TOTAL QUALITY MANAGEMENT, CIRCULAR MANUFACTURING AND PRODUCTIVITY OF MANUFACTURING FIRMS IN NAIROBI, KENYA

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RESEARCH PROJECT PRESENTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF BUSINESS ADMINISTRATION (OPERATIONS MANAGEMENT), FACULTY OF BUSINESS AND MANAGEMENT SCIENCES, UNIVERSITY OF NAIROBI

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DECLARATION

This research project is my original work and has not been presented for the award of degree in any other university or institution for any other purpose.

Signature ……Date ……28th November 2023...

Alfine Wawira D61/10972 / 2018

This research project has been submitted for examination with my approval as university supervisor.

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DEDICATION

I dedicate this research project to my family members for bearing with my long hours away undertaking this research, my supportive parents for their immense belief, prayer, and encouragements.

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ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
CE	Circular Manufacturing
DCT	Dynamic Capability Theory
GDP	Gross Domestic Product
KNBS	Kenya National Bureau of Statistics
SPSS	Statistical Package for Social Science
TQM	Total Quality Management
USA	United States of America
VIF	Variance Inflation Factor

ABSTRACT

Firms embrace different practices to try and improve productivity. However, the key issue is, do the firms embrace similar practices across the divide? More specifically, owing to the variance in productivity across manufacturing subsectors and product lines, there is need to find out why the firms productivity differ with view of finding whether TQM and circular manufacturing make productivity different across the firms. Thus, more specifically, the study was guided by the following questions; Are TQM and circular manufacturing practices embraced by firms in Kenya? And, do firms which embrace these practices register improved productivity? Two Theories anchored the present study and these are the Deming Theory of Management and the Dynamic Capability Theory (DCT). The present study was grounded on a descriptive survey research design. The 454 manufacturing firms in Nairobi constituted the study population from which 454 management staff was targeted. Cluster sampling was used to select 213 manufacturing firms as they were from diverse sectors from where one management staff was selected. The study employed two research instrumentation tools to gain data relevant to this study. The first one was the questionnaires and the second instrument was a documentary checklist to collect secondary data on productivity of the firms. Cronbach Coefficient test was used to test reliability and an acceptable score of 0.716 was realized. Validity was tested using the exploratory factor analysis. Descriptive statistics tools characterized by frequency, percentage, mean and standard deviation offered a description of the results. Inferential statistics in the form of One Sample T-Test and both Pearson Correlations and regression analysis were used. The results show that 6 out of 4 descriptive statements presented have a mean score >3.00 with many at the 4.00 mark. Thus, the results show that mostly, manufacturing firms practiced circular manufacturing and all the 8 descriptive statements presented have a mean score >3.00 with many at the 4.00 mark and thus, the manufacturing firms in Nairobi Kenya had adopted TQM practices significantly. Also, the productivity of the firms have increased for the years 2022. Further, the findings from the correlations and regression analyses show that the adjusted R Square score of .607 gives evidence that productivity manufacturing firms in Nairobi, was predicted by TQM and CE at 60.7%. Further the regression analysis shows that TQM (β=.534 p-value <0.05) and CE (β=.428 p-value <0.05) have a statistically significant effect on productivity of manufacturing firms in Nairobi, Kenya. The study thus recommends that: The manufacturing firms should embrace the full scope of circular manufacturing to focus on refurbishing its products to restore them to original functionality; have a robust recycling program and have a robust recovering program of materials that were considered waste but which can be recovered. This should be done alongside the other adopted CE practices which will help improve their productivity. Also, the manufacturing firms should continue with the TQM practices they have adopted and tighten those they are still struggling to implement. This will also help them to improve firm productivity. Finally, the manufacturing firms should find meaningful strategies that help them integrate TQM and CE within their operations almost in a hybrid system. Such integration will help them to improve firm productivity.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Organizations are increasingly operating in a highly competitive market where productivity is always demanded. Thus, firms are forced to produce goods and services that effectively compete in the cutthroat market (Shet, Patil & Chandawarkar, 2019). This creates the need for these organizations to adopt approaches of continuous quality improvement. This is particularly vital because heightened competition has also come with greater customer enlightenment especially related to quality of products and services (Moldovan & Blaga, 2022).

One of the more notable management approaches that have been adopted by organizations seeking to improve quality of products and services is Total Quality Management (TQM). TQM entails a full organizational approach meant to meet the customers' needs and expectations by involving the entire staff both at management level and lower ranks in employing quantitative methods that help to continuously improve the processes, products plus services of the organization (Nguyen & Nagase, 2019). In the words of Abbas (2020), TQM is an organizational attempt to advance that organization's structure, competitiveness and effectiveness.

Total Quality Management has also gained significant attention especially within the circular economy paradigm. This is because organizations operating in the present sustainability age are also focused on reducing elements of pollution and wastage through reduction, repair and reuse which are essential circular economy components (Corvellec, Stowell & Johansson, 2019). Previous studies have shown that current customer trends and expectations are more attracted to quality products and services that are also ecologically-friendly (Stahel, 2018). To this extent, for organizations to align themselves, customer needs and expectations, must in the process of improving the processes, products and services also ensure that those processes, products and services reduce wastage and pollution though reduction, repair and reuse (Corvellec et al., 2019). Clearly, therefore, TQM and circular economy appear to be linked especially for organizations intending to improve their productivity and overall performance. To this extent, the present study intends to establish total quality management measures, circular manufacturing approaches and how it affects productivity of manufacturing firms in Nairobi, Kenya.

1.1.1 Total Quality Management

Total Quality Management as used within organizational circles has received significant scholarly attention. Dezi, Hysa, Calabrese and Mercuri (2022) define TQM as the mutual cooperation of the entire organization staff from every cadre to produce quality products and services which not only meets but also hopefully exceeds customer needs and expectations. Luthra, Garg, Agarwal and Mangla (2020) on their part describe TQM as both a management practice and a philosophy that operates firm-wide to continuously improve products, services and their associated processes in a bid to meet customers' needs and expectations and consequently improve customer satisfaction, firm performance and productivity. Reed, Lemak and Mero (2018) see TQM as an approach within the systematic quality improvement space whose purpose is to engage everyone in improving firm performance as it relates to quality, profitability, customer satisfaction and productivity.

The descriptions of TQ mentioned above shows that TQM constitutes management techniques, tools and approaches as well as principles, concepts and a philosophy of management. Further, it shows that TQM is all inclusive in terms of all staff cadres of the organization and its aim is to meet and hopefully exceed the needs and expectations of customers in order to achieve positive organizational outcomes. Further, TQM from the descriptions is a continuous practice that must be ingrained in the culture of the organization and as such is not a one-day or one-shot program (Abbas, 2020; Nguyen & Nagase, 2019).Further, TQM is appropriately underscored by Deming's Theory of Management. The basic assumption of the theory is that the success, effectiveness and growth of any organization is dependent on a unified and uniform commitment of every person in the organization to quality in all areas of the organization (Deming,1986). The theory is particularly appropriate because of the explanation of the fourteen principles that underpin TQM.

1.1.2 Circular Manufacturing

The focus on sustainability that demands a combination of profit concerns with social and environmental considerations has led to a focus on circular economy or circular manufacturing (Stahel, 2018). Circular economy (CE) has been defined by Kirchherr, Reike, and Hekkert (2017) as a model of consumption and production that comprises of leasing, sharing, repairing, reusing, refurbishing and recycling existing products and materials as long as is practicable. Stahel(2018) sees circular economy as a systems solutions paradigm that

confronts global challenges characterized by climate change, pollution, biodiversity, wastage and loss. Korhonen, Honkasalo, and Seppälä (2018) look at circular economy from a market approach and thus describe it as entailing markets that offer incentives to organizations that reuse and recycle materials and products as opposed to scrapping and extracting fresh resources. From the descriptions above it is clear that there are diverse definitions of circular economy,thusthe focus is on reuse and recycling to minimize wastage and pollution.

Further, circular economy is grounded on three principles of transformation which are getting rid of waste and pollution, then circulating materials and products and finally regenerating nature (Kirchherr et al., 2017). Also, CE is described as divergent to the conventional linear economy approach which is characterized mainly by taking materials, making a product, using it and eventually disposing it (Korhonen et al., 2018; Stahel, 2018). The linear economy approach has been noted to contribute to high emissions of greenhouse gases and has led to high-level pollution (Corvellec et al., 2019). Further, the linear economy approach is considered to act contrary to the values of sustainability in business growth and performance (Murray, Skene and Haynes, 2017).

The concepts and philosophies of circular manufacturing have been studied extensively government, academia and business in the last ten years. CE has gained traction in these spaces owing to its capacity to reduce dangerous emissions and minimize undesirable consumption of raw materials (Kirchherr et al., 2017; Murray et al., 2017). Further, CE is popular because it has extensively expanded the market prospects, has increased resource efficiency and also created options for sustainable consumption all of which are aligned to new market trends and needs (Geng, Sarkis and Bleischwitz, 2019). Something to note however, are scanty empirical reviews that have looked at circular economy or manufacturing and how it affects productivity of manufacturing firms in Kenya.

Circular manufacturing is more appropriately underscored by The Dynamic Capability Theory (DCT) which is a theory first described by Teece, Pisano and Shuen (1997). The basic premise of DCT is that organizations must possess the capability to purposefully and meaningfully adapt the organization’s resource status to always suit the changing business environment (Teece et al., 1997). DCT applies to the present study because from the analysis of studies, it is clear that circular manufacturing changes the business dynamic drastically.

1.1.3 Productivity of Manufacturing Firms

In a competitive market, organizations main focus often becomes to improve growth and productivity. Drucker (2018) takes the more traditional view of productivity when he defines it as a measure of organizational performance that compares the quantity of products and services generated (output) against the quantity of inputs inserted to generate those products and services. Del Gatto, Di Liberto, and Petraglia (2021) defined productivity as the efficiency attached to the production of goods and services that is measured by expressed as a ratio between aggregate output to a measurable aggregate input. Thus, Del Gatto et al. (2021) measures productivity by again comparing the total amount of output of goods and services against the total amount of input used to produce the goods and services.

In measuring productivity, businesses have looked at labour productivity which is the ratio of GDP to the total number of hours expended by workers (Schreyer and Pilat, 2019). In this case, labour is measured by looking at the capital invested in each worker, the training and experience of the workers and the leveraging of technology in labour (Del Gatto et al., 2021; Drucker, 2018). Productivity has also been measured by considering the total factor production that aggregates factors like investment in equipment and plant, logistics, innovations and improvements in enterprise outputs among others (Drucker, 2018). Capital productivity that looks at the sum of financial resources used to produce goods and services is another measure (Schreyer and Pilat, 2019). So is material productivity that looks at the quantity of materials used against the outputs of goods and services (Del Gatto et al., 2021; Drucker, 2018).

1.1.4 Total Quality Management, Circular Manufacturing and Productivity in Kenya

Empirical studies show a strong and positive correlation between TQM, Circular manufacturing and improved growth and productivity (Pambreni, Khatibi, Azam, & Tham, 2019; Shafiq, Lasrado & Hafeez, 2019).Studies done in the USA and the UK have observed heightened adoption of circular manufacturing as a means of entrenching resource efficiency, accessing more customers especially among the Generation Y and X who are deeply immersed in quality products that are environmentally friendly and improving the sustainable credentials of their businesses (Moldovan & Blaga, 2022). Other studies done in the Eastern parts of the world like China and Singapore have adopted circular manufacturing also for the same reasons mentioned above but additionally to offer products and services that are able to effectively compete in the global marketplace (Shet et al., 2019). The efforts of the

companies in these countries to use approaches that engage all cadres of employees to continuously improve the ecological quality of products and services to satisfy the needs and expectations of customers, means that TQM has also found space within circular manufacturing (Sader, Husti & Daróczi, 2019).

Within the African context, circular manufacturing is also gaining momentum. This is largely based on the realization that dependence on the linear economy approach results in high Carbon Dioxide emissions which increases the cost of production (Desmond & Asamba, 2019). Further, circular manufacturing in Africa is expanding again for reasons related to resource efficiency, sustainability concerns and customer needs and expectations (Boon & Anuga, 2020). However, studies also show that the adoption of circular manufacturing in Africa is low due to low commitment among business managers to embrace it, lack of expertise in the operationalization of circular manufacturing and inability to finance the infrastructure needed to effectively implement circular manufacturing (Desmond &Asamba, 2019). In this case it is possible to infer that TQM may be useful in expanding circular manufacturing which would most possibly increase productivity.

Thus, from the foregoing, it is clear that TQM that involves firm-wide efforts to continuously improve products, services and their associated processes in a bid to meet customers' needs and expectations can be implemented in manufacturing firms that are focused on circular manufacturing and this may help improve productivity of these firms. Basically, TQM can be implemented in firms focused in circular manufacturing with heightened productivity as a possible outcome (Sader et al., 2019; Shet et al., 2019).

In Kenya, circular manufacturing is a new concept that is slowly but steadily gaining momentum (Koech & Munene, 2020). Circular manufacturing is becoming a key focus in Kenya as a response to the global emphasis on reduction of greenhouse emissions that would help conserve energy (Desmond & Asamba, 2019). It is also gaining momentum in Kenyan manufacturing space as an effort to increase the manufacturing contribution to Kenya's GDP from an average 8.4% to over 15% with the knowledge that linear economic approach has failed to increase that contribution (Koech & Munene, 2020).

Further, Kenyan manufacturing realize that the global exhaustion of resources is very high and to effectively compete on a global scale, there would be need to have an approach that conserves resources effectively with circular manufacturing offering that option (Desmond &Asamba, 2019). The biggest challenge that manufacturing companies in Kenya are

grappling with in so far as circular manufacturing is concerned is the complexity involved in adopting and implementing a circular manufacturing approach. Studies show that it requires a "all-in approach" from government, citizens and industry (Ghosh, 2020). Consequently, in Kenya, CE is viewed as complex, capital intensive but necessary (Koech & Munene, 2020). Having observed that the employ of TQM within circular manufacturing has improved productivity of companies in the Western and Eastern parts of the world, it would be instructive to ascertain if a similar case exists within the Kenyan manufacturing sector; hence the need for the present study.

1.1.5 Background of Manufacturing Firms in Kenya

Manufacturing in Kenya is pivotal in job creation efforts and significantly determines the country's economic development. Further, Manufacturing and its associated firms have contributed to Kenya's Gross Domestic Product (GDP) at an average 7.7% (KNBS Report, 2022).Also, there is significant diversity in Kenya's manufacturing industry. The sector thus comprises of various sub-sectors based on the services and production uniqueness. Some of the key subsectors include plastics, metal, automotive, food and beverages, textile among others. It is important to note that food and beverages is the largest subsector in terms of financial returns (KNBS Report, 2022). Thus, the manufacture of milk, alcohol, beans and other grains products constitute the largest manufacturing field.

While production has increased for some manufacturing firms in Kenya, it has decreased for others. According to the Kenya National Bureau of Statistics (2022), the manufacturing sector report of 2021 showed a 6.9% growth in manufacturing productivity up from a 0.4% negative growth in 2020. The manufacturing value of output over the same period was 876.4 billion shillings. However, this growth was attributed to heightened productivity of goods related to processed milk (increased by 16.2%), sugar (increased by 16.0%), wheat (increased by 14.6%), soft drinks (soda) (increased by 6.1%), cement production (increased by 23.1%) and assembled vehicles (increased by 29.3%) while productivity of manufactured goods related to maize milling (decreased by 8.2%), steel mills (decreased by 6.3%), feeds manufacture (decreased by 7.0%) and textile (decreased by 16.8%) showed either decreasing or slowing down results (KNBS, 2022).

While there could be many reasons for this variability in production of manufacturing firms, could the differences in productivity be attributed to practices adopted that relate to a combination of TQM and circular manufacturing? The problem is further compounded by

considering that according to the KNBS report (2022) the manufacturing firms that post lower productivity are also the ones that are more import-dependent because in the same period (2020-2021), imports increased to Ksh 2,151.2 billion up from Ksh 1,643.6 billion and the products imported related to iron sheets, textile products and industrial machine. Thus, there was need to find out why the firms productivity differ with view of finding if TQM and circular manufacturing make productivity different across the firms.

1.2 The Research Problem

Productivity across manufacturing firms in Kenya varies across production subsectors. For instance, productivity in the last financial years (2021-2022) increased as far as processed milk, sugar, wheat, soft drinks, cement production and assembled vehicles. However, production decreased as far as maize milling, steel mills, feeds manufacture and textile are concerned (KNBS, 2022). Several approaches to spur the aforementioned productivity exist. They include, TQM, circular manufacturing, strategic management among others. Firms embrace different practices to try and improve productivity. However, the key issue is, do the firms embrace similar practices across the divide? More specifically, owing to the variance in productivity across manufacturing subsectors and product lines, there is need to find out why the firms productivity differ with view of finding whether TQM and circular manufacturing make productivity different across the firms.

Studies done within the Kenyan context have shown a positive effect of TQM on productivity of manufacturing firms. Keinan and Karugu (2018) examined productivity in Bamburi Cement and found that TQM increased productivity by 13%. Nganga and Nyaga (2022) examined continuous improvement through TQM and productivity at the Nairobi Bottlers Limited and found a strong and positive correlation between TQM and productivity. Simani (2017) looked at TQM as it relates to competitive strategies and how it affects performance of manufacturing firms. The study noted that TQM enabled a firm-wide approach that improved every outcome of the manufacturing firm. While these studies are vital and useful in determining the relationship between TQM and productivity, this researcher has not come across studies that show manufacturing firms engaging in circular manufacturing and how TQM within those firms affect productivity; hence the need for the present study that examines Total quality management, circular manufacturing and productivity of manufacturing firms in Kenya. Further, there is paucity of studies that have looked at TQM, circular manufacturing and productivity of firms in Kenya and especially in Nairobi. More specifically, the study was guided by the following questions; Are TQM and circular

manufacturing practices embraced by firms in Kenya? And, do firms which embrace these practices register improved productivity?

1.3 Research Objectives

This study sought to examine Total quality management, circular manufacturing and how they affect productivity of manufacturing firms in Kenya.

The specific objectives of this study were to:

i. Determinethe practices of circular manufacturing embraced by manufacturing firms in Nairobi, Kenya.
ii. Establish Total Quality Management practices adopted by manufacturing firms in Nairobi, Kenya.
iii. Determine the effects of adopting Total Quality Management and circular manufacturing practices on the productivity of manufacturing firms in Kenya.

1.4 Value of the Study

1.4.1 Practical Implications

Firstly, this study will give practical pointers on how Total Quality Management and Circular Manufacturing operate and the extent to which their implementation will affect productivity. Also, the study will highlight certain aspects of TQM and CE to the managers of the manufacturing firms that will help the firms to recognize gaps and areas of further improvement.

1.4.2 Theoretical Implications

Further, the findings of this study may help in underscoring theory related to TQM, circular manufacturing and firm productivity and eventually lead to changes in appropriate policy and practice. Moreover, this study may help academicians in related fields to add on to their body of work the findings; and also help in filling a significant gap in research.

1.4.3 Contribution for Policy Formulation

Furthermore, this study may help the management of manufacturing firms with information about TQM and circular manufacturing and how they influence productivity. Such knowledge may help them craft appropriate policies that would help their firms improve productivity. In so far as policy directions are concerned, this study may assist manufacturing firms to draw policies related to the 14 principles of TQM as explained by Deming (1996).

Also, it may help manufacturing firms to initiate policies that underscore the tenets of circular manufacturing and how circular manufacturing can be interrelated with TQM to help improve productivity. Other strategic policies around the study variables can also be crafted appropriately.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section considers literature that relates to total quality management, circular manufacturing and productivity of manufacturing firms. To effectively do this, the study discusses the applicable theories anchoring the study, reviews literature on the practices of TQM, circular manufacturing and productivity. Further, it presents empirical literature related to the study variables and presents the research gaps and conceptual framework

2.2 Theories Anchoring the Study

Two notable theories undergirded the study and these are the Deming Theory of Management and the Dynamic Capability Theory (DCT). The two theories are selected because the first, Deming Theory of Management relates to a key variable-TQM while the second, Dynamics Capability Theory relates to circular manufacturing, another key study variable.

2.2.1 The Deming Theory of Management

The Deming's Theory of Management which was first postulated in 1986 by the scholar's crafting of fourteen points on Total Quality Management was the anchor theory. The basic assumption of the theory is that the success, effectiveness and growth of any organization is dependent on a unified and uniform commitment of every person in the organization to quality in all areas of the organization (Deming,1986). Deming (1986) thus argued that for organizations to achieve this total quality management, fourteen practices and philosophies must be adhered to.

The first one is to formulate a framework in the organization that is focused on a clear purpose to improve the services and products. This can be achieved by a company radically redefining their role and instilling concepts and practices of innovation, creativity, maintenance, research and constant improvement (Deming, 1986). The second is the adoption of a new philosophy that is aligned with the new economic age where companies must become learning organizations and where negativism and mistakes are discouraged. The third is to stop practices of mass inspection by simply improving the quality of the product. The fourth point that Deming (1986) offered was the end of awarding tenders and new business based on price and start to award based on minimum total cost. The fifth point was efforts to continuously improve products and services (Deming, 1986). This is with the view that

organizations must stop one-shot improvement and start to engage in a never-stopping effort to always improve the quality of goods and services.

The sixth point relates to instituting a training framework that equips workers effectively. Deming (1986) said that the problem with training was getting new workers being trained by existing workers who themselves were not trained properly. The seventh point is to create a leadership framework that helps staff learn through objective methods and one that helps workers do excellent jobs. The eight one is to make workers feel secure in themselves by driving out the fear that stops them from asking pertinent questions and expressing their full potential. Deming's (1986) ninth point is to break down bottlenecks and barriers that exist among departments by getting these departments to work as a team. The tenth point touches on eliminating slogans and numerical targets by letting workers come up with their own slogans.

Further, the eleventh point is on the elimination of work quotas which are only quantitative and not qualitative and thus offer inaccurate and incomplete measurement for productivity and performance (Deming, 1986). The twelfth pointer is removing defective materials, incompetent supervisors and faulty equipment that often stop workers from taking pride in their work and workmanship. The thirteenth point is instituting an education program that equips employees at all levels with knowledge on new techniques and concepts. The final pointer is having a top management team with the commitment and action plan to implement the whole process (Deming, 1986).

The fourteen points are touted to have been the principal contributor to the massive product and quality growth of companies in Japan that led that country to be an economic powerhouse much to the disappointment of the USA-based companies that had refused to accept these components of TQM (Hillmer & Karney, 2017). Despite positive outcomes for businesses that have entrenched the Deming Theory of Management, the theory is not without criticism. One of the key criticism is that Deming did not include implementation tools that would help progress the TQM processes from start to finish thus leaving managers with no option but to guess (Hillmer & Karney, 2017). Of course, Demis, (1991) in his response, famously said *"you are the manager, you figure it out* (p.23)"

Deming's Theory of Management is appropriate for the present study because it presents the components that constitute TQM which is one of the key variables of the study. The fourteen

points are vital for the study because they will constitute the measures that the study will use to analyze TQM as used in manufacturing firms in Nairobi.

2.2.2 Dynamic Capability Theory

The Dynamic Capability Theory (DCT) is a theory that was first described by Teece, Pisano and Shuen (1997). The basic premise of DCT is that organizations must possess the capability to purposefully and meaningfully adapt the organization's resource status to always suit the changing business environment (Teece et al., 1997). Teece et al. (1997) in fact defined DCT as *"the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments (pg, 511)."*The DCT is particularly an attempt to deal with the gaps in the Resource-based View of the Firm (RBV) that was hitherto the go-to theory on sustainable competitive advantage. Consequently, DCT attempts to explain how businesses operating in a changing business environment operate and thus feel a gap left by RBV which only identified the mechanisms that exist in a sustainable competitive business; mechanisms that include the valuable, non-substitutability, rare and inimitable nature of a company's internal resources (Bleady, Ali & Ibrahim, 2018).

DCT simply says that organizations that succeed are those that speedily and effectively react to innovations and business trends and actions that change significantly the structure, operations and processes of organizations (Teece et al., 1997). Such companies are thus flexible and quicker while efficient in the process. Two significant components undergird DCT. The first is the capability of companies to quickly refresh their existing competencies in the wake of changes in the market and the second is the capacity of business managers to employ strategic forces to leverage on the needed skills plus competencies that effectively meet up with the requirements underlie businesses operating in the changing market environment (Teece et al., 1997). DCT has thus been instrumental in advancing capacities in organizations which enable them to always be ready for any shift in the market environment and to adapt to these shifts accordingly (Bleady et al., 2018).

Dynamic Capabilities Theory is also not without criticism with the main one being its inability to meaningfully satisfy customers' expectations and needs at all times (Bleady et al., 2018). The other criticism is that DCT and its outcomes are difficult to ascertain using empirical methods. As such, DCT cannot be measured to determine who it practically applies to the market (Bleady et al., 2018).Obviously the last criticism has been disputed by a host of different scholars (Pisano, 2015).

DCT applies to the present study because from the analysis of studies, it is clear that circular manufacturing changes the business dynamic drastically. If DCT is to be believed, the companies that speedily and flexibly adapt to changes created by circular manufacturing and use their competencies through TQM are the ones who will benefit from the value of circular manufacturing and eventually see improved productivity. Consequently, this theory will enable the study to see how the findings align or misalign with DCT.

2.3 Total Quality Management

A closer look at TQM shows that it is underpinned by eight principles. The first one is that TQM is customer focused (Gunasekaran, Subramanian & Ngai, 2019). This means that it is the customer who eventually determines the quality notwithstanding the training, resourcing, design integration and innovativeness that has gone into the product (Gunasekaran et al., 2019). Two, TQM works only if there is total employee involvement in all cadres of the employee structure (Nguyen & Nagase, 2019). Consequently, it operates in an environment where fear has been replaced by empowerment and as such employees are not just passive participants but actively involved (Abbas, 2020). Three, TQM is also process-centered to the extent that systems both developing and monitoring are employed to measure and track improvements of operations from start to finish. Four, TQM is also an integrated system which avoids the hierarchical and mechanical structures that characterize many traditional businesses. In this case, TQM demands that both top-down and bottom-up processes are employed (Pambreni, Khatibi, Azam & Tham, 2019). Five, TQM encompasses both a systematic approach with a strategic approach. In this front, strategy formulation, strategic plans and strategic implementation are an integral part of TQM (Sader, Husti, & Daróczi, 2019). As already noted, sixthly, TQM is grounded on a continuous form of product and service improvement and not just a once-off process (Abbas, 2020). The last two principles are that one, TQM depends on and espouses a fact-based process and two, TQM underscores the value of effective communication (Gunasekaran et al., 2019).

Studies that have been done to look at the benefits of TQM have mentioned a myriad of them. One is that TQM strengthens company competitive position especially in a market that is highly differentiated and competitive (Nguyen & Nagase, 2019). Further, TQM allows for adaptability of a company to changes in the market environment and in the same vein leads to improved market image (Pambreni et al., 2019). Other positive outcomes from TQM include improved employee morale and satisfaction, increased job security, improved productivity, lowered costs of doing business and as if tied to circular manufacturing, others have noted

that TQM lowers wastage and eliminates defects (Gunasekaran et al., 2019). Others have found a positive and direct correlation between TQM and improved productivity (Pambreni et al., 2019).

Further, while TQM may be adopted by various organizations around the globe, each company may have unique approaches and strategies used to implement TQM (Shafiq et al., 2019). This is because each company has unique management practices coupled with differing organizational cultures that would make a uniform TQM implementation framework impossible (Nguyen & Nagase, 2019). Remember that TQM founders like Deming (1989) left the implementation tools of TQM to individual managers of organizations and in such a case, those implementation frameworks may be different. So far, some of the implementation tools used to implement TQM have included the guru approach that implements TQM through the lenses of the writing and teachings of one considered to be an expert in some business concept (Abbas, 2020). There is also the organizational model approach which is practiced by having managers and employees of one organization benchmark another successful organization in a bid to integrate what they learn there with their own management practice. There is also the Japanese total quality approach which is where an organization integrates lessons from the Deming (1986) management theory as successfully applied in Japan and using those to manage their organizations. Within the manufacturing sector, lean management, the ISO certification and the six sigma are some of the more notable TQM implementation strategies (Nguyen & Nagase, 2019).

Historically, TQM was coined by the USA-based Naval Air Systems Command that sought to describe the Japanese total management model that had successfully been practiced there (Pambreni et al., 2019). The seeds for TQM were planted in the 1920s with the emphasis and development of scientific management which among other things sought to include workers in planning and implementing organizational goals (Gunasekaran et al., 2019). This was followed in the 1930s with Walter Shewhart development of control of quality and statistical analysis methods for organizations (Sader et al., 2019). But it was the work of W. Edwards Deming, Joseph Juran and Philip Crosby in the 1950s especially in crafting for the Japanese business models to help them improve product and service quality that TQM was grounded proper (Abbas, 2020). In 1968, the Japanese named the process companywide quality control and it is from here that TQM took a life of its own. Until today, TQM is a key organizational management model that is still popular within many organizations (Sader et al., 2019).

2.4 Circular Manufacturing

The concept of circular manufacturing or economy cannot be attributed to one concept or author but to different business-related schools of thought (Corvellec et al., 2019). Consequently, circular manufacturing can be drawn from the Systems model propounded by Bertalanffy who looked at organizational structures as having both closed and open structures. Boulding (1987) then applied this framework to circular economy by arguing that circular economy at its essence is a prerequisite to the sustainability of human life that operates within an open and limitless environmental space. Kneese (1988) then identified the depletion of resources and the need for renewable energy and advocated for circular economy as a solution.

In the 1990s, Pearce and Turner (1990) described the necessary shift from the linear economic approach to circular economy. However, it is important to note that circular economy gained traction in the 2000s especially around China and Europe largely as a result of the economic recession of 2008, renewed focus on sustainability as a valid outcome for forward looking businesses and the sudden increase of raw materials around that time (Stahel, 2018).

Over the years, several models of circular manufacturing have been presented. The more popular model is the 3R principle that looks at circular manufacturing under the tags of Reduce, Reuse, and Recycle (Breteler, 2022). However, Breteler (2022) notes that a review of many of the circular manufacturing models have led to the creation of the 10R principle of circular manufacturing. The 10 Rs include refuse, reduce, redesign or renew, reuse, refurbish, repair, repurpose, remanufacture, recycle and recover (Cramer, 2017).

Circular manufacturing posits some notable benefits both for organizations and for the economy. Studies have shown significant benefits in material costs saving, energy costs saving, recalibration and quality redesign of products and services, creative innovations on products that are ecologically friendly, inventions of new business models that are aligned with the current market, cross-sector collaboration and improved productivity (Corvellec et al., 2019; Stahel, 2018). Further, scholars like Ranta et al. (2018) in an extensive study done in the USA to review circular economy as practiced by Dell company, one of the first major corporations to adopt circular manufacturing, noted that CE had almost eradicated wastage and created ecologically-friendly products that were attuned to the expectations and needs of

customers. Of note however was that, CE is still a complex concept that many managers are still unfamiliar with (Ranta et al., 2018).

Critics of circular economy abound. One argues that circular economy is inundated by so many diverse definitions that it becomes increasingly problematic to identify what it really is (Corvellec et al., 2019). Others argue that circular economy is premised on the wrong natural assumptions by suggesting that it can recycle and renew resources infinitely yet the laws of thermodynamics assert that no one can either create or eventually destroy matter (Stahel, 2018). Further, being a new concept, there is still scanty empirical results that show the practicability and sustainability of circular economy over the conventional linear economy (Corvellec et al., 2019).

2.5 Productivity

Drucker (2018) defines it as a measure of organizational performance that compares the quantity of products and services generated (output) against the quantity of inputs inserted to generate those products and services. Further as earlier noted, Del Gatto et al. (2021) defined productivity as the efficiency attached to the production of goods and services that is measured by expressed as a ratio between aggregate outputs to a measurable aggregate input. From the descriptions above, productivity is related to used resources and how they are in fact utilized (Sickles &Zelenyuk, 2019). Also, productivity has been strongly linked to the creation of value (Del Gatto et al., 2021). This means that in productivity is observed when the inputs that drive outputs are geared towards creating a product that has value. Productivity is thus viewed in contradistinction to wastage. Thus, to improve productivity, wastage must be avoided or even eliminated (Del Gatto et al., 2021).

While it may appear that the term productivity is easy to define, it also in the same vein brings confusion to illustrate that it may not be as easy a term as is presented. For instance, many people confuse productivity with the measures of production. The latter is about amount or quantity of products and services produced while the former compares the measures of production with inputs inserted to produce (Drucker, 2018).Therefore, increased production does not necessarily mean increased productivity. Further, productivity comes with a certain form of ambiguity. This is largely because productivity is dependent on various inputs from material, capital to labour among others which may affect productivity of product A and not product B (partial productivity) or may affect all the products within the organization (total productivity) depending on the nature, processes and value of inputs

(Sickles &Zelenyuk, 2019). Nonetheless, productivity is a vital part of any organization's goals and cannot be ignored (Del Gatto et al., 2021).

2.6 Empirical Studies

Bocken, De Pauw, Bakker and Van Der Grinten (2016) looks at TQM through its capacity to enhance continuous quality improvement and evaluates circular economy among manufacturing firms in The USA and how both TQM and circular manufacturing impacts on productivity. The study uses mixed methodology by combining qualitative data with quantitative data collected from 15 manufacturing firms. The study found that when TQM is practiced in companies that have adopted circular manufacturing, the level of productivity of those firms increases by 18.6%. Further, the study from the inferential analysis done finds that TQM and circular manufacturing are positively correlated with overall business performance characterized by improved profitability, effectiveness, customer satisfaction, staff morale and cost-savings in many of the operational aspects of the firm. It would be instructive to determine if similar results apply in manufacturing firms in Kenya which operate in a developing country context as opposed to a developed nation like the USA.

Zhang et al. (2021) does an explanatory study to examine TQM, circular manufacturing and sustainable performance of manufacturing firms in China. The study uses both descriptive and inferential statistics to analyze data collected from 5 manufacturing firms in Guangzhou, China. The study finds a positive correlation between TQM, CE and sustainable performance of those firms. The study also observes that knowledge management positively mediates between the relationship between TQM and sustainable performance. While this study offers valuable insights about the effect of TQM, circular manufacturing and sustainable performance it does not look at the two independent variables and their effects on productivity as the present study will do.

Dezi et al. (2022) did a study to evaluate TQM in firms engaged in circular manufacturing and how those firms have performed and produced. The study is done in Patagonia using an inductive approach. The study finds that TQM within a circular economy is undergirded by sustainability expressed in the Triple Bottom Line model which espouses the need for organizations to not only value profitability but also entrench social and environmental considerations. The study thus views TQM as practiced in companies engaged in circular manufacturing as an attempt of those companies to expand their value through sustainability. A major gap of this study is that even though one of its primary intentions was to link TQM,

CE with performance it does not do that. The current study nonetheless does this by linking TQM, circular manufacturing and productivity of manufacturing firms in Kenya.

Yin, Jia, Cheng and Wang (2023) evaluate circular economy practices and sustainable performance of manufacturing firms in Pakistan. The study is anchored on quantitative research methods and thus examines 8 manufacturing firms as the primary unit of analysis. From the study, it is noted that circular economy approaches grounded on reuse, recover and recycle have a positive effect on cost saving, reduction of wastages and pollution, enhancement of operational efficiency and general sustainable performance. The study also finds that CE is unswervingly associated to heightened customer satisfaction and the upsurge of customer expectation. To this end, the study links CE to practices that are aligned to TQM and says that these have a positive effect on sustainable performance of manufacturing firms. Is this true for manufacturing firms in Kenya?

Within the African set-up, differing results relating to TQM, circular manufacturing and productivity are noted. In a study to examine TQM used in circular manufacturing adopting firms in Nigeria done by Bansal et al. (2022) shows significant and salient results. The descriptive survey study finds that TQM practiced in companies that have adopted circular manufacturing post increased performance and productivity levels than companies that do not practice TQM. The study however observes that very few companies have embraced circular manufacturing in Nigeria owing to the intensive and complex nature of CE especially for manufacturing firms within the small and medium size Enterprises (SMEs).

Another study done in Ghana by Saha et al. (2022) to examine the potential of TQM to advance sustainability in firms that practice circular manufacturing found that both TQM and circular manufacturing are rarely practiced within the Ghanaian business environment. However, where it is practiced, productivity levels are stagnant. This implies that unlike many other studies that find positive effect of TQM on productivity of firms that practice circular manufacturing, this study finds a negative effect.

Studies done within the Kenyan context have shown a positive effect of TQM on productivity of manufacturing firms. Keinan and Karugu (2018) examined productivity in Bamburi Cement and found that TQM increased productivity by 13%. Nganga and Nyaga (2022) examined continuous improvement through TQM and productivity at the Nairobi Bottlers Limited and found a strong and positive correlation between TQM and productivity. Simani (2017) looked at TQM as it relates to competitive strategies and how it affects performance

of manufacturing firms. The study noted that TQM enabled a firm-wide approach that improved every outcome of the manufacturing firm. While these studies are vital and useful in determining the relationship between TQM and productivity, they do not consider manufacturing firms engaging in circular manufacturing and how TQM within those firms affect productivity; hence the need for the present study that examines Total quality management, circular manufacturing and productivity of manufacturing firms in Nairobi, Kenya.

2.6.1 Summary of Literature Reviewed

From the reviewed literature, studies done globally, find a positive correlation between TQM, CE and sustainable performance of those firms. Within the African set-up, differing results relating to TQM, circular manufacturing and productivity are noted. Survey studies find that TQM practiced in companies that have adopted circular manufacturing post increased performance and productivity levels than companies that do not practice TQM. In other studies, where TQM and circular manufacturing are practiced, productivity levels are stagnant. Studies done within the Kenyan context have shown a positive effect of TQM on productivity of manufacturing firms.

2.7 Conceptual Framework

Independent Variable

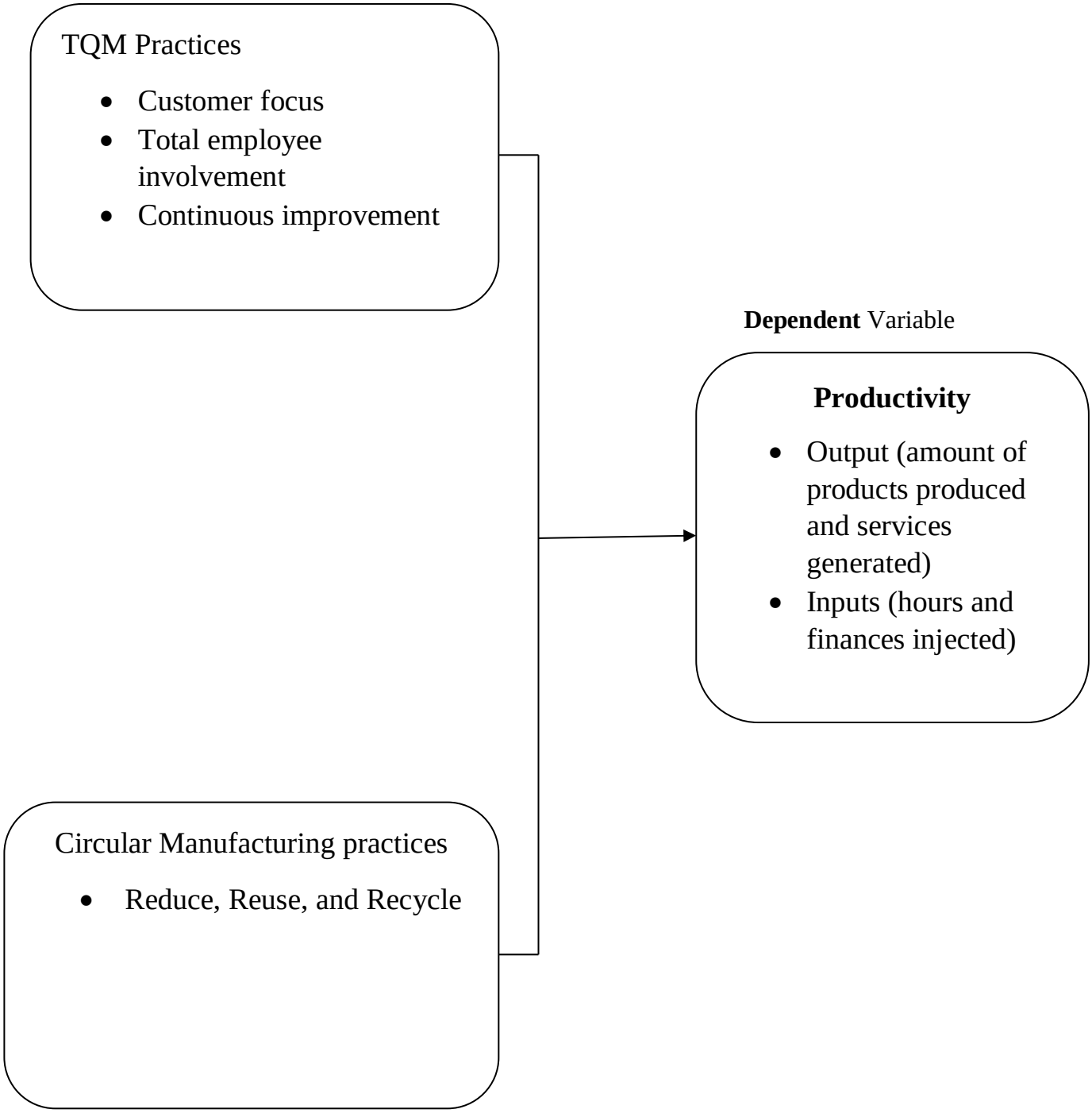

Figure 2.1: Conceptual Framework

The conceptual framework presents a diagrammatic representation of the study variables in terms of independent and dependent variables. TQM is measured using the main principles as espoused in Deming's Management Theory while circular manufacturing is measured by the

3R Model. Productivity is measured using the output and input indicators which are the conventional descriptions and indicators of productivity.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter discusses the methodological underpinning used to examine total quality management, circular manufacturing and how they affect productivity of manufacturing firms in Kenya. The part of the study describes the research design that underpins the study coupled with the sttudy population followed by the study sample size and procedure thereof, the data collection instruments and their collection procedures and finally, the data analysis techniques.

3.2 Research Design

The present study was grounded on a descriptive survey research design which foundationally sought to describe occurrences, events and circumstances in an area of study in an objective format (Busetto, Markus &Actun., 2015). Descriptive survey research also becomes appropriate because it allows for the collection and analysis of quantitative approaches based on statistical and numerical data (Busetto et al., 2015). The descriptive survey research design was appropriate for the present study because it aimed at evaluating and examining Total quality management, circular manufacturing and how they affect productivity of manufacturing firms in Kenya. The TQM and circular manufacturing practices as used in the manufacturing firms plus the productivity numbers are describable and largely quantitative.

3.3 Population of the Study

To effectively access reliable data on total quality management, circular manufacturing and how they affect productivity of manufacturing firms in Kenya the 454 manufacturing firms in Nairobi constituted the study population (Nairobi County Government, 2023; KNBS, 2023). Nairobiwas selected as a microcosm of manufacturing firms in Kenya but also because the variances in productivity across manufacturing sub sectors was also witnessed in firms in Nairobi. Thus, the study targeted the management staffworking at the manufacturing firms in Nairobi (one from each of the firms). The management staff were considered because they are directly involved in formulation and implementation of TQM and circular manufacturing practices in their respective firms.

3.4 Sample Size and Sampling Procedure

TheYamane, (1967), formula to calculate and access a credible sample size from the target population was utilized:

$$n = \frac{N}{1+Ne^2}$$

Where, n is size of sample

N is population of sample

e^2 is probability of error

Table 3.1 Sample Population

Category	Population	Formula	Sample size
Manufacturing firms	454	$n = \frac{454}{1+454\ (0.0025)}$	213
Total	454		213

Cluster sampling was used to select 213 manufacturing firms as they were from diverse sectors from where one management staff was selected.

3.5 Data Collection

The study employed two research instrumentation tools to gain data relevant to this study. The first one was the questionnaires dispensed to the management staff from the manufacturing firms to collect primary data. This questionnaire was based onthree sections: The first being the demographic section with background information on gender, age and experience plus the level of education. The second section had questions on TQM practices. The third section focused on circular manufacturing practices. The second instrument was adocumentary checklist to collect secondary data on productivity of the firms. This helped augment the data and give an in-depth analysis.

3.5.1 Validity and Reliability of Research Instruments

Validity and reliability regarding the data collection instruments were computed and statistically tested**.** As far as reliability was concerned, construct validity which examines the measurable indices and capability of the exact variables under study was measured through an exploratory factor analysis. The EFA measures the strength of the inter-item correlations within the items in the instruments (Green &Salkind, 2011). Content validity on the other hand was measured by having the supervisor examine the content of the questionnaires to see if they adequately answered the research questions. Reliability measures the extent that the results bear the potential to give consistent and repeatable results. Thus, to check reliability of the survey instrument (questionnaire), the Cronbach's alpha model was employed, getting a score of 0.716 which is an acceptable score (DeVellis, 2003; Busetto et al., 2015).

3.6 Operationalization of Variables

Variables	Type	Indicators	Measuring Scale
Total Quality Management	Independent Variable	Customer focus Total employee involvement Continuous improvement	Interval
Circular Manufacturing	Independent Variable	Reduce Reuse Recycle	Interval
Productivity	Dependent Variable	Output (amount of products produced and services generated) Inputs (hours and finances injected)	Ordinal

3.7 Diagnostic Tests

The diagnostic tests that were used are those aligned to the assumption of the regression analysis. Thus, the tests of autocorrelation, multicollinearity and normality were done. To check if autocorrelation exists or not, the Durbin-Watson test was used. A score that is <0.05

will indicate absence of autocorrelation while a score of >0.05 will indicate presence of autocorrelation. The the Kolmogorov-Smirnov test was used to test normality; the Kolmogorov-Smirnov test was used because the sample size exceeded 50 respondents. A score of >2.0 in the the Kolmogorov-Smirnov test is a mark of acceptable normality. Multicollnearity test was done by examining the multicollinearity score which should not exceed 0.08.

3.8 Data Analysis

First, the accessed data was cleaned via the elimination of ambiguity and outliers found within the variables. Then, secondly, descriptive statistics tools characterized by frequency, percentage, mean and standard deviation offered a description of the results. Inferential statistics in the form of One Sample T-Test was used to ascertain the variance of the means against the hypothesized population and thus check for relationships among the variables. A p-value of <0.05 was a mark of statistical significance. Both Pearson Correlations and regression analysis were used. The SPSS Software Version 25wasemployed in the computation and analysis of the data.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter presents the research findings related to total quality management, circular manufacturing and how they affect productivity of manufacturing firms in Kenya. Specifically, it presents the response rate, the demographic characteristics of the management staff and the descriptive statistics related to the research objectives. It further presents the inferential statistics. The findings are also compared and contrasted with literature to undergird the discussion of the findings.

4.2 Response Rate

The study sampled 213 respondents drawn from small and medium manufacturing firms and large manufacturing firms. However those who fully responded to all questions and returned the questionnaires were 169. This represents a 79.3% response rate as shown in Table 4.1.

The response rate was deemed acceptable, as Kothari, (2014) assert that a response rate of 70% is considered sufficient to make informed and reliable conclusions . Further, the noted response rate falls within similar reviews like the study done by Keinan and Karugu (2018) which posted a response rate of 75% when engaged in a study to examine TQM practices and how they influence performance of manufacturing firms in Kenya.

Table 4.1: Response Rate

Response	**Frequency**	**%**
Actual and Full Response	169	79.3
Non Response	44	20.7
Total	**213**	**100.0**

4.3 Demographic Characteristics

Information was also collected on gender, age, education level and experience of the respondents. The demographic results were done considering that the management staff selected was instrumental in ascertaining the TQM and circular practices used in their respective manufacturing firms. The succeeding tables show those results.

4.3.1 Gender of the Respondents

The result of the Gender of the manufacturing firm employee respondents is shown in Table 4.2.

The results from Table 4.2 show that majority at 63.3% of the management staff working in the manufacturing firms in Nairobi were male and only 36.7% were female. This implies that the demographics of the manufacturing firm management staff in terms of gender was male dominated. This result agrees with literature like that by Koech and Munene (2020) that show that organizations that deal with engineering, manufacturing or related works are often male dominated owing to higher male inclinations towards that profession. Nonetheless, the sizeable number of female employees means that the potential for the results to offer reliable findings are improved.

Table 4.2: Gender of the Respondents

Response	**Frequency**	**%**
Male	107	63.3
Female	62	36.7
Total	**169**	**100.0**

4.3.2 Age of the Respondents

The result of the age of the management staff working in the manufacturing firms in Nairobi respondents is shown in Table 4.3.

An observation of Table 4.2 is clear that that slightly more than half of the respondents' age was between 36 and 45 years. This was succeeded by 24.9% whose ages were between 26 and 35 years, 18.3% were over 45 years and only 6.5% were aged between 18-25 years. This implies that a significant majority of the management staff working in the manufacturing firms in Nairobi (75.2%) had ages connecting 26 to 45 years. It further implies that the management staff working in the manufacturing firms in Nairobi is at the middle quartile and could be considered youthful.

Table 4.3: Age of the Respondents

Response	Frequency	%
18-25 years	11	6.5
26-35 years	42	24.9
36-45 years	85	50.3
>45 years	31	18.3
Total	**169**	**100.0**

4.3.3 Level of Education of the Respondents

Data was collected on the level of education of the management staff working in the manufacturing firms, with results shown in Table 4.4.

Results from Table 4.4 show that majority at 45.6% had undergraduate degree qualifications, followed by 28.4% with diploma qualifications. Also, 17.2% had post-graduate qualifications and only 8.9% had certificate qualifications. This implies that the management staff working in the manufacturing firms in Nairobi was significantly educated. This is important because Zhang et al. (2021) had mentioned that a higher level of education observed among respondents is a testament to higher reliability of the results because the conceptual understanding of the respondents about the issues under investigation is always sharper. For this study therefore, the fact that over 90% of the respondents had diploma qualifications and above means that they were able to reliably underscore the issues related to total quality management, circular manufacturing and how they affect productivity of manufacturing firms in Kenya.

Table 4.4: Level of Education of the Respondents

Response	Frequency	%
Certificate	15	8.9
Diploma	48	28.4
Undergraduate	77	45.6
Post-graduate	29	17.2
Total	**169**	**100.0**

4.3.4 Level of Experience of the Respondents

Further, there was collection of data on the level of experience of the management staff working in the manufacturing firms, with results shown in Table 4.5.

The results from Table 4.5 show that 42.6% had worked at the manufacturing firms for over 10 years. They were followed by 29.6% who had worked for between 5 and 10 years and 27.8% who had worked for less than 5 years. The results implies that the management staff working in the manufacturing firms was experienced and their longstanding duration of working at the firms suggests that they would better understand, based on long exposure, the management strategies used to improve productivity at the firms.

Table 4.5: Level of Experience of the Respondents

Response	**Frequency**	**%**
<5 years	47	27.8
5-10 years	50	29.6
>10 years	72	42.6
Total	**169**	**100.0**

4.4 Diagnostic Tests

Diagnostic tests to ascertain the assumptions of the regression analysis were done. First, the test of normality was done. This test is necessary in order to determine if the analysis is well-modeled through a normal distribution, absence of which leads to unreliable results.

The Kolmogorov-Smirnov test applied to this study and not the Shapiro Wilk because the sample size was >50. Thus, the Kolmogorov-Smirnov score are >0.05, the least of those scores being 177 for circular manaufacturing. This means that all the calculated independent variables are normal increasing the likelihood of rejecting any null hypotheses.

Table 4.6 Tests of Normality

Capabilities		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	Df	Sig.
Productivity	TQM	.193	239	.200*	.911	169	.822
	CE	.177	239	200*	.910	169	.808

a. Lilliefors Significance Correction

*This is a lower bound of the true significance

A test for multicollinearity was done in order to check if there is any inter-association between the study variables, an inter-association that may lead to unreliability and invalidation of the results.

The results from Table 4.7 show no multicollinearity problem considering that the highest VIF is 1.862 and the other VIF results falling being between 1 and 10 scores. Circular Manufacturing (Tolerance=943; VIF=1.862) posted the highest relationship with the other variable (TQM). Further, considering that the tolerance scores for each of the measured variables were closer to 1 and away 0.1 implies a lack of the multicollinearity problem.

Table 4.7: Test for Multicollinearity

	Collinearity Statistics	
	Tolerance	VIF
TQM	.571	1.531
CE	.943	1.862

The test for autocorrelation was done using the Durbin-Watson test as shown in the model summary (Table 4.12). The resultant score is 2.361 which then imply negative autocorrelation as that score exceed 2.0. Any score laying between 1 and 2 would have meant the presence of autocorrelation which would have disturbed the goodness of fit and thus affected the statistical significance of the results.

4.5 Practices of Circular Manufacturing Embraced by Manufacturing Firms in Nairobi

The results in Table 4.8 present the findings for the practices of circular manufacturing embraced by manufacturing firms in Nairobi, Kenya which represents the first objective.

The results on the practices of circular manufacturing embraced by manufacturing firms in Nairobi, Kenya shown in Table 4.8 shows that 7 out of 10 descriptive statements presented have a mean score >3.00 with many at the 4.00 mark. The said statements also have high t-test scores accompanied by a verifiable significant score of <0.05 showing that the variance

been the states mean and the mean of the normal distribution is significant. Thus, the results show that mostly, manufacturing firms practiced circular manufacturing particularly as far as rethinking on every product with a view of reducing their environmental impact; using and manufacturing products in smarter ways to reduce wastage and negative environmental impacts; reusing some of its products and materials to enact zero-wastage; repairing its materials and products to avoid unnecessary throwaway and obsolescence behaviour. Also as far as the firm manufacturing some of its products in the sense that parts of a discarded product are used on another product to make them functional; and the firm repurposing many of its materials in order to use them for other purposes.

However, the manufacturing firms based on the mean scores <3.00 with negative t-test scores were still not able to refuse to possess unnecessary and unsustainable products by having mechanisms that maximize the utilization of fewer goods; refurbish its products to restore them to original functionality; have a robust recycling program and have a robust recovering program of materials that were considered waste but which can be recovered. Clearly therefore, manufacturing firms in Nairobi were engaged in circular manufacturing but with some notable challenges.

The results above showing marked adoption of circular manufacturing among firms in Nairobi have concurrence in literature with studies showing that the focus on sustainability that demands a combination of profit concerns with social and environmental considerations has led to a focus on circular economy or circular manufacturing (Stahel, 2018). Further, CE has gained traction in these spaces owing to its capacity to reduce dangerous emissions and minimize undesirable consumption of raw materials (Kirchherr et al., 2017; Murray et al., 2017). Further, CE is popular because it has extensively expanded the market prospects, has increased resource efficiency and also created options for sustainable consumption all of which are aligned to new market trends and needs (Geng et al., 2019). This means that manufacturing firms in Nairobi are concerned about sustainability, reduction of wastage, climate change issues, pollution matters and an expanded market prospect in a presently highly-competitive market.

Table 4.8 Practices of Circular Manufacturing Embraced by Manufacturing Firms in Nairobi

Statement	N	Mean	StD	t-value	Sig. (2 tail)
The firm rethinks on every product with a view of reducing their environmental impact	169	4.44	1.98	12.11	.000
The firm repurposes many of its materials in order to use them for other purposes	169	4.43	.97	12.88	.000
The firm reuses some of its products and materials to enact zero-wastage	169	4.41	.99	14.90	.000
The firm uses and manufactures products in smarter ways to reduce wastage and negative environmental impacts	169	4.32	1.10	10.56	.000
The firm reuses some of its products and materials to enact zero-wastage	169	4.41	.99	14.90	.000
The firm repairs its materials and products to avoid unnecessary throwaway and obsolescence behaviour	169	4.19	.87	17.90	.000
The firm remanufactures some of its products in the sense that parts of a discarded product are used on another product to make them functional	169	4.16	.98	14.56	.000
The firm has a robust recovering program of materials that were considered waste but which can be recovered	169	2.89	1.00	-17.90	.331
The firm refuses to possess unnecessary and unsustainable products by having mechanisms that maximize the utilization of fewer goods	169	2.12	1.18	-18.76	.000
The firm has a robust recycling program	169	1.11	1.00	-18.50	.564
Average	**169**	**3.19**	**1.06**		

4.6 Practices of Total Quality Management Embraced by Manufacturing Firms in Nairobi

The results in Table 4.9 present the findings for the practices of Total Quality Management embraced by manufacturing firms in Nairobi, Kenya which represents the second objective. The results on the practices of Total Quality Management embraced by manufacturing firms in Nairobi, Kenya shown in Table 4.9 shows that all the 8 descriptive statements presented have a mean score >3.00 with many at the 4.00 mark. All the 8 statements also have high t-test scores accompanied by a verifiable significant score of <0.05 showing that the variance been the states mean and the mean of the normal distribution is significant. Thus, the manufacturing firms in Nairobi Kenya had adopted TQM practices significantly. It can particularly be noted that the manufacturing firms had embraced the three main tenets of TQM which is customer focus, total employee involvement and continuous improvement

There is concurrence of this practice with literature. Reviewed studies show that TQM constitutes management techniques, tools and approaches as well as principles, concepts and a philosophy of management (Desi et al., 2022; Luthra et al., 2020). Further, it shows that TQM is all inclusive in terms of all staff cadres of the organization and its aim is to meet and hopefully exceed the needs and expectations of customers in order to achieve positive organizational outcomes (Desi et al., 2022; Luthra et al., 2020). Further, TQM from the descriptions is a continuous practice that must be ingrained in the culture of the organization and as such is not a one-day or one-shot program (Reed et al., 2018). Also, studies that have been done to look at the benefits of TQM have mentioned a myriad of them. One is that TQM strengthens company competitive position especially in a market that is highly differentiated and competitive (Nguyen & Nagase, 2019). Further, TQM allows for adaptability of a company to changes in the market environment and in the same vein leads to improved market image (Pambreni et al., 2019). Other positive outcomes from TQM include improved employee morale and satisfaction, increased job security, improved productivity, lowered costs of doing business and as if tied to circular manufacturing, others have noted that TQM lowers wastage and eliminates defects (Gunasekaran et al., 2019). Others have found a positive and direct correlation between TQM and improved productivity (Pambreni et al., 2019). Consequently, it can be adduced that the manufacturing firms in Nairobi have adopted TQM to strengthen company competitive position especially in a market that is highly differentiated and competitive, be adaptive to the dynamic market environment, improve

employee morale and satisfaction, increase job security, improve productivity, lower costs of doing business among others.

Table 4.9 Practices of Total Quality Management Embraced by Manufacturing Firms in Nairobi

Statement	N	Mean	StD	t-value	Sig. (2 tail)
In the firm, there are systems, both developing and monitoring, employed to measure and track improvements of operations from start to finish	169	4.70	.91	17.43	.001
The system at the firm avoids the hierarchical and mechanical structures often seen in traditional firms, therefore top-down and bottom-up processes are employed	169	4.40	.98	17.90	.000
Management of the firm is grounded on a continuous form of product and service improvement and not just a one-off process.	169	4.31	1.07	13.87	.000
In the firm, the management encompasses both a systematic approach with a strategic approach, that is strategy formulation, strategic plans and strategic implementation are an integral part of the management system.	169	4.25	.97	21.28	.000
The management at the firm relies on and espouses a fact-based managerial process.	169	4.13	.99	17.50	.001
The management at the firm highlights the value of effective communication.	169	4.13	.97	15.62	.000
In my firm, the customer is the focus in the sense that it is the customer who eventually determines the quality of product	169	4.12	.98	22.56	.000
In my firm, there is total employee involvement in all cadres of the employee structure	169	4.04	.98	16.11	.000
Average		**4.06**	**.99**		

4.6 Level of Productivity of the Manufacturing Firms

The results in Table 4.10 present the secondary data findings for the level of productivity in manufacturing firms in Nairobi, Kenya which represents the dependent variable.

The results from Table 4.10 show improved sales for both small and medium manufacturing firms and large manufacturing firms at 5.4% and 4.7% annual average growth rate

respectively, improved productivity at 5.7% and 4.2% respectively. The labour costs for both categories (2.7% and 5.7%), energy costs (2.3% and 4.3%) and material costs (3.1% and 4.1%) respectively have marginal improvements which may be attributed to adoption of CE and TQM practices. What is clear is that for manufacturing firms (both small and medium manufacturing firms and large manufacturing firms), the productivity of the firms have increased for the years 2022.

Table 4.10: Level of Productivity of the Manufacturing Firms

		Small and medium manufacturing firms		**Large Manufacturing Firms**	
Productivity Indices	**N**	**Annual Average Growth Rate (%)**	**Contribution to the Overall Firm Growth (%)**	**Annual Average Growth Rate (%)**	**Contribution to the Overall Firm Growth (%)**
Output					
Sales (kshs)	169	5.4	11.2	4.7	9.2
Production (Volume)	169	5.7	11.6	4.2	10.2
Input					
Labour Cost	169	2.7	4.8	5.7	6.1
Energy Cost	169	2.3	3.8	4.3	5.8
Material Cost	169	3.1	4.3	4.1	6.3

Further, an ANOVA test was done to check the variance between the different categories of manufacturing firms. Table 4.9 shows the results.

Based on the results, both small and medium scale manufacturing firms (p-value=0.00; <0.05) and large manufacturing firms (p-value=0.00; <0.05) had a significant statistical difference with productivity.

Table 4.11 ANOVA Test for Categories of Manufacturing Firms and Productivity

Small and Medium Manufacturing Firms	Sum of Squares	df	Mean Square	n	Sig.
Between Groups	15.714	1	13.934	15.711	.000
Within Groups	216.108	162	.686		
Total	231.822	163			
Large Manufacturing Firms					
Between Groups	12.042	1	9.112	15.755	.000
Within Groups	217.010	162	.065		
Total	229.052	163			

4.7 Effects of Adopting Total Quality Management and Circular Manufacturing Practices on the Productivity of Manufacturing Firms in Kenya

The third objective sought to determine the effects of adopting Total Quality Management and circular manufacturing practices on the productivity of manufacturing firms in Kenya. This is appropriately measured using both the correlations and the regression analyses.

4.7.2 Correlation Analysis

To check the association between the independent variables (TQM and CE) and the dependent variable (productivity) a Pearson's correlation analysis was done as shown in Table 4.12.

An interpretive key for any Pearson's Correlations analysis is any r-score that fall between 0.1-0.3 is reflective of a weak correlations score. Further, any score between 0.4-0.5 is at the medium range and any figure that is above 0.5 up to 1.0 is reflective of a strong correlations score. It is however noted that the score should ideally not exceed 0.8 to avoid multicollinearity problems. The results from Table 4.12 first show that all the r-scores or values are strong because they are above the 0.5 score but also show that TQM (r=0.647; P-value <0.00) had the highest correlation with productivity of manufacturing firms in Nairobi, Kenya. This was followed by CE (r=0.625; P-value <0.00). CE also had a strong positive association with TQM (r=0.597; P-value <0.01). This implies that TQM and CE have a positive relationship with productivity of manufacturing firms in Nairobi, Kenya.

Table 4.12: Pearson Correlations

		Productivity	TQM	CE
Productivity	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	169		
TQM	Pearson Correlation	.647**	1	
	Sig. (2-tailed)	.000		
	N	169	169	
CE	Pearson Correlation	.625**	.597**	1
	Sig. (2-tailed)	.000	.001	
	N	169	169	169

4.7.3 Regression analysis Tests

To measure the quantitative scales that underpin the study, multiple regression analysis was utilized and interpreted. Tables 4.13, 4.14 and 4.15 present these results.

The R result shown in Table 4.13 of .668[a] denotes a positive direction of the whole equation showing a strong and significant relationship between the observed and predicted scores. This means that the regression results align with the assumption that there is a proportionate relationship between the dependent variable and the independent variables such that any increase in the independent variables leads to an increase in the dependent variable. Also, the adjusted R Square score of .607 gives evidence that productivity of manufacturing firms in Nairobi, was predicted by TQM and CE at 60.7%. This agrees with literature like that by Bocken et al. (2016) who looks at TQM through its capacity to enhance continuous quality improvement and evaluates circular economy among manufacturing firms in The USA and how both TQM and circular manufacturing impacts on productivity. The study found that when TQM is practiced in companies that have adopted circular manufacturing, the level of productivity of those firms increases by 18.6%. Further, the study from the inferential

analysis done finds that TQM and circular manufacturing are positively correlated with overall business performance characterized by improved profitability, effectiveness, customer satisfaction, staff morale and cost-savings in many of the operational aspects of the firm. It would be instructive to determine if similar results apply in manufacturing firms in Kenya which operate in a developing country context as opposed to a developed nation like the USA. The other is that one by Zhang et al. (2021) which examine TQM, circular manufacturing and sustainable performance of manufacturing firms in China and which finds a positive correlation between TQM, CE and sustainable performance of those firms. The study also observes that knowledge management positively mediates between the relationship between TQM and sustainable performance.

Table 4.13: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.668[a]	.649	.607	.177	2.361

a. Predictors: (Constant), CE and TQM

b. Dependent Variable: Productivity

Results from Table 4.14 show that the sum of squares which measures the variability of data away from the mean points is 186.533. This is a higher figure that shows a higher variability from the mean and can thus be interpreted that the results are reliable due to the higher deviation. The same case applies to the mean square which is 52.036. Moreover, the F-statistic (64.806) generally confirms the fitness of the model whose significance is <0.05 considering the noted p-value of .000. As a result, TQM and CE have a statistically significant effect on productivity of manufacturing firms in Nairobi, Kenya.

Table 4.14: ANOVA[b]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	186.533	4	52.036	64.806	.000[a]
	Residual	11.209	109	.694		
	Total	197.742	113			

The Coefficients results seen in Table 4.15 show all the p-values as being <0.05. This basically shows that TQM (β=.534 p-value <0.05) and CE (β=.428 p-value <0.05) have a statistically significant effect on productivity of manufacturing firms in Nairobi, Kenya. What this means is that an increase of the productivity measure is determined by a 0.534 increase in TQM. Also, an increase of the productivity measure is determined by a 0.428 increase in CE.

Further, the t-values observed are above the 2.0 mark. It should be noted that the higher the t-values above 2.0 mark, the greater the confidence of the calculated coefficients. As such, it is clear that the model's confidence is high and thus it can be concluded that the regression results are fit and significant.

Table 4.15: Coefficients

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.734	.3931	.279	7.890	.000
	TQM	.549	.083	.534	5.756	.001
	CE	.431	.063	.428	3.433	.000

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings based on the results, the conclusions categorized under the research objectives, the recommendations from the conclusions and suggestions for further studies.

5.2 Summary of Findings

Based on the results of the first objective, the findings show that 7 out of 10 descriptive statements presented had a mean score >3.00 with many at the 4.00 mark. The said statements also have high t-test scores accompanied by a verifiable significant score of <0.05 showing that the variance been the states mean and the mean of the normal distribution is significant. Thus, the results show that mostly, manufacturing firms practiced circular manufacturing particularly as far as rethinking on every product with a view of reducing their environmental impact; using and manufacturing products in smarter ways to reduce wastage and negative environmental impacts; reusing some of its products and materials to enact zero-wastage; repairing its materials and products to avoid unnecessary throwaway and obsolescence behaviour. Also as far as the firm manufacturing some of its products in the sense that parts of a discarded product are used on another product to make them functional; and the firm repurposing many of its materials in order to use them for other purposes. However, the manufacturing firms based on the mean scores <3.00 with negative t-test scores were still not able to refuse to possess unnecessary and unsustainable products by having mechanisms that maximize the utilization of fewer goods; refurbish its products to restore them to original functionality; have a robust recycling program and have a robust recovering program of materials that were considered waste but which can be recovered. Clearly therefore, manufacturing firms in Nairobi were engaged in circular manufacturing but with some notable challenges.

Based on the results of the second objective, the finding shows that all the 8 descriptive statements presented have a mean score >3.00 with many at the 4.00 mark. All the 8 statements also have high t-test scores accompanied by a verifiable significant score of <0.05 showing that the variance been the states mean and the mean of the normal distribution is

significant. Thus, the manufacturing firms in Nairobi Kenya had adopted TQM practices significantly. It can particularly be noted that the manufacturing firms had embraced the three main tenets of TQM which is customer focus, Customer focus, total employee involvement and continuous improvement

Based on the results of the third objective, the findings from the correlations and regression analyses show that all the r-scores or values are strong because they are above the 0.5 score but also show that TQM (r=0.647; P-value <0.00) had the highest correlation with productivity of manufacturing firms in Nairobi, Kenya. This was followed by CE (r=0.625; P-value <0.00). CE also had a strong positive association with TQM (r=0.597; P-value <0.01). Also, the adjusted R Square score of .607 gives evidence that productivity of manufacturing firms in Nairobi, was predicted by TQM and CE at 60.7%. Further the regression analysis shows that TQM (β=.534 p-value <0.05) and CE (β=.428 p-value <0.05) have a statistically significant effect on productivity of manufacturing firms in Nairobi, Kenya.

5.3 Conclusion

Based on the results of the first objective, it is clear that mostly, manufacturing firms practiced circular manufacturing particularly as far as rethinking on every product with a view of reducing their environmental impact; using and manufacturing products in smarter ways to reduce wastage and negative environmental impacts; reusing some of its products and materials to enact zero-wastage; repairing its materials and products to avoid unnecessary throwaway and obsolescence behaviour. Also as far as the firm manufacturing some of its products in the sense that parts of a discarded product are used on another product to make them functional; and the firm repurposing many of its materials in order to use them for other purposes. However, the manufacturing firms were still not able to refuse to possess unnecessary and unsustainable products by having mechanisms that maximize the utilization of fewer goods; refurbish its products to restore them to original functionality; have a robust recycling program and have a robust recovering program of materials that were considered waste but which can be recovered. Clearly therefore, manufacturing firms in Nairobi were engaged in circular manufacturing but with some notable challenges.

Based on the results of the second objective, it is clear that the manufacturing firms in Nairobi Kenya had adopted TQM practices significantly. It can particularly be noted that the

manufacturing firms had embraced the three main tenets of TQM which is customer focus, total employee involvement and continuous improvement

Based on the results of the third objective, it is clear that TQM had the highest correlation with productivity of manufacturing firms in Nairobi, Kenya followed by CE. Also, there is evidence that productivity of manufacturing firms in Nairobi was predicted by TQM and CE at 60.7%. Thus it can be concluded that TQM and CE have a positive relationship with productivity of manufacturing firms in Nairobi, Kenya. The results here agree with literature to a very significant extent. For instance, look at Bocken et al. (2016) who looks at TQM through its capacity to enhance continuous quality improvement and evaluates circular economy among manufacturing firms in The USA and how both TQM and circular manufacturing impacts on productivity. The study found that when TQM is practiced in companies that have adopted circular manufacturing, the level of productivity of those firms increases by 18.6%. The other is that one by Zhang et al. (2021) which examine TQM, circular manufacturing and sustainable performance of manufacturing firms in China and which finds a positive correlation between TQM, CE and sustainable performance of those firms. The study also observes that knowledge management positively mediates between the relationship between TQM and sustainable performance and productivity.

5.4 Recommendations

The recommendations first examines the recommendations for policy and secondly the recommendations for theory.

5.4.1 Recommendations for Practice

The manufacturing firms should embrace the full scope of circular manufacturing to focus on refurbishing its products to restore them to original functionality; have a robust recycling program and have a robust recovering program of materials that were considered waste but which can be recovered. This should be done alongside the other adopted CE practices which will help improve their productivity.

The manufacturing firms should continue with the TQM practices they have adopted and tighten those they are still struggling to implement. This will also help them to improve firm productivity.

The manufacturing firms should find meaningful strategies that help them integrate TQM and CE within their operations almost in a hybrid system. Such integration will help them to improve firm productivity.

5.4.2 Recommendations for Theory.

The results from this study align with the study theories. First the findings align with the Deming's Theory of Management whose basic assumption is that the success, effectiveness and growth of any organization is dependent on a unified and uniform commitment of every person in the organization to quality in all areas of the organization (Deming,1986). Deming (1986) thus argued that for organizations to achieve this total quality management, fourteen practices and philosophies must be adhered to. The TQM practices adopted by manufacturing firms attest to the positive association with productivity of those firms just as Deming had mentioned.

The findings on CE are also aligned to the Dynamic Capability Theory (DCT) whose basic premise of DCT is that organizations must possess the capability to purposefully and meaningfully adapt the organization's resource status to always suit the changing business environment (Teece et al., 1997). The adoption of CE by the manufacturing firms in this case is those firms attempt to be adaptive to the dynamic market environment in order to maintain competitiveness and access positive performance outcomes.

5.4.2 Recommendations for Policy

The manufacturing firms should initiate a policy that integrates TQM and CE in order to improve their productivity. The results attest to the fact that when the two strategies are integrated and synthesized, productivity increases.

Also, the manufacturing firms should initiate a policy that reviews TQM and CE from time to time because as theory attests, these concepts are dynamic with improvements coming in every time.

5.5 Suggestion for Further Studies

Further studies should engage other strategic-based issues like innovativeness and diversification and how they affect productivity of manufacturing firms. Further, more studies on the place moderating effect of CE on the relationship between TQM and manufacturing firm performance should be done; this will help offer an in-depth analysis of the matter.

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APPENDICES

Appendix 1: Introduction Letter

Greetings,

RE: Letter of Introduction

I am a student seeking a Master'sof Business Administration (Operations Management) from the Universityof Nairobi**.** I am undertaking a study titled, **TOTAL QUALITY MANAGEMENT, CIRCULAR MANUFACTURING AND PRODUCTIVITY OF MANUFACTURING FIRMS IN NAIROBI, KENYA**. Being a core respondent, kindly fill the questions fully. The study promises to adhere to all ethical considerations including confidentiality and using the data only for the purposes intended.

Yours sincerely,

Alfine Wawira

Appendix 2: Questionnaire for Staff

Instructions

You are requested to mark in the allotted spaces with either a tick (✓) or a dot (.).

Kindly indicate your consent prior to completion.

◯ I agree ◯ I disagree

PART ONE- DEMOGRAPHIC DATA

1. Gender

   Male [ ] Female [ ]

2. Age

   [ ] 18-25 years [ ] 26-35 years [ ] 36-45 years

   [ ] 46-55years [ ] Over 55 Years

3. Highest level of education attained

   Certificate [ ] Diploma [ ]Degree [ ] Post Graduate Degree

4. How many years have you been a staffer at the manufacturing firm?

   [ ] less than 5 years [ ] 5-10 years

   [ ] above 10 years

Part B- Total Quality Management Practices

5. Please tick [√] your view based on what you know about the statement below. The Value of Scale is given below

SA-Strongly Agree (5), A-Agree (4), U-Undecided (3), D-Disagree (2), SD-Strongly Disagree (1)

Item	SA	A	U	D	SD
In my firm, the customer is the focus in the sense that it is the customer who eventually determines the quality of product	5	4	3	2	1
In my firm, there is total employee involvement in all cadres of the employee structure	5	4	3	2	1
In the firm, there are systems, both developing and monitoring, employed to measure and track improvements of operations from start to finish	5	4	3	2	1
The system at the firm avoids the hierarchical and mechanical structures often seen in traditional firms, therefore top-down and bottom-up processes are employed	5	4	3	2	1
In the firm, the managementencompasses both a systematic approach with a strategic approach, that is strategy formulation, strategic plans and strategic implementation are an integral part of the management system.	5	4	3	2	1
Management of the firm is grounded on a continuous form of product and service improvement and not just a one-off process.	5	4	3	2	1
The management at the firm relies on and espouses a fact-based managerial process.	5	4	3	2	1
The management at the firm highlights the value of effective communication.	5	4	3	2	1

Part C- Circular Manufacturing

6. Please tick [√] your view based on what you know about the statement below. The Value of Scale is given below

SA-Strongly Agree (5), A-Agree (4), U-Undecided (3), D-Disagree (2), SD-Strongly Disagree (1)

Item	SA	A	U	D	SD
The firm refuses to possess unnecessary and unsustainable products by having mechanisms that maximize the utilization of fewer goods	5	4	3	2	1
The firm rethinks on every product with a view of reducing their environmental impact	5	4	3	2	1
The firm uses and manufactures products in smarter ways to reduce wastage and negative environmental impacts	5	4	3	2	1
The firm reuses some of its products and materials to enact zero-wastage	5	4	3	2	1
The firm repairs its materials and products to avoid unnecessary throwaway and obsolescence behaviour	5	4	3	2	1
The firm refurbishes its products to restore the to original functionality	5	4	3	2	1
The firm remanufactures some of its products in the sense that parts of a discarded product are used on another product to make them functional	5	4	3	2	1
The firm repurposes many of its materials in order to use them for other purposes	5	4	3	2	1
The firm has a robust recycling program	5	4	3	2	1
The firm has a robust recovering program of materials that were considered waste but which can be recovered	5	4	3	2	1

The END

Appendix 2: Documentary Checklist to Check Productivity

Items	Comment
Output • **Sales kshs** • **Production (volume)**	
Inputs • Labour cost • Energy cost • Material cost	
Any other..	