual gap since a greater percentage of the previous studies focused on either one industry or on other performance measures such as environmental or sustainability performance. To meet the objective, a cross-sectional survey design was adopted for the study where data was collected across all the 61 manufacturing firms listed by KAM in 2019. Data collected was majorly quantitative through usage of questionnaires. Response rate was 73.77%. Green product design and development, GSCM and efficient processes have significant effect in enhancing operational performance while end-of-life product management was found to have insignificant relationship with operational performance. It was found out that most of the manufacturing firms feared that as soon as the new technologies are adopted they would be obsolete, the firms experienced high short-term costs due to the sunk costs, inadequate resources was a challenge especially for small-sized manufacturing firms. Inadequate management support, inadequate green culture and uncertain future economic benefits and inadequate government policies and regulations were also cited among the respondents. The implementation of green manufacturing in totality leads to reduction in production cost, increased flexibility, increased speed and improved quality thus enhancing operational performance, which leads to the firm gaining competitive advantage.

ABBREVIATIONS AND ACRONYMS

EMT	-	Ecological Modernization Theory
EMS	-	Environmental Management System
EU	-	European Union
GDP	-	Gross Domestic Product
GM	-	Green Manufacturing
GSCM	**-**	Green Supply Chain Management
GoK	-	Government of Kenya
ISO	-	International Standards Organizations
KAM	-	Kenya Association of Manufacturers
NEMA	**-**	National Environmental Management Authority
NRBV	-	Natural Resource Based View
UN	-	United Nations
UNEP	-	United Nations Environmental Programme
UNICEF	-	United Nations Children's Fund
RoHS	-	Regulations of Hazardous Substances
SCM	-	Supply Chain Management
SD	**-**	Standard deviation
WEEE	-	Waste Electronics and Electrical Equipment
VIF	-	Variance Inflation Factors

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Due to globalization, firms have shifted to competing within supply chains by reducing cost of production, increasing flexibility, continuous improvement of quality and improving on delivery (Famiyeh, Adaku, Gyampha, Darko & Teye, 2018). Customers are changing their behavior by integrating environmental considerations into their lifestyles therefore, making purchasing decisions based on not only how well these products satisfy their need but also the effect they have on the natural environment. Industries are striving to enhance competitiveness within the supply chain by meeting the needs of the customers effectively (Rundh, 2013). The cost of energy is going up with the world experiencing energy crisis more frequently than ever (Li & Zhang, 2018) necessitating reduction in fuel consumption and use of renewable energy. Pollution levels are increasing every year with industrialization, leading to global warming and climatic change thus impacting negatively on the quality of life hence, the need for manufacturing firms to engage in sustainability in manufacturing by engaging in practices that use of less natural resources, more utilization of renewable resources and reduced pollution (Zhang, 2018).

Ecological Modernization Theory, Natural Resource Based View and Informational Theory formed theoretical basis of the study. With the growing concerns on Climatic Change and global warming, governments and trade organizations have formulated policies and regulations that manufacturing firms are to adopt. Ecological Modernization Theory articulates that environmental regulations and policies imposed on manufacturing firms can motivate them to implement green manufacturing (Sezen, 2013). Natural resource based view advocates for effective use of the available natural resources and capabilities by manufacturing firms to gain competitive advantage across the supply chains. (Hart & Gowell, 2011). Informational theory calls for constant effective communication in the supply chains to reduce information asymmetry. Global awareness on environmental sustainability is on the rise leading to green movement, which is shaping customer requirements globally (Alvi, 2013). Manufacturing industries are communicating "greenness" to their consumers through social responsibility, packaging, design and environmental sustainability thus meeting the needs of customers who are environmental conscious effectively.

Kenya is an agricultural based economy and faces challenges of manufacturing of goods since it has not fully attained industrialization. Climatic change has adversely affected the country's economy due to the increased frequency of droughts and famine leading to straining of resources like energy, water and raw materials (UNICEF, 2017). As a way of curbing the effects of over-reliance on agriculture, the country has set up a grand plan towards achieving industrialization by 2030. Green manufacturing is the way to go for the country since resources are limited though the number of manufacturing firms are on the rise. There is the need for the manufacturing industries to engage in practices that will promote sustainability like use of energy efficiently and conservation of the limited natural resources.

1.1.1 Green Manufacturing

Green Manufacturing is a new manufacturing model that puts into consideration environmental sustainability and resource optimization throughout the product life cycle starting at design stage through transformation process, delivery to customers, consumption and recycling to waste disposal (Deif, 2011). The model aims at maximizing resource efficiency and minimizing negative impacts to the environment while reaping maximum economic and social benefits. Green manufacturing puts emphasis on abating environmental effect by reducing, reusing, recycling and remanufacturing leading to source reduction, optimization of resource consumption and enhancing use intensity (Fore & Mbohwa, 2014; Shang, 2010). Green manufacturing dimensions include; green design and development, GSCM, investment recovery and efficient processes (Shrivastava & Shrivastava, 2017; Neto et. al, 2009; Rehman & Shrivastava, 2013).

Green manufacturing embraces the use of raw materials, which are harmless to the environment, green product design, green packaging, efficient process and reuse/ recycle after useful life of the product. Green manufacturing thus involves recycling, waste reduction management, regulatory compliance, environmental protection and pollution management (Rehman & Shrivastava 2013, Orji & Wei, 2016). According to Eltayeb (2019), green manufacturing has four dimensions: sustainable product design, sustainable process, sustainable supply chain management and sustainable end of life management. The study focused on green product design and development, efficient processes, GSCM and end- of-life product management as the green manufacturing concepts.

1.1.2 Operational Performance

Operational performance is the strategic dimension by which a company focuses to compete in (Narasimhan & Das, 2001). These dimensions are cost, quality, flexibility and speed (Ketchen, Rebarick, Hult & Meyer, 2008). Manufacturing capabilities must thus be directed towards enhancing competitive priorities, which business unit should translate to strategic capabilities. Operational performance attributes to reduction of costs and achieving step-changes in productivity and ensuring that the customers are satisfied thus earning the organization profits. Operational performance seeks to reduce operational cost and improve asset utilization through better maintenance, operating practices, and debottlenecking (Sawhney, 2006). Firm's competitive advantage depends on the ability to manipulate the four dimensions over their competitors. Competitive advantage of a firm can be attributed reduction in production cost, continuous improvement of quality, increased flexibility and improved delivery time (Famiyeh et. al. 2018). Manufacturing firms should thus employ green manufacturing strategies that will not only help them gain but also sustain the competitive advantage in the ever-dynamic global market.

To reduce on production costs the manufacturers employ strategies that use energy efficiently, reduce on inventory levels to optimal levels, process that are efficient, reduced transportation costs due proper location of warehouses and optimal product designs; and eliminate wastage of resources (Famiyeh et. al., 2018). By adopting green manufacturing practices energy is used efficiently with reduced emissions to environment, efficient process minimize on wastage of resources where the same amount of raw materials are used to produce larger amounts of products (Orji &Wei, 2016). The initial capital required to purchase manufacturing equipment and machines is high with most firms in developing unable to upgrade the archaic methods used in production thus may not be enjoying the benefits of green manufacturing with their production costs being high. (Fore & Mbohwa, 2014).

Quality of product can be perceived as conformance of products to specifications therefore, performance measures ought to focus on eradicating non- conformance (Chen, 2011). This will help in reduction of costs and wastes incurred in rework and re-engineering. Poor quality of products is costly to the firm since if leads to low stakeholder satisfaction, products failing in the market, defects and damages the firm's image (Zhu, Sarkis & Geng, 2005). Perceived quality is much dependent on the customer's value addition concept of the product, manufacturers should adopt strategies that meet and exceed the quality expectations of the customer (Rundh, 2013). Quality of products and process can be achieved through quality management systems, green culture and continuous improvement. Manufacturing firms should embrace total quality management and green manufacturing strategies that produces products that meets the needs of green customers effectively (Famiyeh et. al., 2018).

Customer's quality is a moving target and thus excellent product can only be achieved by meeting the evolving needs of a customer (Bosch & Enriquez, 2010). Thus, manufacturing firms should have flexible operations that easily adapt to the changes in customer tastes and preferences. Dynamism in customer needs impacts on the manufacturing operations since they should be customized towards meeting the needs of the customers effectively thus remaining competitive. There is increased environmental awareness to enhance sustainability therefore, governments and organizations have set up policies and regulations (Kazancoglu et. al., 2018) which keep on changing. Manufacturing firms have to keep on making changes in their manufacturing strategies to adhere to those policies (Alvi, 2013). The world today is moving towards green production, thus firms are compelled to use green energy, eliminate on waste, recycle materials and reduce on pollution. Technologies and innovations are evolving with time, with every innovation addressing the challenges experienced in manufacturing especially on conformance to environmental policies, quality issues and reduction in production cost (Slack, Chambers & Johnston, 2005) thus flexibility is essential in sustaining competitive advantage.

Speed is the measure of how a company responds to customer needs in a timely manner in accordance to planned prices and costs (Ketchen et. al., 2008). Production resources should be used effectively and efficiently, this requires ongoing decision making to optimize on batch size and product mix thus effective communication and rapid flow of information is necessary in decision-making process (Vachon & Klassen, 2008). Right product mix coupled with optimal batch size in line with customer needs should be considered in production processes therefore determining the process capacity and flow time to ensure maximum value creation (Slack et. al., 2005). Manufacturing firms should optimize the product mix and batch size by use of continuous production process (Digalwar et. al., 2016). Time -to-market should be reduced through teamwork and collaborations to meet the needs of customers effectively thus positively affecting competitive advantage (Chase, Jacobs & Acquillano, 2011).

1.1.3 Green Manufacturing and Operational Performance

Due to globalization, there is increased competition in globe with manufacturing firms being under intense pressure to improve productivity at the same time enhancing environmental sustainability (Ahmad, 2015). Adopting green energy, green process, waste management and minimization and reduction of pollution enables the manufacturing enterprises enhance performance objectives like reducing cost, corporate image and reduced discharge of hazardous substances to the environment. Green manufacturing practices helps to optimize resources, improve reliability and reduction of pollution. They also ensure waste reduction thus translating to better consumption of resources by using fewer raw materials and use of energy efficiently. This have an effect of cost reduction and improvement of quality (Sivapirakasam, Mathew & Surianayana, 2011). This enhances operational performance of the manufacturing industries.

1.1.4 Manufacturing Firms in Mombasa

According to KAM (2019), manufacturing industries carry out processing and value addition. Manufacturing industries include; building, mining and construction; chemical and allied; energy, electrical and electronics; leather and footwear; metal and allied; automotive; paper and board; pharmaceutical and medical equipment; plastics and rubber; textile and apparel; timber, wood and furniture; agriculture and fresh produce. Pillar 1 of Industrial transformation in Kenya is competitiveness and level playing field; this pillar lays emphasis on cost reduction, use of energy efficiently while Pillar 5 is on securing the future of manufacturing industries through green growth and sustainable manufacturing (GoK, 2015).

Pillar 1 of the 'Big 4 Agenda' in Kenya is manufacturing though the manufacturing sector has constantly contributed 11% to GDP for the last decade thus it has remained flat (GoK, 2018). Kenya is an emerging economy, which is striving to move away from agriculture-based economy to an industrial and middle-income economy, for her achieve this objective manufacturing sector should grow its share in GDP contribution. The pillar aims at creating regional industrial hubs with Mombasa County selected to be an industrial hub in the Coastal region. The Kenyan government aims at making production of goods sustainable with reduction of raw materials costs by coming up with policies that encouraging manufacturers to recycle wastes and minimize use of electricity and use of green energy (GoK, 2018).

An estimate of 9% of the total population of Kenya is in coast region and growing at the rate of 3.1% per annum, which is relatively faster than the national growth of 2.9% per annum (GoK, 2009). This leads to increase on the demand of products hence manufacturers are setting up industries in the Mombasa to meet the demand. The two factors coupled have an effect of increasing number of manufacturing firms in Mombasa County. Natural resources are strained and industries faces challenges of energy waste minimization, waste management, and compliance to regulations and policies. The ecosystem in the environment receives watershed discharge into the ocean which impact on the biodiversity, productivity and system functioning (NEMA, 2018). Consequently, adoption of green manufacturing will be an option for these manufacturing firms (Lisney, Riley & Banks, 2003). The study was focused on KAM registered manufacturing firms in Mombasa County listed on the Appendix II.

1.2 Research Problem

Consumption of natural resources such as fuel, minerals, water and food is on the rise every day with their availability shrinking therefore, it is paramount to conserve and manage the resources (Bhattacharya, 2011) which in turn conserves the environment enhancing sustainability. It is estimated that by 2050 greenhouse gases emissions will have doubled due to the steps made by countries to achieve industrialization goals. Global temperatures are estimated to rise by 4-6^{0}C over the pre-industrial levels thus greatly affecting global ecosystems, crop production, sea levels and hydrological levels. According to Ahmad (2015), manufacturers are under intense pressure to improve productivity while adhering to policies and regulation laid by external institutions in order to remain competitive. To improve productivity there is the need minimize on waste, reduce cost of production by adopting efficient processes, use green designs and green packaging that meets the needs of green customers.

Kenya is a developing country with fewer manufacturing industries compared to developed countries but she is expected to achieve industrialization goals by 2030. Kenya has unfavorable balance of trade, to make it favorable the country has to reduce her imports and expand her exports base. The Kenyan products should not only be able meet requirements set by EU and other institutions but also the needs of green customers on the global arena. According to NEMA (2018), pollution levels are on the rise and there is the need to seek permanent solutions to mitigate the problem of pollution. Kenyan government being member of UN and to extension follows policies laid by UNEP. The policies are meant to reduce pollution especially in developing countries by implementing environmentally sound policies and practices. It would be necessary for manufacturing firms to adopt sustainability in manufacturing by implementing use of efficient process that would minimize waste and reduce pollution.

Shrivastava and Shrivastava (2017) carried out a study on Green manufacturing concepts on India Cement manufacturers; they established that Cement manufacturing industries by adopting green cement production processes coupled with efficient use of energy helps the firms to reduce cost while reducing the negative effects to the environment without losing on quality, reliability and performance. A study done by Orji and Wei (2016) on costing green manufacturing on China firms found out that the total product cost in firms which have implemented green manufacturing was lower than that in convectional manufacturers. Li and Zhang (2018) carried out a study green manufacturing and environmental productivity growth across European countries and found out that carbon abetment impacts on environmental productivity growth though it depends on the nature of technologies, level of innovation and environmental regulations.

Fore and Mbohwa (2014) carried out study on green manufacturing practices on South Africa Cement manufacturers. They established that most of the South African Cement manufacturers were using archaic methods and there was need to for the industries to invest in process optimization and process control innovations in order to minimize on waste and reduce on environmental impact on lime production. A study carried out by Eshikumo (2017) on green manufacturing and operational performance in cement industry in Kenyan context, established that the Clinker cost significantly reduces when industry use of green energy and thus reducing environmental impacts.

Green manufacturing is an emerging concept thus there is need to develop knowledge in the area. Most of studies on the green manufacturing are on specific industry and therefore the study fills the gap by extending to firms. There is also a contextual gap, in that there are few studies carried in Kenya and to some extent in developing countries on green manufacturing and operational performance. The research seeks to establish relationship between green manufacturing and operational performance on manufacturing firms. The study addresses the research gaps through finding answers to questions: Does the implementation of green manufacturing lead to improved operational performance? Which are the challenges faced by manufacturing firms in adopting green manufacturing?

1.3 Research Objectives

The broad objective of the study was to determine the effect of green manufacturing on operational performance on manufacturing firms. The specific objectives of the study were:

i. To find out the effect of green manufacturing on operational performance on manufacturing firms in Mombasa County.
ii. To investigate the challenges of adoption of green manufacturing amongst manufacturing firms in Mombasa County

1.4 Value of the Study

The study made remarkable contributions to the body of knowledge, management and policy. To the green manufacturing body of knowledge, the study provides theoretical insights to researchers on the relationship between green manufacturing and operational performance of manufacturing firms and forms a basis of further study on the un-explored concepts of green manufacturing.

Kenya being a developing country and aiming to achieve industrialization by 2030, calls for better policies to enhance sustainability and be at par with other manufacturing nations in terms of quality thus favorably competing in the global market. Kenya Association of Manufacturers (KAM) is the body entrusted with policy making for manufacturing industries. The study is useful to KAM and other institutions responsible for formulating policies and regulations in developing countries. The study helps the country not only become industrialized but also conserve the environment through green manufacturing.

The study encourages policy makers to adopt favorable policies that will motivate investors to invest in green manufacturing.

The study will be valuable to managers since it offers guidance to them as they execute the broad functions of planning, organization and controlling to gain competitive advantage by using green manufacturing strategy and improve the firm's operational performance. It provides useful knowledge to managers on the challenges of adopting green manufacturing and areas of improvement to remain competitive or gain competitive advantage.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter forms the literature review for the study and discusses the theoretical foundations anchoring the study. The study was founded on Informational theory, Ecological Modernization Theory and Natural Resource Based View. The chapter describes green manufacturing practices adopted by the study. The third section of the chapter discusses challenges to green manufacturing as revealed by literature. The fourth section encompasses empirical review on scholarly works done on the concepts, summary of the literature review gaps and conceptual framework adopted for the study.

2.2 Theoretical Foundation of the Study

The study was based on Ecological Modernization Theory, Informational Theory and Natural Resource Based View. Ecological Modernization Theory explains how pressures exerted by external institutions forces manufacturing firms to adopt to green manufacturing. Information theory explains how manufacturing firms should continuously communicate effectively with customers to enhance competitive advantage while Natural Resource Based View entrust manufacturers to enhance sustainability of natural resources through adopting green manufacturing strategies.

2.2.1 Ecological Modernization Theory

The theory is centered towards achieving industrial development at the same time protecting the environment through technological innovation and developments (Jänicke, 2008). The theory encompasses on the evolving politics of pollution that regards to, dynamism of regulations and their impact on environmental innovations. The theory also focuses on innovations in technology, where it posits that manufacturers can gain operational performance improvements through innovations thus gaining competitive advantage (Murphy & Poist, 2003). The strict regulations on the environmental pollution and conservation coupled with the mounting pressure from stakeholders are compelling manufacturers to adopt sustainability measures in manufacturing approaches. Manufacturers are thus adopting production systems that minimize the negative impacts of operations on the environment and natural resources (Kazancoglu et. al., 2018; Bai & Sarkis, 2018: Laosirihongthong & Tan, 2013). Manufacturers are striving to comply to regulations and policies set by governments and environmental institutions on carbon emission limits by use of 6R strategy which is redesign, reduce, remanufacture, recycle, reuse and recover (Toptal , Ozlu & Konur, 2014; Vachon & Klassen, 2007; Ouardighi, Sim & Kim, 2016).

The formulation of international environmental regulations like RoHS and WEEE coupled with increased environmental awareness of consumers have brought significant impact to manufacturing firms in the global trade (Chen, 2011). This regulations and policies are imposing pressure to manufacturers to conform to them so as remain competitive in the global markets. The new quality management system proposed by ISO: 14000 series, is concerned with environmental management, its main objective is to minimize the environmental damage due to industries. The system advocates for industries to eliminate operations that have a negative effect to the environment; and adhere to environmental laws and regulations. Though registration to ISO is voluntary, consumers perceive those industries not ISO certified to be producing goods of low quality and has a negative effect on their sales (Terlaak, 2007).

2.2.2 Natural Resource Based View

Firm's resources are assets, competencies, processes, attributes, information and knowledge, dynamic capabilities and natural resources controlled by the firm that enables it to build and implement strategies that improve its competitive advantage (Hart & Gowell, 2011). NRBV theory articulates for the connection among firm resources, capabilities and competitive advantages in that the firm should look for opportunities to gain competitive advantage from within rather than from the external environment. Tapping into resources that are valuable, scarce, inimitable and resources that cannot be easily substituted, maintains competitive advantage of a firm (Alberto & Sharma, 2003; Shi, Koh, Baldwin & Gucchiella, 2012).

NRBV focuses on two dimensions, which are environmental pollution prevention and sustainable manufacturing. Environmental pollution prevention is through product stewardship, which advocates for manufacturing industries to design, produce and market products that minimizes environmental impact through the product's lifecycle including the end of life management in collaboration with other stakeholders (Vachon & Klassen, 2007). NRBV also focuses on sustainable development where manufacturing industries are compelled to innovate processes that minimize on waste, use energy efficiently and use of clean technologies. The process should use fewer resources to produce the same or more products thus the reducing cost and enhance operation performance (Hart & Gowell, 2011, Alberto & Sharma, 2003).

A firm development in its resources and capabilities is demonstrated through improvements in quality, speed, reduction in cost and increased flexibility. Building these operational capabilities through green manufacturing supports the value, scarcity, distinctiveness, and non-substitutability, which are features of NRBV thus enhancing competitive advantage of the firm. Dynamic capabilities relates to organizational learning and aims at building knowledge resources within the organization (Menguc & Ozanne, 2005; Shi et.al, 2012). Environmentally oriented learning through sharing resources helps in conservation of the environment and meeting the needs of green customers thus developing competitive advantage. Manufacturing industries are supposed to reconfigure the external and internal competences with the objective of addressing the dynamic environments through developing learning capabilities (González, Sarkis & Andenso-Diaz, 2008). Manufacturing industries should develop strategies that address the challenges of pollution and minimization of waste. This calls for better utilization of natural resources, eco-efficiency, product stewardship, pollution prevention and use of clean technologies. The aim is to reduce environmental impacts and improve on the operational performance of organization. (Hart & Gowell, 2011)

2.2.3 Informational Theory

According to Sarkis (2012) firms may want to communicate their environmental performance to external stakeholders, though it may be challenging due inadequate information on the materials flowing through their supply chains. Greening manufacturing is derivative of the capability of a firm to produce and market green products. Such capabilities potentially develops new products thus building competitive advantage of enterprise (Simpson, Power & Samson, 2010). Greater interactions between the industries and other external institutions enhances sharing of information thus reducing information asymmetry. RoHS regulation prohibits some materials into European market especially those with high levels of heavy metals. Manufacturing firms heavily dependent on suppliers to unveil informational content on supplies, parts and processes (Erlandsson & Tillman, 2009).

Coordination, closeness, congruence and collaboration between manufacturing firms and other institutions result in reduced information asymmetry thus in turn improving environmental performance and image of the firm. Implementation of ISO 14001 certification by manufacturers is a signal to the market that the firm is operating within recognized environmental management practice (González et. al., 2008). Poorly performing units may have adopted ISO 14001 certification, signaling to the market that they are improving operations though this is may not be the case (Terlaak, 2007).

2.3 Components of Green Manufacturing

Green manufacturing is a concept that enhances sustainability of resources while conserving the environment. Green manufacturing touches on all aspects of production right from design and development, supply of materials through transformation process to end of the life recovery management (Deif, 2011). Green Manufacturing is a continuous loop where the design determines the processes and recovery process. Green manufacturing enhances cost reduction, improves on speed and flexibility without compromising on quality thus a useful manufacturing strategy to gain competitive (Eltayeb, 2019).

2.3.1 Green Product Design and Development

Green product design is enhanced by use of design for the environment guidelines, which helps manufacturers design products that meet specific goals (Johansson & Lindhqvist, 2005). At the design stage, the designer views the manufacturing through a closed loop that starts at design stage to product recovery management (Deif, 2011). All materials and energy requirements through the product life is considered. Green product design aims at reducing or eliminating hazardous material, minimizing waste in the product by use of less material, designing products with recycling or re-use capabilities, designing products for re-manufacturability and materials of appropriate shapes and volume for minimal space consumption during storage and transportation (Khor & Udin, 2013).

At the design stage, proper selection of tools, equipment and raw materials is done. Product sequencing is designed in a way to minimize motion thus saving on energy, cost and time (Zhu & Shang, 2008). The material cutting tools are designed to minimize on wastage of resources while the machines are designed with appropriate controls. Equipment and machine parameter controls are efficiently designed to minimize on wastage through reworks and energy wastage. Raw materials considered for manufacturing of products by the designers should be enhance sustainability in that they should be less hazardous to the environment, minimize wastage of resources like conservation of energy and utilize green processes (Orji & Wei, 2016).

2.3.2 Efficient Processes

Efficient processes are those processes that use green energy, minimizes on wastage of resources with no rejects and rework required on products. The processes generate less undesirable wastes by minimizing on production of solid wastes and reduced emission of green- house gases (Rashid, Sakundarini & Thurasamy, 2017). The processes must have reliable and measurable standards, defined by baseline quality controls. When the processes fails to meet the standards it calls for rework, re-engineering or even rejects produced, which leads to wastage of resources and increased production costs (Chen, 2011). These processes must therefore, not only meet but also exceed the quality conformance standards. Efficient processes use minimum resources to create value addition in products manufactured enhancing on competitive advantage (Elyateb, 2019).

Efficient processes employ the use green manufacturing technologies. Green manufacturing technologies leads to substitution of raw materials with alternative raw materials, which are less hazardous, have re-manufacturing, re-use and recycle capabilities (Varma, 2006: Ahn, 2014). The wastes generated are not only minimized through efficient use of resources by enhancing use intensity but also the little wastes produced are consumed internally (Rosen & Kishawy, 2012). Emission of gases and discharge of harmful wastes to the environment are highly controlled with the processes fitted with control filters (Ahmad, 2015). Resource reduction is enhanced through conservation of energy through batch optimization and proper product mix thus manufacturing firms should adopt continuous processes (Rosen & Kishawy, 2012).

Green technologies employ the use of green energy as alternative source of energy. The energy consumption of these technologies are minimal since energy is used efficiently (Rehman & Shrivastava, 2013). Green processes enables firms to reduce material cost variance, improve on process efficiency and effectiveness at the same time reducing negative effects to the environment (Zhu & Sarkis, 2007), this enables the firms improve profit margins and grow market share. Employees should be empowered so as incorporate total quality management principles in the production processes (Rao and Holt, 2005). Use of safety systems and prevention measures are adhered to during production to prevent risks, damage and accidents (Shi et. al., 2012).

2.3.3 Green Supply Chain Management

The relationship between GSCM and green manufacturing has significant implications to operational performance of the organization and environmental sustainability (Eltayeb, 2019). Green purchasing practices is one of GSCM practices and involves purchase of services and raw materials that have lesser effect to human health and the environment compared to alternative raw materials. Collaboration between manufacturers and supplier is essential to ensure that manufacturers supply raw materials, which are less hazardous and meet the required safety and health standards (Rao & Holt, 2005; Sroufe, 2005). Compliance of suppliers to regulations and policies, eco-labelling and disclosure of products by use of environmental management system (EMS) reduces negative impacts to environment by eliminating hazardous materials at the source (Eltayeb, 2019; Rao & Holt, 2005).

GSCM involves green warehousing where inventory levels are maintained at optimum levels with the objective of reducing inventory cost and usage of space (Eltayeb, 2019). During distribution, products are packaged in such a way to enhance sustainability. Green packaging involves packaging of products at the reduced package materials, or materials that can be recycled/re-used or harmless to human or animal life (Shi et. al, 2012). Appropriate storage and apt disposal of hazardous materials aiming at eliminating wastage and negative effects to the environment is also considered as dimension of sustainable SCM (Rashid et. al, 2017).

Green warehousing practices involves use of optimized facility layout, resource saving such as water and power and use of energy efficient equipment. These practices aim at reducing carbon footprint; minimize cost and wastage, increasing social responsibility and reduction of environmental pollution. The warehouses for the distribution of final products to the consumers should be located in a way to minimize the transportation costs. The logistics adopted should ensure minimized energy consumption and be compliant to EMS principles (Eltayeb, 2019; Sarkis, 2003; Rao, 2004). Greening SCM is positively associated to competitiveness since it leads to reduction of costs due to elimination of wastage thus providing customer with the same value at a reduced cost (Cosimato & Troisi, 2015).

Customer collaborations are essential factor in GSCM. They involve holding discussions with customer in order learn about the firm's operations and plan effectively. This will ensure that customer needs are met effectively since their voice will be hard wired into the products (Vijayvargy, Thakkar & Agarwal, 2017). Cooperation between organization and its customers is strongly associated with environmental performance since customers are becoming more sensitive to the environment and puts pressure on the organization to respond effectively to their changing needs (Bai & Sarkis, 2010).

2.3.4 End-of -Life Management

End-of -life management aims at sustaining long-term ecological balance through recycling, re-use and remanufacturing thus safeguarding natural resources from depletion and the environment is not harmed by disposal of materials (Eltayeb, 2019). Recycling, re-use and remanufacturing must be factored in during product design and development through designing products for environment where the organization should have a clear plan which components or materials should be recovered for remanufacturing or recycling at end of product life (Deif, 2011). Recycling is the most common product recovery management method because it generates economic value for materials recovered through restoration of the functional capability allowing re-use thus decreasing the continuous use of new raw materials thus enhancing sustainability (Maruthia & Rashmi, 2015; Alvi, 2013).

The manufacturer must maintain contact with the customer for purposes of collection of the product after end- of life for either proper disposal, for remanufacturing, replacement during the warranty period. This has an advantage to the manufacturer since it assist in identifying the changes in needs of the customer thus gaining competitive advantage (Rao & Holt, 2005). End-of-life management also helps in reducing cost through reduction in the consumption of virgin raw materials and reduction in material supply risk thus conserving natural resources and reducing negative impacts to the environment (Khor & Urdin, 2013).

2.4 Challenges of Green manufacturing

Despite the efforts made by governments and manufacturing firms to go green, they face numerous challenges that inhibit them from implementing green manufacturing practices (Bhanot, Rao & Deshmukh, 2015). Ghazilla, Sakundarini, Rashid, Ayub & Olungu (2015) identified eight general challenges that affect the implementation of green manufacturing amongst manufacturing firms. These categories are; organizational barriers which involves weak organizational structures, poor employee empowerment, internal politics, inadequate expertise and underdeveloped green manufacturing culture. Environmental knowledge barrier; which involves inadequate access to green manufacturing knowledge and expertise. Business environment challenges, which involve inadequate market, inadequate, green manufacturing measures, distortion of verifiers of green manufacturing.

Societal challenges involves inadequate research and development, design and testing of green manufacturing products, inadequate new technologies and materials, most organizations have limited green manufacturing alternative solutions, organizations are not flexible into switching to green manufacturing, organizations lack innovations on green manufacturing and inadequate human resources and capabilities in adopting green manufacturing. Government and regulations challenge which involves inadequate support and regulation authorities on green manufacturing, governments are not keen to enforce regulations on green manufacturing and inadequate incentives and financial support of green manufacturing practices. Financial challenges involve existence of sunk costs, which makes firms to incur short-term losses, firms have limited financial resources to acquire green manufacturing technologies and training and the initial capital required to implement green manufacturing practices are high. Supply barriers involves poor supply commitment to green manufacturing, difficulties obtaining information on materials and maintaining awareness on green manufacturing practices (Bhanot, et.al, 2015; Ghazilla et. al, 2013, Fore & Mbohwa, 2017).

2.5 Empirical Review

A study by Shrivastava and Shrivastava (2016), titled Green Manufacturing Concepts in Indian Cement manufacturing industries, found out that Cement manufacturing industries by adopting green cement production processes coupled with efficient use of energy helps the firms to reduce cost while reducing the negative effects to the environment without losing on quality, reliability and performance. A study carried out by Fore and Mbohwa (2014), on green manufacturing practices in South Africa Cement manufacturers found out that most of the South African Cement manufacturers used archaic methods. There was need for the industries to invest in process optimization and process control innovations in order to minimize on waste and reduce on environmental impact on lime production. The manufacturing industries that adopted green methods such as bucket transport minimized the spillage and that led to reduction in waste of the raw materials and reduced emissions to the environment. They suggested that good housekeeping practice such maintaining optimal inventories led to reduction in production costs.

A study by Eshikumo (2017) on green manufacturing practices and operational performance of cement industry opined that green manufacturing practices such as waste reduction and energy efficiency have an effect of reducing cost of the product and thus enhancing operational performance. From the study, the firms that adopted green manufacturing practices minimized on cost while preventing environmental pollution. They suggested that in Kenya, there was a need to enforce laws and regulations on environmental pollution since most of industries had not adhered to the laws and regulations laid down. The study revealed that green manufacturing practices are positively related to reduction of cost, which results from reduction of waste thus enhancing competitive advantage. A study by Orji and Wei (2016) on costing of green manufacturing amongst China manufacturing firms found out that the overall production cost of green manufacturing firms is much less than that in conventional manufacturing firms.

A study by Deif (2011) on green manufacturing model, affirmed that green manufacturing should considered as a continuous loop from the design stage to end-of-life management. A study by Li and Zhang (2018) on green manufacturing and environmental productivity growth found at that green manufacturing positively impacts on environmental productivity due to reduction in waste and gases emission and reduction in use of virgin materials. A study by Digalwar et. al. (2017) implementation of green manufacturing practices found out that effective implementation of GM improves on quality and reduces production cost. A study by Sezen (2011) on effect on green manufacturing and eco-innovation on sustainability found at that eco-innovative process enhance sustainability performance since green manufacturing lowers material cost and reduces production inefficiencies. Rao and Holt (2005) established that a strong positive association exists between green practices and environmental performance. This in coherence with findings of a research carried by Zhu and Sarkis (2005).

2.6 Conceptual Framework

The study was guided by conceptual framework detailed in Figure 2.1, where independent variables are green product design and development, efficient processes, GSCM and end-of-life management. The dependent variable is operational performance, which was measured through quality, cost, flexibility and dependability.

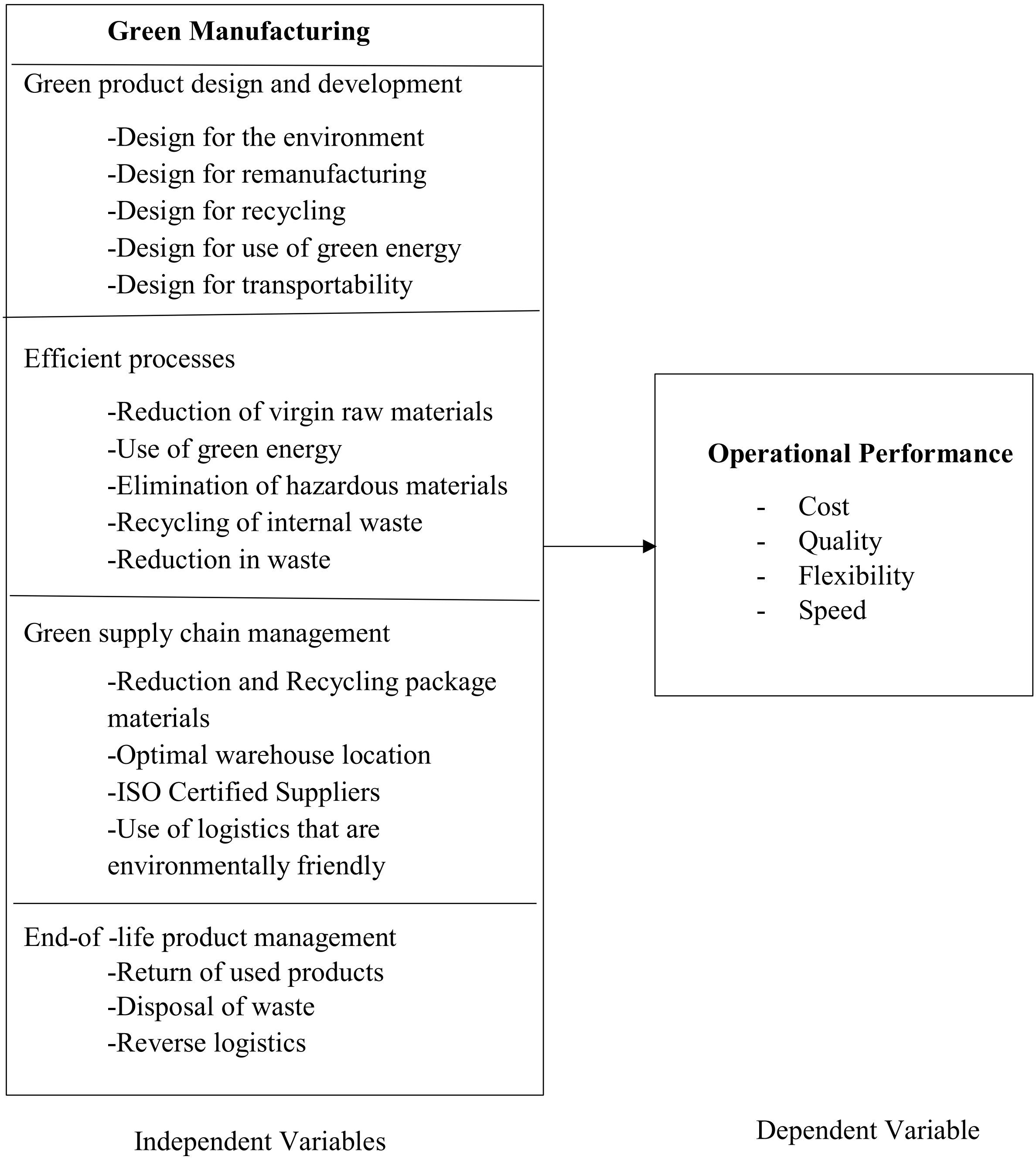

Figure 2.1: Conceptual Framework of the study

2.7 Summary of Literature Review

The literature review reveals that there is contextual gap and conceptual gap to be addressed by further research. Most of the studies have been carried in European and Asian context with few studies on the developing countries context. Most of the studies carried out are on a single industry and cannot be generalized on the other manufacturing firms (Eshikumo, 2017; Orji & Wei, 2017; and Fore & Mbohwa, 2014; Shrivastava & Shrivastava, 2016). Majority of the studies are on GSCM, green manufacturing has fewer studies since it is an emerging concept.

The literature review was sufficient to reveal the existing gap on green manufacturing in Kenyan context and developing countries. The research aims at filling the existing gap since the study was done across several manufacturing firms from different industries. The country needs to develop framework that will guide policy making in sustainable manufacturing and attaining her industrialization goals by 2030. To develop the policy structure and offer guidance to the process of industrialization adequate literature is necessary. The study aims at filling the contextual gap and conceptual gap on green manufacturing and operational performance. The research leads to development of the concepts in green manufacturing is which is a relatively new concept.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a discussion of the research methodology that was used in the study. It details the research design, describes the population of the study, discusses data collection, as well as data analysis adopted for the study. The chapter also details the operationalization of the variables. The last section of the chapter discusses normality, reliability and validity tests.

3.2 Research Design

The research design for this study is cross-sectional survey design. According to Mugenda and Mugenda (2003) this type of design is appropriate when the researcher is to establish whether there is relationship amongst the variables. The study is cross-sectional in that data was collected at some point in time. The study aimed at describing relationship between green manufacturing and operational performance by studying all the manufacturing firms in Mombasa County who are members of KAM. The research led to the establishment of the features of the variables of interest thus giving feedback on the research questions. Cross-sectional study was suitable since data was collected across several firms at one point in time (Cooper & Schindler, 2006). The research design has been used in several studies (Rao & Holt, 2015; Shrivastava and Shrivastava, 2016; Deif, 2011; Digalwar et. al. 2017)

3.3 Population of the Study

The population of the study was 61 manufacturing firms registered by KAM and located within Mombasa County (KAM, 2019). A census was appropriate for the study because the firms are not many and also for the purposes of dealing with non-respondents. The firms selected were able to provide information on green manufacturing and the effect on operational performance.

3.4 Data Collection

Data collected for this study was mostly quantitative data with a few sections of qualitative data. Primary data was collected through questionnaires. Most of the questions were closed questions, which were matrix-structured with Likert scale of five point with only a few questions being open-ended. The questionnaire was divided into four sections: section A was the firms' general information, while sections B was green manufacturing variables, section C was operational performance variables and section D were challenges facing implementation of green manufacturing practices. The respondents were required to answer by indicating the scales operationalizing the variables. The researcher delivered the questionnaires to the manufacturing firms and then handpicked them later within the day because the firms were located in centralized area. To avoid duplication a single respondent was targeted from each manufacturing firm. According to Purdie and Hattie (2003) the respondents should have detailed knowledge of what is being studied, thus respondents of the questionnaire were operational managers of all the manufacturing firms since they are knowledgeable on the overall firm's direction in relation to manufacturing practices of the firm.

3.5 Data Analysis

On data analysis multiple regression and correlation analysis were used for the study. Multiple regression was used to establish the relationship between the variables. Operational performance, which is the dependent variable, was regressed against green product design and development, efficient processes, green supply chain management and end-of-life management.

3.5.1 Regression Model

The multiple regression model used to guide data analysis is as follows:

$$Y= \beta_0 +\beta_1X_1 +\beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \varepsilon \quad \text{.................................... Equation 3.1}$$

Where: Y is the dependent variable, which is operational performance of manufacturing firms represented by: β_0 is the Y intercept, which is the other factor affecting operational performance; β_1, β_2, β_3, and β_4 are the coefficients of the predictor variable; X_1 is green product design and development; X_2 is efficient processes; X_3 is GSCM; X_4 is end-of-life management and ε is the error term.

Multiple regression evaluation was used to determine the relationship amid green manufacturing variable and operational performance. Multiple regression analysis has been used to study relationship among variables in green manufacturing practices and performance by Eshikumo (2017), Waithaka (2012) and Sezen (2013) thus the justification of use of the model. According to Szafran (2012) coefficient of determination, R^2 and coefficient of correlation, R are useful in testing the relationship between variables. Descriptive statistics was used to analyze data collected on general information of the manufacturing firm, the variables and challenges facing manufacturing firms on adoption of green manufacturing.

3.5.2 Diagnostic Test

Correlation analysis was used to test for the relationship between the independent variable and the dependent variables. Coefficient of correlation and p-values were calculated and multi-collinearity was checked against the sub variables of the independent variable to test for the absence of correlation amongst the variables. Shapiro-Wilk test was used to test for normality of the data collected on the sub variables on green product design and development, efficient processes, GSCM, end-of-life management and operational management variables.

3.6 Operationalization of Variables

To measure the variables it was necessary to operationalized them into their indicators. Multiple indicators each with a five point Likert-scale was used for each latent construct. Table 3.1 shows how each of the latent construct was operationalized. Green product design and development was measured by using seven indicators, efficient processes and GSCM both had nine indicators, end-of-life product management had six indicators while operational performance had 12 indicators with each the four operational performance measure having three indicators.

Table 3.1: Operational Definitions of Variables

Variable	Sub-variable	Indicators	Source
Green manufacturing	Green product design and development	• Design of processes and product for environmental sustainability by eliminating toxic and harmful materials • Design for recycling by ensuring separation of parts or disassembling • Design products for remanufacture by enhancing refurbishment or reworks • Design products for material reduction • Designs products that use renewable of energy	Rao & Holt 2005, Eltayeb 2019, Orji & Wei 2017, Deif, 2011, Ahn, 2015

	• Design products and processes that saves energy • Designing products for transportability by having appropriate shapes	
Efficient processes	• Recycling/ reusing materials for product manufacturing thus reducing virgin raw materials • Energy saving processes • Processes that use green energy • Elimination of hazardous and toxic materials • Control emission of harmful gases to the environment by use of filters or scrubbers • Recycling of internal waste generated • Reduction in reworks and scrap • Green culture through quality management practices and switching off idle machines • Reduction in material wastage	Rao & Holt 2005, Eltayeb 2019, Orji & Wei 2017, Deif, 2011, Fore & Mbohwa, 2016 Eshikumo, 2017
GSCM	• Reduction overall packaging of products.	Rao & Holt 2005, Eltayeb 2019, Orji

	• Purchasing raw materials from suppliers having environmentally friendly principles • Transport modes with reduced energy wastage • Reduction disposal of packaging material by using materials with recyclable contents. • Reduction in pollution by contracting firms that observe environmentally friendly principles or EMS certified • Reduction on inventory levels • Use of space efficiently during storage and transportation of the product. • Delivery of products directly to the user site. • Reduction use of non-biodegradable	& Wei 2017, Deif, 2011
End-of-life product management	• Installation of collection points for collection of used products and packaging materials. • Safe disposal of unrecyclable waste • Products and packaging materials are returned to suppliers for reuse or recycling or remanufacturing	Rao & Holt 2005, Eltayeb, 2019, Orji & Wei 2017, Deif, 2011

		• Collecting waste generated by the firm's products. • Provision of necessary advice to customers on handling and disposing used products • Systems to monitor reverse flows of materials	
Operational performance	Cost	• Inventory levels reduction • Improved capacity utilization • Cost per operation hour	Slack et.al.,2007
	Flexibility	• Product mix • Ability of firm to vary delivery time to meet demand • Ability to introduce new products in case of demand • Ability of the firm to increase production should an increase in demand arise and vice versa	Slack et. al., 2007
	Speed	• Order lead time • Time to market • Machine set-up time	Slack et. al 2007
	Quality	• Products scrapped and reworked • Perceived quality and customer expectations	Slack et. al 2007

• Products returned by customers

3.7 Validity and Reliability Test

To ensure that the study findings are credible, reliability test and validity test was established. Reliability and validity tests was established at various sections. The following subsections discuss the tests that were conducted.

3.7.1 Reliability Test

According to Joppe (2000) reliability is the extent to which results are consistent over time and are an accurate representation of the total population under study. The research instrument is considered reliable, if under similar methodology the results are reproducible. According to Drost (2008) reliability tests involves establishing equivalence, stability over time and internal consistency. Cronbach's Alpha was used to verify the reliability of each construct and items used in the study, which was found to be 0.633. According to Hatcher (1994) reliability is high if the values of composite reliability scores are greater than 0.6.To determine internal consistency, composite reliability for the constructs forming the model was measured.

3.7.2 Validity Test

Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are (Trochim, 2006). Construct validity- refers to how well the initial concept that is a construct is operationalized. The exploratory factor analysis was used to determine construct analysis. Face validity is a subjective judgment on the operationalization of a construct (Drost, 2008). To enhance face validity the questionnaires were administered to five managers in operational department and the instrument adjusted to cater for the issues raised. Content validity was used to determine whether the concept were clear and a representation of the domain. Content validity was ensured in the data collection tool through consultation with experts from literature (Hair, Money, Samuel & Page, 2007).

CHAPTER FOUR

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the analyses conducted to test the relationships in conceptual model and reports the results of this study. It provides general information of the firms, response rate and respondent's characteristics. The chapter also gives descriptive statistics of the variables and indicators, the findings as presented in the objectives of the study, regression analysis of the model and ends with discussion of the findings.

4.2 Response Rate

The study focused on all 61 manufacturing firms in Mombasa County who are members of KAM. Out of the 61 questionnaire distributed only 48 were filled and collected back. On screening of the questionnaires, it was found that 1 of the questionnaire had missing information. A total of 14 firms did not respondent this was because of no-survey policy and flat refusal of respondents to respond to the questionnaire. A few missing responses were found randomly in two questionnaires. This may have been due to oversight of the respondents or may have perceived the information as confidential. The response rate was 73.77% as shown in Figure 4.1.

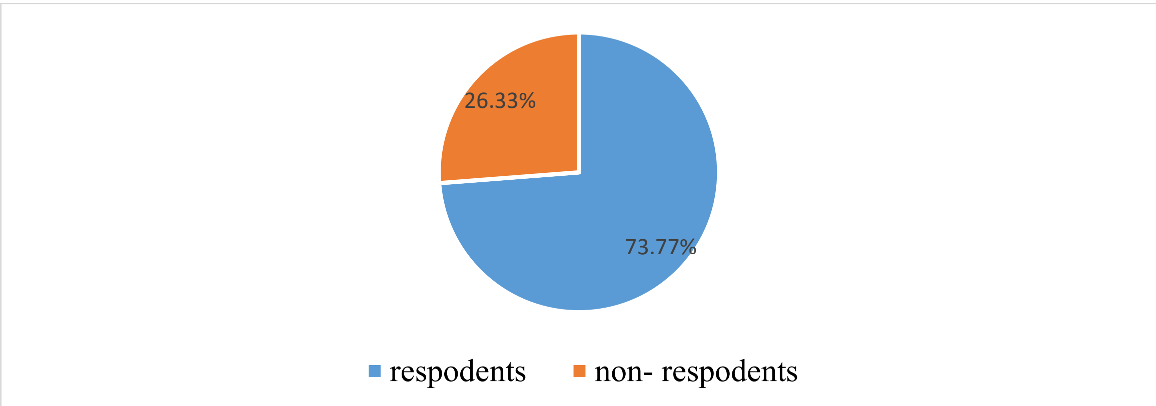

Figure 4.1: Pie Chart of Response Rate

4.3 General Information

This section discusses general information of the firms, which include: scope of operation in terms of the market served by the manufacturing firms, the category of the manufacturing firms, number of employees, ownership and ISO 14001 certification.

4.3.1 Firms Demographic Characteristics

When asked to state their ownership structure 60% of the firms that responded were locally owned, whereas 33.3% were foreign owned. Only 6.7% of the firms have a mix of local and foreign ownership as represented in figure 4.2.

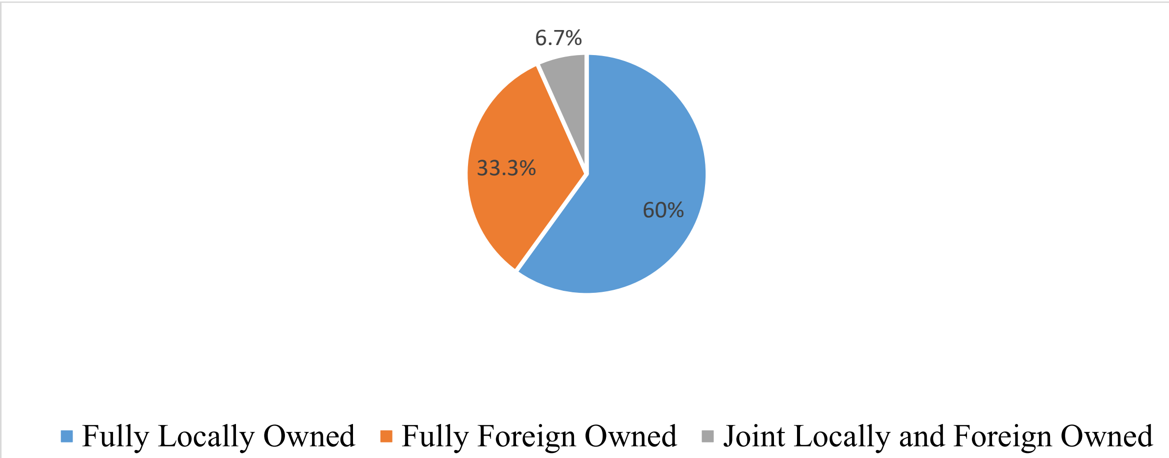

Figure 4.2: Pie Chart of Ownership Status

4.3.2 Manufacturing Sub-sector

Table 4.1 presents the findings with majority of the firms that responded being from Food, Beverage and Tobacco (29.2%) subsector with Plastics and Rubber constituting 13.3% of the respondents. Chemical & Allied was 11.1% of firms that responded while Textiles & Apparels and Motor Vehicles & Accessories each constituted 8.9% of total respondents. Building, Construction & Mining, Metal & Allied and Electrical & Electronics each subsector constituted to 6.7% of the respondents whereas Paper & Board was 4.4% of the firms surveyed. Pharmaceuticals & Medical and Consultancy and Industrial Services each with 2.2% of the respondents were the least.

Table 4.1: Manufacturing Sub-sector

Manufacturing Subsector	Frequency	Percent
Building, Construction & Mining	3	6.7
Chemical & Allied	5	11.1
Consultancy and Industrial Services	1	2.2
Electrical & Electronics	3	6.7
Food, Beverage &Tobacco	13	29.2
Metal & Allied	3	6.7
Motor Vehicles & Accessories	4	8.9
Paper & Board	2	4.4
Pharmaceutical & Medical Equipment	1	2.2
Plastics & Rubber	6	13.3
Textiles & Apparels	4	8.9
Total	45	100.0

4.3.3 Market coverage

When requested to state the market coverage 46.7% stated that they were operating in the local market, whereas 42.2% were operating in the region. Only 11.1% of the surveyed firms were operating on global scale. The results are presented in Figure 4.3.

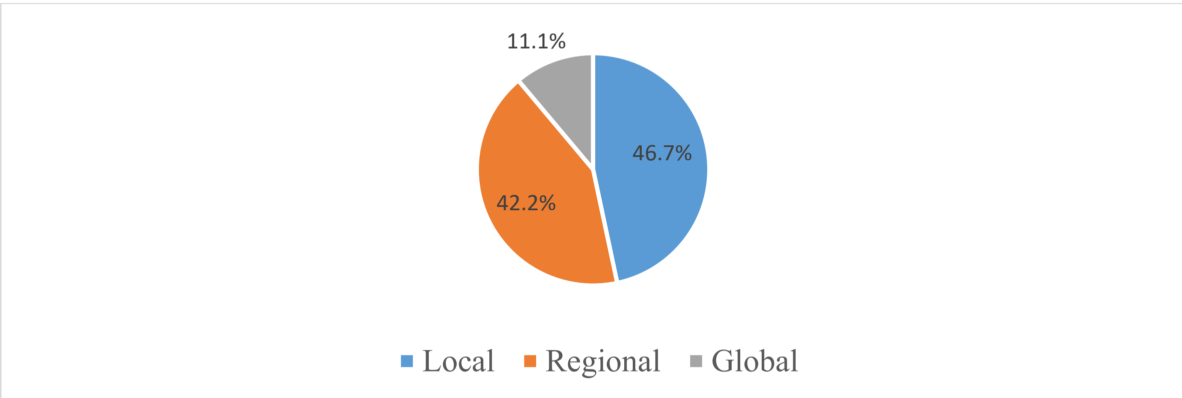

Figure 4.3: Pie Chart of Market Coverage

4.3.3 Employees in the manufacturing firms

When requested to indicate the number of employees employed by the manufacturing firms, 42.22% of the firms that responded had employee between 300 to 499, 24.44% of the firms had 100 to 299 employees, 17.78% had employees in the range of 500-699 while 8.89% had over 700 employees. Only 6.67% of the firms that responded had less than 100 employees as depicted in Table 4.2.

Table 4.2: Employees in the Manufacturing Firms

Number of full-time employees	Frequency	Percentage
Less than 100	3	6.67%
100 to 299 employees	11	24.44%
300 to 499 employees	19	42.22%
500 to 699 employees	8	17.78%
700 and above	4	8.89%

4.3.4 Age of Firm

Table 4.3 presents the results on age of the firms surveyed. Majority of the firms of the firms (71.1%) that responded had been in operation for more than 20 years, 13.3% of the firms that responded had been in operation for 10 - 20 years, while 13.3% of the firms that responded had been in operation for more than 5-10 years. Only 2.2% of the firms surveyed had less than 5 years in operation.

Table 4.3: Age of the firm

Length of Service in Operation	Frequency	Percent
Less than 5 years	1	2.2
5-10 years	6	13.3
10-20 years	6	13.3
More than 20 years	32	71.1
Total	45	100.0

4.3.5 ISO 14001 Certification

When requested to state whether the firm was ISO 14001 certified, 75.6% of the firms were are not ISO 14001 certified with only 24.4% being certified. The findings are depicted in Figure 4.4.

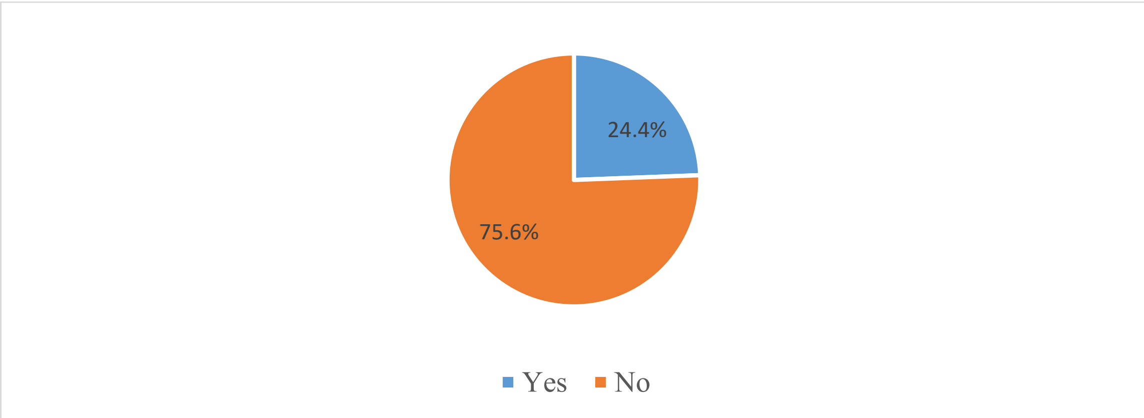

Figure 4.4: Pie Chart of ISO 14001 Certificated Firms

4.4 Reliability Tests

This research had four broad constructs, which are green design and development, efficient processes, GSCM and end-of-life product management. The constructs were further subdivided into 31 sub-constructs. Green design and development had 6 sub-constructs, GSCM had 9 sub-constructs, Efficient processes had 9 sub-constructs and end of life had 7 sub-constructs. Exploratory factor analysis (EFA) was done using principal component analysis with Varimax rotation. Before assessing the factor loadings, Kaiser-Meyer-Olkin Measures of sampling adequacy were evaluated to check the factorability of the items. For every EFA, it was found that manifest variables had KMO Measures of Sampling Adequacy above 0.665 as presented in Table 4.4. The value of KMO was above the threshold of 0.6 (Kaiser, 1974).

Table 4.4: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.665
	Approx. Chi-Square	42.068
	Df	6
	Sig.	.000

Table 4.5 represents Cronbach's Alpha, which was 0.633 at 5% significance level indicating that the constructs were reliable since it surpasses the threshold of 0.6 (Hatcher,1994).

Table 4.5: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
.633	.649	4

The factor loadings for the constructs were found to range from 0.594 to 0.82 as illustrated in Table 4.6, which was above the 0.3 threshold required confirming high reliability. Green product design and development had a factor loading of 0.698, efficient processes had a factor loading of 0.82, GSCM had factor loadings of 0.741 whereas efficient processes had factor loading of 0.594.

Table 4.6: Factor Loadings

Variable	N	Mean	Cronbach's Alpha	Factor loading	Item total-correlation
Green product design and development	45	3.5775	0.849	0.698	0.622
Efficient processes	45	3.6884	0.609	0.82	0.720
GSCM	45	3.6247	0.645	0.741	0.712
End-of-life product management	45	3.3704	0.602	0.594	0.544

4.5 Normality Test

The test for normality was done by use of Shapiro-Wilk with the results are presented in Table 4.7. Green product design had p-value of 0.280, efficient process had p-value 0.561, and GSCM had p-value of 0.060 while end-of-life product management had p-value of 0.360. All the p-values was found to be more than 0.05 implying normal distribution.

Table 4.7: Normality Tests

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Green product design and development	.133	45	.045	.943	45	.280
Efficient Processes	.089	45	.200*	.979	45	.561
Green supply chain management in manufacturing	.178	45	.001	.922	45	.060
End-of-life product management	.117	45	.138	.973	45	.360

4.6: Descriptive Analysis of the Study Variables

The respondents were required to specify various statements on the extent to which green manufacturing concepts were adopted in their firms using a scale of 1 to 5. 1- Not all, 2- small extent, 3- moderate extent, 4- great extent and 5- very great extent. From the findings on the concepts, the means and standard deviation were calculated for interpretations and generalizations.

4.6.1 Green Product Design and Development

When requested to ascertain the extent to which the firm designed products and processes for environmental protection all the firms indicated that they designed products and process but at different extent as presented in Table 4.8. 42.2 % of the firms that responded indicated that design of product and process for environmental protection was to very great extent, 26.6% stated that they practiced to moderate extent, in 24.4% was to great extent and only in 6.7% of the firms was to a small extent. The mean was 4.0222 (SD=0.98832) implying that it was practiced to great extent.

Table 4.8: Product and Process Design for Environmental Protection

	1	2	3	4	5	Total	Mean	SD
Frequency	0	3	12	11	19	45		
Percentage	0%	6.7%	26.7%	24.4%	42.2%	100%	4.0222	.98832

When asked to respond to extent at which the firm practiced product and process design for recycling 28.9% of the firms that responded adopted design for recycling to both great and small extents, 22.2% was to moderate extent while in 17.8% was to very great extent. Only in 2.2% of the firms that responded did not practice design for recycling at all. The findings are presented in Table 4.9. The average was 3.3311 (SD=1.14460), indicating that the respondents practiced product and process design for recycling at a moderate extent.

Table 4.9: Product and Process Design for Recycling

	1	2	3	4	5	Total	Mean	SD
Frequency	1	13	10	13	8	45		
Percentage	2.2%	28.9%	22.2%	28.9%	17.8%	100%	3.3111	1.14460

When requested to respond on the extent to which the firm designed products for remanufacturing all the firms indicated that designed for remanufacturing was practiced but at varying extents. 42.2 % of the firms that responded indicated that design for remanufacturing was to small extent, 26.7% of the firms that responded stated that they practiced to a moderate extent, in 15.6% of the firms that responded stated that design for remanufacturing was to great extent and very great as illustrated in Table 4.10. The average was 3.0444 (SD=1.10691). This implies that product and process design for remanufacturing was to moderate extent among the respondents.

Table 4.10: Product and Process Design for Remanufacturing

	1	2	3	4	5	Total	Mean	SD
Frequency	0	19	12	7	7	45		
Percentage	0%	42.2%	26.7%	15.6%	15.6%	100%	3.0444	1.10691

When requested to state the extent to which the firm adopted design for reduction of material consumption, all the firms ascertained that they practiced the design but at varying extents as shown in Table 4.11. 31.1% of the firms that responded stated that reduction of material consumption was designed at very great and great extent, in 28.9% respondents it was to moderate extent while in only 8.9% of the firms that respondent was to great extent. The mean was 3.8444 (SD=0.97597) implying that product design for reduction of material consumption was to great extent among the firms surveyed.

Table 4.11: Product Design for Reduction of Material Consumption

	1	2	3	4	5	Total	Mean	SD
Frequency	0	4	13	14	14	45		
Percentage	0%	8.9%	28.9%	31.1%	31.1%	100%	3.8444	.97597

Table 4.12 presents results on product design for reduction of energy consumption where all firms stated that efforts were made to reduce energy consumption but at different extents. Majority of the firms surveyed (42.2%) indicated that design for reduction in energy consumption was to a very great extent, in 26.7% of the firms that responded stated it was to great extent whereas in 17.8% of the firms that responded was to small extent. In only 13.3% of the firms that responded the design was to a moderate extent. The mean was 3.933 (SD =1.13618) which indicated that on average the surveyed firms practiced design for reduction in energy consumption to great extent.

Table 4.12: Product Design for Reduction in Energy Consumption and Use of Renewable Energy

	1	2	3	4	5	Total	Mean	SD
Frequency	0	8	6	12	19	45		
Percentage	0%	17.8%	13.3%	26.7%	42.2%	100%	3.9333	1.13618

When asked to state the extent to which the firm designed products in order to reduce consumption of non-renewable resources, 40% of that responded stated that it was to great extent, in 26.7% of the firms surveyed stated it was to a moderate extent. In 13.3% of the firms, that responded stated that design of products to reduce consumption of non-renewable resources was to very great extent while in 11.11% of the respondents was to small extent. Only 8.9% of the firmed that responded did not design products for reduction of consumption of non-renewable resources. The mean was 3.3778 implying design for transportation among the firms surveyed was to a moderate extent. The results are shown in Table 4.13.

Table 4.13: Product Design for Reduction Consumption of Non-Renewable Resources

	1	2	3	4	5	Total	Mean	SD
Frequency	4	5	12	18	6	45		
Percentage	8.9%	11.1%	26.7%	40%	13.3%	100%	3.3778	1.13396

When requested to indicate the extent to which the firms designed products for storage and transportation, in 28.9% indicated that it was to great extent, in 26.7% was to moderate extent, in 24.4% of the firms that responded was to very great extent while in 13.3% of the firms that responded was to small extent. Only 6.7 % of the firms surveyed did not design products for transportation as presented in Table 4.14. The mean was 3.5111 indicating that design of products for transportation and storage was to great extent.

Table 4.14: Reduction of Transportation and Storage Space by Designing Products with Appropriate Shapes

	1	2	3	4	5	Total	Mean	SD
Frequency	3	6	12	13	11	45		
Percentage	6.7%	13.3%	26.7%	28.9%	24.4%	100%	3.5111	1.19891

The grand mean for green product design and development was 3.5775 indicating that the surveyed firms practiced green product design and development to great extent. Cronbach's Alpha was of 0.849 confirming reliability and construct validity.

4.6.2 Efficient Processes

Efficient processes had 9 sub-constructs with a grand mean of 3.6884 which implies that efficient processes amongst the manufacturing firms was to great extent. Cronbach's Alpha was of 0.609 confirming reliability and construct validity. Majority of the firms (48.9%) that were surveyed specified that their process recycled/reused materials to great extent, in 24.4% of the firms was to very great extent while in 15.6% of the firms that responded reduced virgin material consumption to a moderate extent. Only 11.1% of the firm surveyed reduced virgin material consumption to small extent. All the firms specified that there was a continuous effort to reduce virgin material consumption as demonstrated in Table 4.15. The mean was 3.8667 suggesting the firms that responded reduced consumption of virgin materials to great extent.

Table 4.15: Reduction of Virgin Materials Through Recycling or Reuse

	1	2	3	4	5	Total	Mean	SD
Frequency	0	5	7	22	11	45		
Percentage	0%	11.1%	15.6%	48.9%	24.4%	100%	3.8667	.91949

When the firms were asked to respond to the extent to which the firm reduced energy wastage through efficient process, majority (51.1%) of the firms that responded stated that it was to great text, 31.1% of the firms surveyed stated that the practice was to moderate extent while in 8.9% was to very great extent. Only in 4.4% of the respondents, the practice was either to small and not adopted at all presented in Table 4.16. The mean was 3.5556 implying that reduction of energy wastage in the firms that responded was to great extent.

Table 4.16: Reduction of Energy Wastage by Ensuring that Processes Use Energy Efficiently

	1	2	3	4	5	Total	Mean	SD
Frequency	2	2	14	23	4	45		
Percentage	4.4%	4.4%	31.1%	51.1%	8.9%	100%	3.5556	.89330

When asked to respond the extent to which the firm adopted use of green energy by reducing on the consumption of non-renewable energy, 37.8% of the firms that responded indicated that the concept was implemented to great extent. In 33.33% of the firms surveyed was stated that the practiced to moderate extent, while in 11.1% of the respondents it was not implemented at all. Only 8.9% of the firms that responded indicated that they reduced usage of non-renewable energy to small extent or to great extent as presented in Table 4.17. The mean was 3.2444 indicating that reduction of non-renewable energy usage was implemented to a moderate extent.

Table 4.17: Reduction of Usage of Non-Renewable Energy by Use of Green Energy

	1	2	3	4	5	Total	Mean	SD
Frequency	5	4	15	17	4	45		
Percentage	11.1%	8.9%	33.3%	37.8%	8.9%	100%	3.2444	1.11101

Majority of the firms (48.9%) of the firms that were surveyed indicated that elimination of hazardous and toxic materials in their processes was to very great extent, in 24.4% of the firms that were surveyed was to great extent whereas in 13.3% was to moderate extent. Only 6.7% of the firms surveyed stated that they had either implemented elimination of hazardous or toxic materials to small extent or were still using toxic materials as shown in Table 4.18. The mean was 4.0022 indicating that implementation of processes that eliminate usage of hazardous or toxic materials was to great extent.

Table 4.18: Processes That Eliminate Usage of Hazardous and Toxic Materials

	1	2	3	4	5	Total	Mean	SD
Frequency	3	3	6	11	22	45		
Percentage	6.7%	6.7%	13.3%	24.4%	48.9%	100%	4.0222	1.23378

When requested to state the extent to which the firm’s processes controlled emission of harmful gases to the environment all the firms indicated that there was some degree of emission control in their processes as presented in Table 4.19. 44.4% of the firms that responded indicated it was to great extent, 28.9% of the firms surveyed stated it was to moderate extent while 17.8% was to very great extent. Only in 8.9% was to small extent.

Table 4.19: Processes that Control Emission of Harmful Gases to the Environment

	1	2	3	4	5	Total	Mean	SD
Frequency	0	4	13	20	8	45		
Percentage	0%	8.9%	28.9%	44.4%	17.8%	100%	3.7111	.86923

When asked to respondent the extent to which the firm minimized internal waste generated through recycling, 33.3% of the firms surveyed stated recycling of internal waste was to great extent, while 28.9% of the firms that responded stated it was to moderate extent whereas in 26.7% of the firms surveyed indicated control of emissions was to small extent. Only in 11.1% of the surveyed firms, stated internal waste was recycled to great extent. All firms that were surveyed stated that they were recycling internal waste but at varying extents as shown in Table 4.20. The mean was 3.2889 indicating that recycling of internal waste was to moderate extent among the firms surveyed. The findings are presented on Table 4.20.

Table 4.20: Processes that Minimize Disposal by Recycling of Internal Waste Generated

	1	2	3	4	5	Total	Mean	SD
Frequency	0	12	13	15	5	45		
Percentage	0%	26.7%	28.9%	33.3%	11.1%	100%	3.2889	.99138

Majority of the firms (44.4%) surveyed indicated that their processes reduced scrap and reworks to very great extent, in 26.7% was to great extent whereas in 20.0% of the firms that responded stated that it was to a moderate extent. Only in 8.9%, firms that responded reduced scrap and reworks to a small extent. The mean was 4.0667indicating that the firms' surveyed minimized product scrap and reworks to great extent. Table 4.21 shows the findings.

Table 4.21: Processes that Minimize Product Scrap and Reworks

	1	2	3	4	5	Total	Mean	SD
Frequency	0	4	9	12	20	45		
Percentage	0%	8.9%	20.0%	26.7%	44.4%	100%	4.0667	1.00905

When requested to state the extent to which the firms reduced energy consumption through green culture, all the firms ascertained that energy consumption was reduced through green as presented in Table 4.22. In 42.2% of the firms that responded indicated that reduction in energy consumption was to great extent, in 33.3% of the firms surveyed was to very great extent while 17.8% of the firms surveyed indicated that reduction in energy consumption was to moderate extent. Only 6.7% of the firms that responded stated that reduction in energy consumption through green culture was to a small extent. The mean was 4.0222 indicating that reduction in energy consumption through green culture was to great extent.

Table 4.22: Reduction of Energy Consumption Through Green Culture

	1	2	3	4	5	Total	Mean	SD
Frequency	0	3	8	19	15	45		
Percentage	0%	6.7%	17.8%	42.2%	33.3%	100%	4.0222	.89160

When asked to respond on the extent to which reduction of material wastage was implemented, 35.6% of the firms that responded stated that it was to great extent, 31.1% of the firms surveyed stated that the implementation was to moderate extent. In 17.8% of the firms that responded was to small extent whereas in 13.3% of the firms surveyed the practice was to very great extent. Only 2.2%, of the firms surveyed stated that their cutting tools were wasting materials. Table 4.23 presents the findings. The average was 3.4000 implying that proper cutting tools aimed at reducing material wastage were used to moderate extent amongst the firms surveyed.

Table 4.23: Reduction of Material Wastage by Use of Proper Cutting Tools

	1	2	3	4	5	Total	Mean	SD
Frequency	1	8	14	16	6	45		
Percentage	2.2%	17.8%	31.1%	35.6%	13.3%	100%	3.4000	1.00905

4.6.3 GSCM

GSCM had 9 sub-constructs with a grand mean of 3.6247, which implies that manufacturing firms were practicing GSCM to great extent. Cronbach's Alpha was 0.649 confirming reliability and construct validity. When asked to indicate the extent to which the firm has adopted proper usage of storage and transportation space, 48.9% of the firms that were surveyed stated that the practice was implemented to great extent, in 24.4% of the firms that responded implementation was to moderate extent. In 11.1% of the firms that responded stated that implementation was to very great extent. 8.9% of the firms that responded had not yet implemented proper space utilization during transportation and storage in their firms whereas only 6.7% of the respondents', implementation was to small extent. The mean was 3.4667 implying that the appropriate space utilization during distribution among the firms surveyed was to a moderate extent as presented in Table 4.24.

Table 4.24: Proper Usage of Storage and Transportation of Space

	1	2	3	4	5	Total	Mean	SD
Frequency	4	3	11	22	5	45		
Percentage	8.9%	6.7%	24.4%	48.9%	11.1%	100%	3.4667	1.07872

Majority of the firms (53.3%) that responded indicated that they had reduced overall packaging of the products by very great extent, 24.4% of the firms surveyed stated that overall packaging reduction was to great extent. In 13.3% of the firms that responded stated that reduction of overall packaging of products was to moderate extent whereas in 6.7% was to small extent. Only 2.2% of the respondents had not reduced their overall packaging of the products as shown in Table 4.25. The mean was 4.200 implying the overall packaging was reduced to great extent among the firms that responded.

Table 4.25: Reduction Overall Packaging of Products

	1	2	3	4	5	Total	Mean	SD
Frequency	1	3	6	11	24	45		
Percentage	2.2%	6.7%	13.3%	24.4%	53.3%	100%	4.2000	1.05744

When requested to state the extent to which the firm had reduced the use of non-biodegradable materials by using bioplastics, in 35.6% of the firms that responded indicated that it was to small extent, in 26.7% of the firms surveyed stated that use of bioplastics was to moderate extent while in 20% was to a very great extent. 11.1% of the firms surveyed point out that they were using biodegradable packaging materials to great extent. Only 6.7% of the firms revealed that they were not using biodegradable materials for packaging as presented in Table 4.26. The average was 3.0222 meaning that the firms that responded had reduced the use of non-biodegradable materials to a moderate extent.

Table 4.26: Reduction Non-Biodegradable Material by Use of Bioplastics

	1	2	3	4	5	Total	Mean	SD
Frequency	3	16	12	5	9	45		
Percentage	6.7%	35.6%	26.7%	11.1%	20%	100%	3.0222	1.25207

Table 4.27 shows that all the firms that were surveyed had reduced disposal of packaging materials but to varying extents. Majority of the firms (53.3%) that responded indicated that they had reduced disposal of materials by using packaging materials with recyclable content. In 17.8% and 15.6% of the firms that were surveyed indicated reduction of disposal of packaging materials was to very great and moderate extents respectively while 13.3% of the firms that responded stated that the practice was to small extent. The average was 3.7111 translating that reduction of packaging materials through usage of recyclable materials was to great extent

Table 4.27: Reduction of Disposal of Packaging Material by Using Recyclable Materials

	1	2	3	4	5	Total	Mean	SD
Frequency	0	6	8	24	7	45		
Percentage	0%	13.3%	17.8%	53.3%	15.6%	100%	3.7111	.89499

When requested to state the extent to which the firms were using transport modes all firms specified that they were using transport modes with reduced energy wastage but at different extents as shown in on Table 4.28. In 31.1% of the firms that responded the practice was to very great extent, 28.9% of the firms surveyed were utilizing transport modes with reduced energy wastage to both moderate and great extent. Only 11.1% of the firms that were surveyed were using transport modes with reduced energy wastage to small extent. The mean was 3.800 indicating that the firms that responded were using transport mode with reduced energy wastage was to great extent.

Table 4.28: Transport Modes with Reduced Energy Wastage

	1	2	3	4	5	Total	Mean	SD
Frequency	0	5	13	13	14	45		
Percentage	0%	11.1%	28.9%	28.9%	31.1%	100%	3.8000	1.01354

When requested to state the extent to which the firm delivers products to user sites, 35.6% of the firms that responded stated that they delivered products to user site to moderate extent. In 22.2% of the surveyed firms stated delivery of products to consumer site was to small extent while, in 20% of the firms surveyed stated that products were delivered to user sites to both great and very great extent. Only 2.2% of the surveyed firms specified that they do not deliver products to user sites, as presented in Table 4.29. The average was 3.333 implying that the firms surveyed delivered products to user site to moderate extent.

Table 4.29: Delivery of Products Directly to the User Site

	1	2	3	4	5	Total	Mean	SD
Frequency	1	10	16	9	9	45		
Percentage	2.2%	22.2%	35.6%	20%	20%	100%	3.3333	1.10782

When asked to indicate the extent to which the firm had reduced inventory levels for products and raw materials by maintaining optimal levels, 33.3% of the firms surveyed revealed that they had reduced the reduced inventory levels to great extent, in 26.7% of the firms that responded indicated that they had reduced inventory levels to very great extent. In 22.2% of the firms that responded stated, that the inventory levels were reduced to small extent whereas in 11.1% of the firms surveyed the practice was to moderate extent. Only 6.7% of the firms that responded had not reduced inventory levels to optimum levels. The average was 3.5111 showing that the firms that were surveyed had reduced inventory levels to great extent. Table 4.30 depicts the findings.

Table 4.30: Reduction on Inventory Levels by Maintain Optimal Levels

	1	2	3	4	5	Total	Mean	SD
Frequency	3	10	5	15	12	45		
Percentage	6.7%	22.2%	11.1%	33.3%	26.7%	100%	3.5111	1.29021

When requested to state the extent to which the firm was purchasing raw materials from suppliers who have environmentally friendly principles 40.0% of the firms that were surveyed revealed that supplies from suppliers with environmentally friendly principles was to very great extent, in 33.3% of the firms that responded was to great extent. In 15.6% of the respondents was to moderate extent whereas 8.9% of the firms surveyed indicated that it was to small extent. Only 2.2% of the firms that responded were purchasing supplies from any supplier. The average was 3.800 indicated that the firms that responded were purchasing raw materials from suppliers having environmentally friendly principles was to great extent. Table 4.31 illustrates the results.

Table 4.31: Purchasing Raw Materials from Suppliers Having Environmentally Friendly Principles

	1	2	3	4	5	Total	Mean	SD
Frequency	1	4	7	15	18	45		
Percentage	2.2%	8.9%	15.6%	33.3%	40%	100%	3.8000	1.01354

When asked to state the extent to which the firm reduced pollution by contracting firms that observe environmentally friendly principles all firms revealed that they were contracting such firms but at different extents as shown in Table 4.32. Majority (44.4%) of the firms that were surveyed stated that the contracted firms with environmentally friendly principles to great extent, in 35.6% of the respondents was to moderate extent whereas in 11.1% of the firms that responded was to very great extent. Only in 8.9% of the respondents contracted firms that observe environmentally friendly principles to small extent. The mean was 3.5778 implying that the practice was implemented to great extent.

Table 4.32: Reduction in Pollution by Contracting Firms that Observe Environmentally Friendly Principles or EMS Certified

	1	2	3	4	5	Total	Mean	SD
Frequency	0	4	16	20	5	45		
Percentage	0%	8.9%	35.6%	44.4%	11.1%	100%	3.5778	.81153

4.6.4 End-Of-Life Product Management

End-of-life product management had 7 sub-constructs with grand mean of 3.3704 this implies that end-of-life product management was practiced to a moderate extent and Cronbach's Alpha was 0.602 confirming reliability and construct validity. When requested to indicate the extent to which the firm had installed collection points for product recovery, 31.1% of the firms that were surveyed stated that it was to great extent, 26.7% the firms that responded stated that it was to very great extent. In 24.4% of the respondents indicated that it was to moderate extent whereas 15.6% of the respondents stated that it was to small extent. Only 2.2% of the firms that responded revealed that they were yet to establish product recovery collection points as presented 4.33. The average was 3.644 implying that the firms that responded had installed collection points for used products to great extent.

Table 4.33: Installation of Collection Points for Product Recovery

	1	2	3	4	5	Total	Mean	SD
Frequency	1	7	11	14	12	45		
Percentage	2.2%	15.6%	24.4%	31.1%	26.7%	100%	3.6444	1.11101

When asked to state the extent to which the firm was engaged in collection waste generated by the firm's products, 40% of the firms that responded stated that the practice was to moderate extent, in 24.4% of the firms that responded was to great extent. In 17.8% of the firms that responded was to very great extent whereas 13.3% of the firms that were surveyed stated that the practice was adopted to small extent. Only 4.4% of the firms that responded revealed that they do not collect waste generated by the firms' products. Table 4.34 presents the findings. The mean was 3.3778 implying that the firms that were surveyed were collecting waste generated by the firm's products to a moderate extent.

Table 4.34: Collection of Waste Generated by the Firm's Products

	1	2	3	4	5	Total	Mean	SD
Frequency	2	6	18	11	8	45		
Percentage	4.4%	13.3%	40%	24.4%	17.8%	100%	3.3778	1.07215

When requested to indicate the extent to which the firm had put in place systems for monitoring reverse flow of materials all the firms indicated they had such systems though the implementation was to varying degree. Majority (40.0%) of the firms that responded had put in place systems to monitor reverse flow of materials to moderate extent. In 33.3% of the firms that responded stated that implementation was to small extent whereas in 15.6% of the firms that responded was to great extent, with only 11.1% the firms that were surveyed indicating that had put in place systems to monitor reverse flow to great extent. The average was 3.044 indicating that the firms surveyed had put in place firms systems to monitor reverse flow to moderate extent. Table 4.35 presents the results.

Table 4.35: Systems to Monitor Reverse Flows of Materials

	1	2	3	4	5	Total	Mean	SD
Frequency	0	15	18	7	5	45		
Percentage	0%	33.3%	40%	15.6%	11.1%	100%	3.0444	.97597

When requested to indicate the extent to which the firm provided appropriate advice to customers on aspects of handling and disposal 33.3% of the firms indicated that they did provide appropriate advice to customers to moderate extent, in 31.1% of the respondents it was to great extent. In 24.4% of the firms that responded indicated that they provided advice to their customers to small extent while in 8.9% of the firms surveyed advice was offered to very great extent. Only 2.2% of the respondents specified that they do not provide advice to customers on handling and safe disposal of their products. The mean was 3.2 inferring that the firms that responded offered advice to customer concerning handling and disposal of their products to a moderate extent. Table 4.36 depicts the findings.

Table 4.36: Provision of Necessary Advice to Customers of Handling and Disposing Used Products

	1	2	3	4	5	Total	Mean	SD
Frequency	1	11	15	14	4	45		
Percentage	2.2%	24.4%	33.3%	31.1%	8.9%	100%	3.2000	.99087

When asked to respond on the extent to which the firm disposed unrecyclable waste safely all stated that they disposed waste safely though it was to varying extent as shown in Table 4.37. In 44.4% of the firms that responded indicated, that safe disposal of waste was to great extent whereas 28.9% of the respondents stated that they disposed their waste safely to moderate extent. Only 13.3% of the firms that were surveyed indicated that they disposed their waste safely to both very great extent and small extent. The mean was 3.5556 implying that safe disposal of waste by the respondents was to great extent.

Table 4.37: Safe Disposal of Unrecyclable Waste

	1	2	3	4	5	Total	Mean	SD
Frequency	0	5	13	20	6	45		
Percentage	0%	13.3%	28.9%	44.4%	13.3%	100%	3.5556	.94281

When asked to state the extent to which used products and packaging were returned to the suppliers for remanufacturing or recycling, 31.1% of the respondents indicated that the practice implemented to both great extent and moderate extent, in 17.8% of the firms that responded indicated that the concept was adopted to very great extent. 13.3% of the firms that were surveyed indicated that used products and packaging where returned to supplier to small extent whereas 6.67% of the firms revealed that they do not return materials to suppliers for recycling or remanufacturing as presented in Table 4.38. The average was

3.4000 indicating that firms returned materials to suppliers for recycling or remanufacturing to great extent.

Table 4.38: Used Products and Packaging are Returned to Suppliers for Reuse or Recycling or Remanufacturing

	1	2	3	4	5	Total	Mean	SD
Frequency	3	6	14	14	8	45		
Percentage	6.7%	13.3%	31.1%	31.1%	17.8%	100%	3.4000	1.13618

4.6.5: Operational Performance

Operational performance was measured by use of 4 sub-constructs, which are quality, cost, flexibility and speed. To measure quality, speed, cost and flexibility respondents were asked to state the extent to which the firm has benefited in terms of reduction in cost (reduction in inventory levels, reduction in cost per hour and improvement in capacity underutilization), improvement in quality (reduction in scarped or reworked products, improvement in functionality of the products, reduction in products returned. Increased speed (reduction in lead-time, time to market and increased machine set-up time) and improved flexibility (ability to increase production and number of new products). A Likert-scale of 5 point was used with 1 being “not at all” with 5 being to “very great extent”.

Quality had a grand mean of 4.2 implying that quality has greatly improved by adopting green manufacturing practices. Cronbach's Alpha was 0.729 confirming reliability and construct validity. When asked to state the extent to which the firm had reduced scrap and reworks after implementing green manufacturing 60% of the firms that responded stated that they had managed to reduce scrap and reworks to very great extent and 20% of the firms that responded indicated that they had benefited to great extent. 11.1% of the firms that responded stated that the benefit was to moderate extent. In 6.7% of the firms surveyed stated that they had reduced scrap and reworks to small extent. Only 2.2% of the respondents stated levels of scrap and reworks were still high. The mean was 4.2889 implying that the respondents had reduced scrap and reworks to great extent. Table 4.39 presents descriptive analyses of the findings on reduction in products scrapped.

Table 4.39: Reduction in Products Scrapped and Reworked

	1	2	3	4	5	Total	Mean	SD
Frequency	1	3	5	9	27	45		
Percentage	2.2%	6.7%	11.1%	20%	60%	100%	4.2889	1.05792

Majority (31.1%) of the firms stated that product failure in the market had reduced to moderate extent after implementing green manufacturing, in 28.9% of the firms that responded stated that product failure had reduced to great extent whereas 26.7% of the firms surveyed stated that reduction of product failure was to small extent as a result of adopting green manufacturing. Only 13.3% of the firms that responded said product failure had reduced to very great extent. The average was 4.1778 inferring that the firms that were surveyed the benefit of reducing scrap and reworks by implementing green manufacturing is to great extent. Table 4.30 presents the results.

Table 4.40: Reduced Product Failure in the Market

	1	2	3	4	5	Total	Mean	SD
Frequency	0	12	14	13	6	45		
Percentage	0%	26.7%	31.1%	28.9%	13.3%	100%	4.1778	.83364

When requested to state the extent to which the number of products returned by customers had reduced due to implementing green manufacturing all the firms indicated that the numbers have reduced but to varying degree. The descriptive analysis of reduction in quantity of products returned is presented in Table 4.41. 44.44% of the firms that responded stated that the number of products returned had reduced to very great extent, 28.9% of the firms that responded stated that the number of products returned had reduced by a great extent while 26,7% of the firms surveyed indicated that the quantity of products returned by customers had reduced to moderate extent. The mean was 4.2888 implying that number of products returned by customers had reduced to great extent.

Table 4.41: Reduction in Quantity of Products Returned by Customers

	1	2	3	4	5	Total	Mean	SD
Frequency	0	0	12	13	20	45		
Percentage	0%	0%	26.7%	28.9%	44.4%	100%	4.2888	.86923

Production cost has greatly reduced on the adoption green manufacturing practices with a grand mean of 3.729. The Cronbach's Alpha was 0.654 confirming reliability and construct validity. When requested to indicate the extent to which the firm had benefited from green manufacturing in terms of reduction in inventory levels, 33.3% of the respondents stated that inventory had reduced by great extent, 28.9% of the firms that responded indicated that inventory levels had reduced by moderate extent. 17.8% of the firms that responded stated that inventory levels had reduced by very great extent whereas 15.6 % of the firms that responded stated inventory levels had reduced by small extent. Only 8.9% of the respondents revealed that inventory levels had remained constant. The average was 3.4444 suggesting that the inventory levels among the firms surveyed had reduced by moderate extent. Table 4.42 presents the results of reduction in inventory levels.

Table 4.42: Reduction in Inventory Levels

	1	2	3	4	5	Total	Mean	SD
Frequency	2	7	13	15	8	45		
Percentage	8.9%	15.6%	28.9%	33.3%	17.8%	100%	3.4444	1.09867

When asked to respond to the extent by which capacity underutilization had reduced on adopting green manufacturing, majority (42.2%) of the firms that responded indicated that it was by very great extent. 26.7% of the firms surveyed stated that capacity underutilization had reduced by great extent, 20% of the firms that responded stated that capacity underutilization had reduced by moderate extent while 6.7% of the respondents indicated that capacity underutilization had not reduced. Only 4.4% of the firms that responded indicated that capacity underutilization had reduced by small extent. The average was 3.9333 implying that the firms that were surveyed capacity underutilization had reduced by great extent. The findings are presented in Table 4.43.

Table 4.43: Reduction in Capacity Underutilization

	1	2	3	4	5	Total	Mean	SD
Frequency	3	2	9	12	19	45		
Percentage	6.7%	4.4%	20%	26.7%	42.2%	100%	3.9333	1.19469

When requested to indicate the extent cost of operation per hour reduced on implementing green manufacturing, 46.7% of the firms that responded indicated that the cost of operation per hour had reduced by very great extent. 24.4% of the firms that responded stated that operation cost per hour had reduced by great extent, 17.8% of the firms that responded indicated that cost of operation per hour had reduced by moderate extent whereas 4.4% of the respondents stated that cost of operation per hour had reduced by small extent. Only 2.2% of the respondents indicated that cost of operation per hour was still high as shown in Table 4.44. The mean was 4.0444 suggesting that the firms surveyed had managed to reduce the cost of operation per hour by great extent due to green manufacturing.

Table 4.44: Reduction in Cost of Operation per Hour

	1	2	3	4	5	Total	Mean	SD
Frequency	1	2	8	11	21	45		
Percentage	2.2%	4.4%	17.8%	24.4%	46.7%	100%	4.0444	1.10691

The speed due adoption of green manufacturing had grand mean of 3.393 and standard deviation of 1.1984 indicating that the speed has moderately improved. Cronbach's Alpha of 0.6327 indicating that reliability and construct validity was achieved. When requested to indicate the extent to which the firm had benefited from green manufacturing in terms of reduced machine set-up time, 42.2% of the respondents stated machine set-up time had reduced by great extent, 24.4% of the firms that responded stated that machine set-up time had reduced by very great extent. 20.0% of the firms that were surveyed indicated that machine set-up time had reduced by a moderate extent while 11.1% of the firms that responded stated that machine set-up time had reduced by small extent. Only 2.2% of the respondents revealed that machine set-up had not reduced at all. The mean was 3.7556 suggesting that the firms that were surveyed machine set-up time had reduced by great extent after adopting green manufacturing. Table 4.45 presents the findings.

Table 4.45: Reduction Machine Set-Up Time by Ensuring Continuous Production

	1	2	3	4	5	Total	Mean	SD
Frequency	1	5	9	19	11	45		
Percentage	2.2%	11.1%	20%	42.2%	24.4%	100%	3.7556	1.02593

When asked to indicate the extent to which time to market had reduced on implementation of green manufacturing, 48.9% of the firms that responded indicated that time to market had reduced by moderate extent, 31.1% of the firms that responded stated that time to market had reduced by great extent. 11.1% of the firms surveyed stated that time to market had reduced by small extent whereas 6.7% of the firms that responded indicated that the firms time to market had reduced by very great extent with only 2.2% of the firms that responded revealed time to market had not reduced. The mean was 3.2889 implying that time to market among the respondents had reduced by great extent as a result of green manufacturing as shown in Table 4.46.

Table 4.46: Reduced Time to Market

	1	2	3	4	5	Total	Mean	SD
Frequency	1	5	22	14	3	45		
Percentage	2.2%	11.1%	48.9%	31.1%	6.7%	100%	3.2889	.84267

When asked to indicate the extent to which order lead-time had reduced after implementing green manufacturing, 40% of the firms that responded indicated that order lead-time had reduced by great extent, 33.3% of the respondents indicated that order lead-time had reduced by moderate extent. 13.3% of the firms surveyed indicated that order lead-time had not changed even after implementing green manufacturing whereas 8.9% of the respondents indicated that order lead-time had reduced to very great extent. Only 4.4% of the firms that responded indicated that order lead-time had reduced by great extent. The mean was 3.1333 suggesting that the firms surveyed had managed to reduce order lead-time to moderate extent on implementation of green manufacturing as presented in Table 4.47.

Table 4.47: Reduced Order Lead-Time

	1	2	3	4	5	Total	Mean	SD
Frequency	6	4	15	18	2	45		
Percentage	13.3%	8.9%	33.3%	40%	4.4%	100%	3.1333	1.09959

Flexibility had a grand mean of 3.207, SD of 1.1036. This indicates that flexibility moderately improved on the adoption of green manufacturing. Cronbach's Alpha of 0.6327 indicating that reliability and construct validity was achieved. When requested to state the extent to which they introduced new products to the market after implementing green manufacturing, 40% of the firms that responded indicated that it was to moderate extent. 28.9% of the firms that responded indicated introduction of new products to the market had increased by great extent whereas 13.3% of the firms that responded stated that introduction of new products to the market had improved by small extent. 8.9% of the firms surveyed stated the extremes. The mean was 3.1556 suggesting that new products were introduced to the market by the firms surveyed at moderate extent. The findings are shown in Table 4.48.

Table 4.48: Number of New Products to Respond to Changes in Customer Tastes

	1	2	3	4	5	Total	Mean	SD
Frequency	4	6	18	13	4	45		
Percentage	8.9%	13.3%	40%	28.9%	8.9%	100%	3.1556	1.06506

When requested to state the extent to which the firm had varied their production to respond to changes in demand by implementing green manufacturing, 35.6% of the firms that responded stated the varying production to meet demand changes had improved by moderate extent. 33.3% of the firms that responded indicated that their ability to vary production with demand had improved to great extent, 15.6% of the firms that responded stated that the practice had improved by small extent while in 13.3% of the respondents it was to very great extent. Only 2.2% of the firms that responded indicated the variance in production was still high. The mean was 3.400 suggesting that the firms surveyed reduced variance in production as a result of changed demand by moderate extent. Table 4.49 depicts the findings.

Table 4.49: Improved Ability to Vary Production with Changes in Demand

	1	2	3	4	5	Total	Mean	SD
Frequency	1	7	16	15	6	45		
Percentage	2.2%	15.6%	35.6%	33.3%	13.3%	100%	3.4000	.98627

The summary of the operational performance measures is detailed in the Table 4.50

Table 4.50: Summary of Operational Performance Measures

Operational performance measure	Mean	SD	Cronbach's Alpha
Quality	4.2	0.9972	0.729
Cost	3.7926	1.1523	0.654
Flexibility	3.207	1.1036	0.67
Speed	3.393	1.1984	0.6327

4.7 Challenges on Adoption of Green Manufacturing

This section highlights findings on challenges facing by manufacturing firms on the adoption of green manufacturing. A Likert Scale of 5 point was used for the study with 1- not at all and 5- Very great extent. When requested to indicate the extent to which the firm had inadequate organizational resources, 42.2% of the firms that responded indicated that the firm did not have adequate resources to a moderate extent. 33.3% that were surveyed stated that the challenge of adequate resources was to great extent, 17.8% of the firms that responded revealed that they lacked resources to very great extent whereas 4.4% of the firms that responded stated the challenge was to small extent. Only 2.2% of the firms that responded indicated that they had adequate resources as presented in Table 4.51. The mean was 3.600 implying that inadequate resources was a challenge to great extent among the firms surveyed.

Table 4.51: Inadequate Organizational Resources

	1	2	3	4	5	Total	Mean	SD
Frequency	1	2	19	15	8	45		
Percentage	2.2%	4.4%	42.2%	33.3%	17.8%	100%	3.6000	.91453

When asked to indicate the extent to which the firm experienced varying customer demands due to price sensitivity, 42.2% of the respondents stated that they experienced varying customer demand to great extent. 22.2% of the firms that responded the challenge was experienced to a moderate extent, 20.0% of the firms that were surveyed stated varying customer demand due to price changes was to small extent whereas 13.3% of the firms that responded acknowledged that varying customers due to price sensitivity was not a challenge. The mean was 3.444 implying that varying customer demands due to price sensitivity across the respondents was to moderate extent. Table 4.52 presents the results.

Table 4.52: Varying Customer Demands Due to Price Sensitivity

	1	2	3	4	5	Total	Mean	SD
Frequency	1	9	10	19	6	45		
Percentage	2.2%	20.0%	22.2%	42.2%	13.3%	100%	3.4444	1.03475

When requested to indicate the extent to which to the firm had not developed green organizational culture, 42.2% of the firms that responded indicated that green culture was a challenge to great extent. 33.3% of the firms that responded stated that green culture was a challenge to moderate extent whereas 11.1% of the firms that responded stated that green culture was a challenge to both very great extent and small extent. Only 2.2% of the respondents stated that their firm had developed green organizational culture and thus it was no longer a challenge. The results are presented in Table 4.53.The average was 3.4889, indicating that green organizational culture was a challenge among the firms surveyed to a moderate extent.

Table 4.53: Inadequate Green Organizational Culture

	1	2	3	4	5	Total	Mean	SD
Frequency	1	5	15	19	5	45		
Percentage	2.2%	11.1%	33.3%	42.2%	11.1%	100%	3.4889	.92004

When asked to comment the extent to which inadequate government support through regulations and policies was a challenge all firms acknowledged that it was a challenge but to varying extent. 33.3% of the firms that responded stated that the challenge was to moderate extent, 31.1% of the firms that responded stated that inadequate government support was to great extent whereas 26.7% of the firms surveyed stated that government support was a challenge to small extent. Only 8.9 % of the firms that responded indicated that government support was challenge to great extent. The average was 3.222 implying that government support through policies and regulations were inadequate to moderate extent. Table 4.54 presents the findings.

Table 4.54: Inadequate Government Support Through Regulations, Policies and Strategies

	1	2	3	4	5	Total	Mean	SD
Frequency	0	12	15	14	4	45		
Percentage	0%	26.7%	33.3%	31.1%	8.9%	100%	3.2222	.95081

When requested to state the extent to which high short-term cost due to implementation of green manufacturing was a challenge, 37.8% of the firms that responded stated that it was a challenge to very great extent, 22.22% of the firms surveyed stated that it was a challenge to both great extent and small extent. Only 17.8% of the firms that responded stated that high short-term costs was a challenge to moderate extent. The mean was 3.7556 implying that the respondents indicated that high short-term cost was a challenge to great extent as presented in Table 4.55.

Table 4.55: High Short-Term Costs Due to Adoption of Green Manufacturing

	1	2	3	4	5	Total	Mean	SD
Frequency	0	10	8	10	17	45		
Percentage	0%	22.2%	17.8%	22.2%	37.8%	100%	3.7556	1.19003

When requested to indicate the extent to which technological risk due innovations was a challenge, 35.6% of the firms that responded indicated that technological risk was a challenge to great extent, 28.9% of the firms surveyed indicated it was a challenge to great extent. 20.0% of the firms that responded stated technological risk was a challenge to moderate extent whereas 11.1% of the firms that responded stated that technological risk was not a challenge. Only 4.4% of the firms that responded indicated that technological risk was a challenge to small extent. The average was 3.733 suggesting that technological risk was a challenge to great extent among the firms surveyed. Table 4.56 presents descriptive analysis of technological risk arising from technological innovations.

Table 4.56: Technological Risk Due to Innovations in Technology

	1	2	3	4	5	Total	Mean	SD
Frequency	5	2	9	13	16	45		
Percentage	11.1%	4.4%	20%	28.9%	35.6%	100%	3.7333	1.30384

When asked to state the extent to which the firm experienced uncertain economic benefits from adoption of green manufacturing, 37.8% of the firms that responded indicated that the challenge was experienced to moderate extent. 35.6% of the firms that responded stated that the challenge was experienced to great extent, 15.6% of the respondents that they were affected to very great extent whereas 8.9% of the firms that responded the challenge was experienced to small extent. Only 2.2% the firms that responded felt that uncertain future economic benefits of green manufacturing was not a challenge. Table 4.57 shows the findings.

Table 4.57: Uncertain Future Economic Benefits from Adoption of Green Manufacturing

	1	2	3	4	5	Total	Mean	SD
Frequency	1	4	17	16	7	45		
Percentage	2.2%	8.9%	37.8%	35.6%	15.6%	100%	3.5333	.94388

When requested to indicate the extent to which supply of raw materials that are environmentally friendly was a challenge, 37.8% of the respondents indicated supply of environmentally friendly materials was a challenge to moderate extent. 35.6% of the respondents stated that supply of environmentally friendly materials was a challenge to great extent whereas 20% of the firms that responded stated that supply of environmentally friendly materials was a challenge to very great extent. Only 8.9% of the firms surveyed stated supply of raw materials that are environmentally friendly was a challenge to small extent as Table 4.58. The mean was 3.644 implying that supply of environmentally friendly raw materials was a challenge across the firms surveyed to great extent.

Table 4.58: Inadequate Supply of Raw Materials Which are Environmentally Friendly

	1	2	3	4	5	Total	Mean	SD
Frequency	0	4	17	15	9	45		
Percentage	0%	8.9%	37.8%	33.3%	20.0%	100%	3.6444	.90843

When requested to indicate the extent to which there was no adequate management support toward adoption of green manufacturing, 46.7% of the firms that responded stated that it was to moderate extent, 28.9% of the firms surveyed stated that it was to great extent. 15.6% of the firms surveyed stated that adequate management support towards green manufacturing was a challenge to very great extent whereas 6.7% of the firms surveyed stated that the management was ready to support green manufacturing. Only 2.2% of the respondents indicated that management support towards green manufacturing was a challenge to small extent. The mean was 3.444 suggesting that management support towards green manufacturing was a challenge to moderate extent across the firms that were surveyed as depicted in Table 4.59.

Table 4.59: Inadequate Management Support When Adopting Green Manufacturing

	1	2	3	4	5	Total	Mean	SD
Frequency	3	1	21	13	7	45		
Percentage	6.7%	2.2%	46.7%	28.9%	15.6%	100%	3.4444	1.01255

4.8 Green Manufacturing and Operational Performance

The study sought to determine the effect of green manufacturing on operational performance. The respondents indicated that green product design and development, efficient processes and GSCM in manufacturing greatly affect operational performance leading to improvement in quality, reduction in cost, improving on flexibility and increasing speed. End of life product management has insignificant relationship with operational performance.

4.8.1 Correlation Analysis

The Spearman correlation analysis was determined for all the four independent variables included in the model. The results revealed that there existed a statically significant individual relationship with operational performance of manufacturing firms in green product design and development, efficient processes and GSCM in in manufacturing had spearman's rank correlation coefficients of 0.632, 0.419 and 0.455 respectively at 99% confidence level. End-of-life product management was found to have insignificant relationship with operational performance since the correlation coefficient of -0.122 at 99% confidence level. The results are shown in the Table 4.60.

Table 4.60: Correlation Matrix (Spearman Correlation)

		Green product design and development	Efficient Processes	Green supply chain management in manufacturing	End-of-life e333product management
Green product design and development	Coefficient	1.000	.632**	.419**	-.122
	Sig. (2-tailed)	.	.000	.004	.423
	N	45	45	45	45
Efficient Processes	Coefficient	.632**	1.000	.455**	-.108
	Sig. (2-tailed)	.000	.	.002	.479
	N	45	45	45	45
Green supply chain management in manufacturing	Coefficient	.419**	.455**	1.000	-.059
	Sig. (2-tailed)	.004	.002	.	.701
	N	45	45	45	45
End-of-life product management	Pearson's coefficient	-.122	-.108	-.059	1.000
	Sig. (2-tailed)	.423	.479	.701	.
	N	45	45	45	45

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

4.8.2 Regression Analysis

The study sought to determine the effect of green manufacturing on operational performance. Coefficient of determination and regression model are discussed in details in this section to make interpretations and generalizations for the study.

4.8.2.1 Coefficient of Determination

Coefficients of determination were calculated to determine the extent to which each variable influenced operational performance. Green product had a value of R^2 of 0.75 implying that it can predict operational performance up-to 75%, efficient processes had a R- squared of 0.77 implying that it can predict operational performance up-to 77% and GSCM had a R-square value of 0.59 implying could only predict operational performance up-to 59%. End-of-life product management is insignificant in predicting operational performance (R^2=-0.23, p=0.889>0.05). The coefficient of determination was carried at 95% confidence level. The results are shown in Table 4.61.

Table 4.61: Coefficient of Determination

	Type III Sum of Squares	Mean Square	F	Adjusted R^2	Sig.
Green product design and development	33.625[a]	33.625	4.571	0.75	.038
Efficient Processes	74.914[b]	74.914	4.684	0.77	.036
GSCM	74.176[c]	74.176	3.751	0.59	.049
End-of-life product management	.198[d]	.198	.016	-0.23	.899

4.8.2.2 Regression Model

The established regression equation is:

$Y= 5.352+0.140X_1 +0.157X_2 +0.135X_3 -0.05X_4$ …………………………….... Equation 4.1

Where: Y is the dependent variable, which is operational performance of manufacturing firms represented by: 5.352 is the Y intercept, which is the other factor affecting operational performance; X_1 is green product design and development; X_2 is efficient processes; X_3 is GSCM; X_4 is end-of-life management.

The study established that operational performance would be at 5.352 when green product design and development, efficient processes, GSCM and end-of-life product management are held constant at zero. Green product design and development has positive effect on operational performance (0.140). Efficient processes have a statistical significance on improvement on operational performance (0.157). GSCM had a statistical significance on improvement of operational performance (0.135) while end-of-life product management had a statistical insignificance effect and it would thus lead to decrease in operational performance (-0.05). The VIF values green design and development was 2.106, efficient process had VIF value of 1.906, the VIF value of GSCM was 1.452 and the end-of-life product management had a VIF value of 1.033. All the variables had VIF values of less than 5.0 indicating absence of multi-collinearity (Ringle, Wende & Becker, 2015). The results are presented in Table 4.62.

Table 4.62: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	5.352	1.367		3.915	.001		
Green product design and development	.292	.446	.140	.656	.002	.475	2.106
Efficient Processes	.221	.287	.157	.771	.004	.525	1.906
Green supply chain management in manufacturing	.173	.228	.135	.759	.004	.689	1.452
End-of-life product management	-.086	.255	-.050	-.336	.739	.968	1.033

4.8.2.4: Summary of the Model

The summary of the model is presented in Table 4.63. The calculated R at 95% confidence level was 0.363 implying that green manufacturing variables associated with operational performance at 0.363. The adjusted R^2 is coefficient of determination and predicted that there is a variance of 4.5% at 95% confidence level between operational performance and green manufacturing variables, which are green product design and development, efficient processes, GSCM and end-of-life product management. The standard error estimate was 5.74537. This indicated that green manufacturing had positive relationship with operational performance.

Table 4.63: Summary of the Model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.363[a]	.132	.045	5.74537

4.8.2.5 Analysis of Variance

The independent variable have a total variance of 150.67064 thus constitute to the variance of the operational performance. There was a significant goodness of fit between the variables since the calculated F-test value (2.518) is greater than the F-critical which is 1.562 at 95% confidence level. This indicate that the model formed between green product design and development, efficient processes, GSCM and end-of-life management was a good fit for the data. The strength of variation between green manufacturing and operational performance in the firms surveyed was significant ($p=0.015<0.05$)

Table 4.64: ANOVA[a]

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	30.31064	4	7.5766	2.518	.015[b]
Residual	120.36	40	3.009		
Total	150.67064	44			

a. Dependent Variable: Operational Performance

b. Predictors: (Constant), End-of-life product management, Green supply chain management in manufacturing, Efficient Processes, Green product design and development

4.9 Discussion of Findings

Most of the firms considered design for environmental sustainability (mean=4.022), design for renewable energy sources (3.933) and design for material reduction (3.844) were highly considered during the design stage. During manufacturing stage, firms employ processes that use green energy (3.2444) save energy (3.5556), reduce toxic & hazardous materials (4.0222), reduce reworks, and scrap (4.07). In supply chain, firms reduced the overall package materials (4.2) and purchased supplies that are environmentally friendly (4.0). In end-of-life management stage firms had installed collection points to collect materials for recycling (3.44) and employing individuals to collect materials(3.378).This is may be as result of shrinking supply of raw materials and pressure to use renewable sources of energy, aimed at reducing pollution. This propels Deif (2011) argument that green manufacturing is a continuous loop starting with product design stage to the end-of-life product management.

Design for transportability (3.5777) is in tally with manufacturing firms employing transport means are environmentally friendly/EMS certified (3.5778), deliver products to site (3.333) and proper utilization of storage (3.4667) in the supply chain management. Employing of transport modes that reduce energy and are environmentally friendly aims at eliminating the negative effects to the environment (Rao &Holt, 2015). Recycling is often practiced in manufacturing firms compared to remanufacturing. This agrees to findings Ahn (2015).

The findings of the study show that green manufacturing leads to enhanced operational performance. The production cost (mean=3.729, SD=1.1523) significantly reduces on the adoption of green manufacturing. This is in agreement with findings of Eshikumo (2017) who found that the cost of production reduces significantly when manufacturing firms adopt green manufacturing practices. The quality of the products (mean=4.2, SD=0.9972) significantly improves on implementation of green manufacturing. Green manufacturing enhance the quality of products by ensuring that the products produced conform to specifications and do not fail in the market. This is in agreement with findings of Eltayeb (2019) who argued that green manufacturing leads to quality improvement.

Flexibility (mean=3.207, SD=1.1036) of the organization has a significant relationship with green manufacturing. Green manufacturing leads to increased flexibility. This is in accordance with findings of Famiyeh et. al (2018). Green manufacturing leads to increased speed (mean=3.393, SD=1.1984) in terms of improvement in delivery of products, time taken to market, and time taken to respond to changes in tastes is also reduced. This is in correspondence to findings of Alvi (2013). The findings revealed that green manufacturing has a significant relationship with operational performance in that it leads to enhanced operational performance. This is in agreement with findings of Eshikumo (2017), Fore and Mbohwa (2016) and Eltayeb (2019).

Adoption of green manufacturing had an impact of improving quality, reducing cost, increasing flexibility and improving on speed; all have a cumulative effect of enhancing competitive advantage of the firm (Eltayeb, 2019). Despite the efforts made to move from convectional manufacturing, firms still experience challenges such as high technological risks (3.733) because technology keeps on changing and high short-term cost due the sunk costs (3.756) inadequate organizational resources (3.60), varying customer demands (3.44) and green organizational culture (3.4889). The findings are in coherence with findings of Bhanot, Rao & Deshmukh (2015).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter depicts the summary of the data findings obtained on investigating the effect of green manufacturing on operational performance of manufacturing firms in Mombasa County. It also give the conclusions and recommendations drawn from the findings. The chapter is thus, constituted by summary of findings, conclusions, recommendations, limitations of the study and suggestions for further research.

5.2 Summary of Findings

The first objective of the study was to determine the effect of green manufacturing on operational performance of manufacturing firms. Green manufacturing was represented by four independent variables. Green product design and development was practiced to moderate extent among respondents, with design for environmental protection implemented to great extent amongst the firms surveyed. Design for use of renewable energy, design of products for material reduction and design for transportability were implemented to moderate extent; implementation of these concepts determines other green manufacturing concepts in the later stages of manufacturing. Green product design was found to have significant positive relationship with operational performance. Implementing green product design and development leads to enhanced operational performance.

Efficient processes was largely implemented green manufacturing across the manufacturing firms. There was a continuous effort by firms to reduce reworks and material scrapped, this leads to improvement in quality of the products since conformance of products to standards is enhanced reduction of material wastage. Elimination of hazardous and toxic materials during manufacturing, recycling/reuse, control of emission of harmful and energy saving processes were implemented to moderate extent this can be attributed to rise in the regulations banning use of certain materials and reduction of energy wastage. Recycling internal waste and processes that use green energy were the least implemented among efficient processes variables. It was found that efficient processes have the greatest effect on enhancing operational performance. Efficient processes have significant and positive relationship on operational performance.

The findings revealed that firms reduced overall packaging of the products this can be attributed to the continuous effort of the firms to reduce production cost. Purchasing from suppliers with environmentally friendly principles and transport modes with reduced energy wastage was highly practiced among the manufacturing firms surveyed. Reduction of disposal of packaging materials was practiced to moderate extent among respondents. Reduction on inventory levels and proper usage of storage and transportation space and delivery of products to the user site were also common among the firms since they have a cumulative effect of reducing cost thus enhancing operational performance. Reduction in the use of non-biodegradable packaging material was the least practiced this is because biodegradable packaging materials are costly (Zhang & Zhao, 2012). GSCM has significant and positive relationship with operational performance, implementing the GSCM practices leads to enhanced operational performance.

End-of-life product management was found to have insignificant relationship with operational performance. It was the least practiced green manufacturing concept among the green manufacturing concepts studied. Collection of used products for recycling, reusing or remanufacturing was the common method of end-of-life management concept practiced by the manufacturing firms, collection of used products leads to sustainability and reduces usage of virgin materials thus enhancing sustainability. Safe disposal of unrecyclable waste was cited to have been implemented by most the manufacturing firms studied this may be attributed to regulations on waste disposal by government and environmental institutions.

Implementing green manufacturing reduces scrap, reduces failure of the product on the market and the needs of customers are effectively met. It also leads to reduction in cost of production by reducing on capacity underutilization and maintaining inventories at optimal levels. Green manufacturing when implemented leads to reduced time-to-market, reduces lead times and enhances continuous production. It also leads to increased number of new products to meet the change tastes and preferences of consumers, reduces variability in demand and improved delivery time. Green manufacturing has a direct positive relationship with operational performance. Implementation of green manufacturing reduces production cost, enhances flexibility, increases speed and leads to quality improvement.

The other objective was to establish challenges of adopting green manufacturing amongst the manufacturing firms. It was found out that most of the manufacturing firms feared that sooner or later the technologies adopted become obsolete, the firms experienced high short term costs due to the sunk costs, inadequate resources was a challenges especially for small-sized manufacturing firms. Inadequate management support, inadequate green culture and uncertain future economic benefits and inadequate government policies and regulations were also cited among the respondents.

5.3 Conclusions

The key conclusion of this study is that the implementation of green manufacturing in totality leads to reduction in production cost, increased flexibility, increased speed and improved quality thus enhancing operational performance which leads to the firm gaining competitive advantage (Rao & Holt, 2005; Lee et al., 2012; Green et al., 2012, Eltayeb, 2019). Implementing green manufacturing contributes to a wide range of competitive benefits and environmental sustainability. It leads to reduction in wastes produced and those that are produced are recycled, those that cannot be recycled are disposed safely to reducing pollution. Reduction in the overall packaging was the most employed green manufacturing concept followed by reduction in scrap and elimination of hazardous and toxic materials.

Recycling and design for environment were highly implemented commonly among the manufacturing firms this sync with findings of a study by Ahn (2015). End-of-life product management was the least practiced green manufacturing concept among the manufacturing firms. To embrace the practice requires long-term investment and commitment by the firm which most of the firms are lacking (Hart, 2011). This may also be attributed to inadequate government support or pressure from other institutions since most of the manufacturing firms used for the study were found to be operating locally. Manufacturing firms ought to install collection points to collect the used products, for the purposes of recycling or remanufacturing thus reducing disposal of waste and enhancing environmental and sustainability performance. Installation of collection points should be coupled with putting in place systems to monitor reverse flow of materials so as to enhance effectiveness and efficiency of the process.

Green manufacturing has a wide of range of benefits. Despite the advantages of green manufacturing, firms face a number of challenges. The major challenge is the high short-term costs due to sunk costs. Adequate resources such as renewable energy and materials with recyclable content and biodegradable were not in adequate supply in the market. This is because they are costly and firms shun away from them in order to cut the cost of production.

5.4 Recommendations of the Study

This study has established that green manufacturing leads to improved operational performance. Manufacturing firms ought to implement green manufacturing practices in all the stages of manufacturing starting at product design and development, through efficient processes and GSCM to end-of-life product management since green manufacturing is a continuous loop. Manufacturing firms will gain competitive advantage when they implement green manufacturing since it leads to quality improvement, reduction in cost, increased flexibility and speed. Managers should commit to long-term investment on end-of-life management since it is the least employed green manufacturing concepts.

The government and other regulating institutions should come up with policies that encourage manufacturing firms to implement end-of-life product management practices since it is the least practiced green manufacturing concept. This is attributed to the fact that it eliminates the need for disposal and additional consumption of virgin raw materials and enhances the firm's image and hence its competitive advantage. Government should thus re-evaluate the regulatory structure and policies that can facilitate end-of-life product management and recovery. The government and manufacturing firms should engage in public awareness on the benefits of collection and recovery of used products and packaging among consumers. Past research has showed that recovery of products has an impact on reducing pollution (Laosirihongthong et al., 2013).

The major contribution to knowledge of this study is that it establishes with a sound theoretical foundation and prior empirical analysis that the implementation of green manufacturing has a positive direct effect on operational performance. Effectively, the finding adds to the body of knowledge on positive links between the effectiveness of green manufacturing and operational performance. This finding helps clear the air on the true effect of green manufacturing on operational performance. The research add to the existing pool of knowledge on green manufacturing and operational performance by investigating the paths that enhance operational performance. The research also adds to the existing literature of green manufacturing.

5.5 Limitations of the Study

This study was limited by the fact that some respondents deemed the information required as confidential and no survey policy. Most of the respondents were reluctant to corporate. The study focused on manufacturing firms operating within the Mombasa County, which a narrow area of focus thus did not capture the views of a wider population spread all over the country. The study was only focused on green manufacturing concepts and their effect on operational performance, thus did not take into account other variables that affect operational performance. The study did not focus on the other performance measures such as environmental performance, organizational performance and sustainability performance; it was only limited to operational performance.

5.6 Suggestions for Further Study

Though the objectives of the study were achieved, other intervening variables such as management support on implementation of green manufacturing should be investigated. The study concentrated on the effect of green manufacturing on operational performance further studies can also been done on the effect of green manufacturing on other performances such as environmental performance, sustainability performance and organizational performance. The study investigated challenges of green manufacturing, which was a minor objective, thus more research should be done on challenges of adopting green manufacturing.

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APPENDICES

Appendix I

Questionnaire

UNIVERSITY OF NAIROBI
COLLEGE OF HUMANITIES AND SOCIAL SCIENCES
SCHOOL OF BUSINESS-MOMBASA CAMPUS

Telephone 020 2059161
Telegrams "Varsity" Nairobi
P.O. Box 30197 – 00100, G.P.O.
Nairobi, Kenya

Our Ref: D61/6550/2017

8th October 2019

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

REF: **REQUEST TO COLLECT DATA FOR MANAGEMENT RESEARCH REPORT**

The bearer of this letter, **Musau Eric Mutie** of Registration Number **D61/6550/2017** is a Master of Business Administration student of the University of Nairobi, Mombasa Campus.

He is required to submit as part of his coursework assessment a research project report. We would like the student to do his project on ***Effect of Green Manufacturing on Operational Performance of Manufacturing Firms in Mombasa County.*** We would, therefore, appreciate if you assist him by allowing him to collect data within your organization for the research.

The results of the report will be used solely for academic purposes and a copy of the same will be availed to the interviewed organization on request.

Thank you.

UNIVERSITY OF NAIROBI
SCHOOL OF BUSINESS
MOMBASA CAMPUS

Zephaniah Ogero Nyagwoka
Administrative Assistant, School of Business-Mombasa Campus

SECTION A: FIRM'S DEMOGRAPHIC INFORMATION

1. Name of the organization____

2. What is the ownership status of your firm?

Locally owned [1]

Foreign owned [2]

Mix local and foreign ownership [3]

Other (please specify) [4]

3. In which manufacturing sub-sector does your firm operate?

Building, Construction & Mining [1]

Chemical & Allied [2]

Electrical & Electronics [3]

Food Beverages & Tobacco [4]

Leather & Footwear [5]

Metal & Allied [6]

Motor Vehicle & Accessories [7]

Paper & Board. [8]

Pharmaceutical & Medical Equipment [9]

Plastics & Rubber [10]

Timber, Wood Products & Furniture [11]

Textiles & Apparels [12]

Consultancy & Industrial Services [13]

Others(specify)…………………………………………………………………………

5. What is the size of the staff of your company (full time employees)? ______________

6. What is the scope of the market served by your firm?

Local [1]

Regional [2]

Global [3]

7. How long your firm has been operating?

a) Less than 5 years [1]

b) 5-10 years [2]

c) 10-20 years [3]

d) More than 20 years [4]

8. Is the firm ISO 14001 certified?

Yes [1]

No [2]

SECTION B: GREEN MANUFACTURING

9. Please use the scale below to indicate to what extent your firm has implemented green product design and development in initial stages of production

[1] Not at all [2] Small extent [3] Moderate extent [4] Great extent [5] Very great extent

	Green product design and development	1	2	3	4	5
1.	Our firm designs products and processes for environmental protection					
2.	Our firm designs products for recycling through ease disassembling of product.					
3.	Our firm designs products for remanufacture through facilitation of repair and rework.					
4.	Our firm designs products to incorporate reduction of material use by a product in the design stage					
5.	Our firm designs products that incorporates reduction of energy usage by a product and use of green energy					
6.	There is an effort by our firm design products that incorporates reduction of consumption of non-renewable resources					
7.	There is an effort by our firm to reduce transportation and storage space by designing products with proper shapes					

10. Please use the scale below indicate the extent to which your firm has implemented the efficient processes in manufacturing of products.

[1] Not at all [2] Small extent [3] Moderate extent [4] Great extent [5] Very great extent

	Efficient processes	1	2	3	4	5
1.	There is continuous effort by our to use processes which use fewer virgin raw materials by enhancing recycling and reuse of materials					
2.	There is an effort by our firm to continuously adopt processes that reduce on energy wastage by ensuring that the processes use energy efficiently					
3.	There is a continuous effort by our firm to reduce usage of non-renewable energy sources by adopting green energy					
4.	Our processes eliminate the use of hazardous and toxic materials					
5.	Our processes use control filters that control emission of harmful gases to the environment					
6.	Our processes employ methods that minimize waste disposal by recycling internal waste generated					
7.	There is an effort by our firm to ensure products conform to standards					
8.	There is an effort by our firm to reduce energy wastage by turning off idle machines and bulbs					
9.	Our firm ensure there is reduction of raw material wastage by use proper cutting tools and accurate standards					

11.Please use the scale below to state extent to which the firm has implemented the green supply chain management in manufacturing of products.

[1] Not at all [2] Small extent [3] Moderate extent [4] Great extent [5] Very great extent

	Green supply chain management in manufacturing	1	2	3	4	5
1.	There is effort by our firm to reduce overall packaging of products.					
2.	There is a continuous effort by our firm to reduce space wastage when storing or transporting goods by adopting proper product shapes and sizes.					
3.	Our firm has reduced use of non-biodegradable material by adopting use of bioplastics and bio-nanocomposites for packaging.					
4.	There is an effort by our firm to reduce disposal of packaging material by using materials with recyclable contents.					
5.	We employ transport modes with reduced energy wastage					
6.	Our firm has continuously minimized the number of intermediaries by ensuring that we deliver products directly to the user site.					
7.	There is an effort by our firm to continuous reduce inventory levels by maintain optimal levels in our warehouses					
8.	We use raw materials that do not have hazardous substances by purchasing from suppliers have environmentally friendly principles					
9.	Our firm uses logistics that ensure reduction in pollution by contracting firms that observe environmentally friendly principles or EMS certified					

12. Please use the scale below to indicate the extent to which your firm has implemented end-of-life product management in manufacturing of products.

[1] Not at all [2] Small extent [3] Moderate extent [4] Great extent [5] Very great extent

	End-of-life product management	1	2	3	4	5
1	We have reduced disposal of recyclable end-of-life products by installing collection points for product recovery					
2	There is continuous effort by our firm to reduce pollution through collection of waste generated by the firm.					
3	There is an effort by our firm to reduce administrative, transportation and support costs by putting in place systems that aid in reverse flow monitoring					
4	There is continuous effort by our firm to reduce customer defections by providing proper advice to customers on the handling, consumption and disposal of our products					
5	There is a continuous effort by our firm to reduce pollution by ensuring safe disposal of unrecyclable waste					
6	There is continuous effort by our firm to reduce loses on capital investment assets by ensuring that used products are returned to suppliers for remanufacturing or reusing					

SECTION C: OPERATIONAL PERFORMANCE

13. Please use the scale below to indicate the extent to which your firm has benefited in terms of operational performance measures from the adoption of green manufacturing.

[1] Not at all [2] Small extent [3] Moderate extent [4] Great extent [5] Very great extent

There is a continuous effort by our firm to reduce the number of products scrapped and reworked by ensuring that the products conform to standards					
There is a continuous effort by our firm to reduce failure of the our products in the market by ensuring that they exceed customer expectations					
There is a continuous effort by our firm to minimize products returned by customers by ensuring that the products meet customer needs					
Our firm has reduced machine set-up time by ensuring continuous production					
Our firm has reduced time to market					
Our firm has reduced the order lead time					
There is continuous effort by our firm to reduce inventory levels					
There is a continuous effort by our firm reduce capacity underutilization					
Our firm has continuously reduced cost of operation per hour					
Our firm has reduced on the time taken to respond to changes in taste and preferences of customers through introduction of new products					
Our firm has improved on ability to increase production depending on the changes in demand					

SECTION D: CHALLENGES OF IMPLEMENTING GREEN MANUFACTURING Please select from the list of the challenges below using the scale provided indicate to what extend they affect your firm

[1] Not at all [2] Small extent [3] Moderate extent [4] Great extent [5] Very great extent

	Challenges to Green Manufacturing	**1**	**2**	**3**	**4**	**5**
1.	Our firm has adequate organizational resources					
2.	Our firm experiences varying customer demands due to price sensitivity					
3.	Our employees demonstrate green organizational culture					
4.	There is adequate government support through regulations, policies and strategies					
5.	Our firm has high short term costs due adoption of green manufacturing					
6.	Our firm experiences technological risk due to innovations in technology					
7.	Our firm experiences uncertain future economic benefits from adoption of green manufacturing					
8.	There adequate supply of raw materials which are environmentally friendly					
9.	There is adequate management support when adopting green manufacturing					

Others specify

…………………………………………………………………………………………
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Thank you for your cooperation

Appendix II

List of Manufacturing Firms in Mombasa County

The study will be undertaken across the 61 manufacturing industries in Mombasa County registered by KAM:

1. Africa Cotton Industries
2. Africa PVC Industries Ltd
3. African Marine General and Engineering Co. Ltd
4. Bakhresa Millers
5. Brollo Kenya Ltd
6. Buzeki Group of Companies
7. Chandaria Industries
8. Container Technology Ltd
9. Cook 'N Lite Ltd
10. Coast cables Ltd
11. Diamond Industries Ltd
12. Dutch Water Ltd
13. East Africa Glassware
14. Eastern Chemicals Industries Ltd.
15. Flora Printers Ltd.
16. Global (IVECO) Motors Centre Ltd .
17. Gold Crown Beverages (K) Ltd.
18. Grain Bulk Handlers Greif Kenya Ltd.
19. Ideal ceramics
20. Intertek Testing Services (EA) (PTY) Ltd.
21. Italian Gelati and Food Produce Ltd.
22. Kamyn Industries Ltd.
23. Kenya General Industries Ltd.
24. Kenya Shirts Manufacturers Company Ltd.
25. Kenya Suitcase Manufacturers Ltd.
26. Kitui Flour Mills Ltd.
27. Krish Commodities Ltd.
28. Kwality Packaging House Ltd.
29. LAB International Kenya Ltd.

30. Manji Food industries
31. Mkakate steel fabricators
32. Milly Fruit Processors Ltd.
33. Milly Glass Works Ltd
34. Mombasa Cement Ltd
35. Mombasa Maize Millers Ltd
36. Mombasa Polythene Bags ltd
37. Mwananchi Bakers Ltd
38. Mzuri Sweets Ltd
39. Nitro Chemicals
40. Packaging manufacturers
41. Pearly LLP
42. PollyPropelin ltd
43. Pride Industries Ltd(Devson Industries)
44. Pwani Oil Products Ltd
45. Raffia Bags (K) Ltd
46. Saj ceramics
47. Shreeji Chemicals Ltd
48. Sollatel Electronics (Kenya) Ltd
49. Southern Engineering Co. Ltd
50. Summit Fibres Ltd
51. Synergy Lubricants (K) Ltd
52. Sweet R Us Ltd
53. TSS. Grain Millers Ltd
54. Tarmal Wire Products Ltd
55. Top Steel Kenya Ltd.
56. Twiga chemicals
57. Uneeco Paper Products Ltd.
58. Wanainchi Marine Products (K) Ltd.
59. Zaverchand Punja Ltd
60. Standard Rolling Mills Ltd
61. Associated Vehicle Assemblers Ltd.