A STUDY ON FLEXIBLE MANUFACTURING OPERATIONS IN KENYA: A CASE OF BIDCO OIL REFINERIES LIMITED.

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Declarations

This management project is my original work and has not been presented for a degree in any other University.

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This management project has been submitted for examination with my approval as University supervisor.

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Dedication

This project is dedicated to my dear wife, Fiona and son Jeremy. Your support and forbearance has helped me overcome all the big boulders that obstructed my path, and my view. To My Parents Saul and Roselyn and sibling (Tom, Pamela, Purity, Grace, Gladys and Walter) who inspired me to greater heights

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List of Tables and Figures

TABLE OF CONTENT

List of Abbreviation and Acronyms

AGVS	Automated Guided Vehicles System
AMHS	Automated Material Handling System
AS/RS	Automated Storage and Retrieval System
CAD	Computer-Aided Design
CAE	Computer-Aided Engineering
CAM	Computer-Aided Manufacturing
CAPP	Computer-Aided Process Planning
CEO	Chief Executive Officer
CIM	Computer Integrated Manufacturing
EPZ	Export Processing Zone
FMC	Flexible Manufacturing Competence
FMS	Flexible Manufacturing System
GDP	Gross Domestic Product
JIT	Just-In-Time
MRP	Material Requirement Planning
OIP	Operations Improvement Practices
TQM	Total Quality Management
UAMT	Use of Advanced Manufacturing Technology

Abstract

This case study on Bidco Oil Refineries Ltd was to have an in-depth understanding of the concept of flexibility competence in operations of a manufacturing plant and was achieved by exploring three objectives that brought out clearly the implementation, the benefit and the challenges that go with its implementation. The study was geared to act as a guide to Bidco Oil Refineries Ltd managers and other manufacturing firms in their steps towards developing more competitive edge in the market and pursuing market leadership in the industry.

The case study design followed a structured format to extract essential information needed to present the company's flexibility position and adopted a field-based data collection method such as self-administered questionnaires, interviews and focus group discussions.

It was observed from the findings that Bidco Oil Refinery Ltd has developed its capability in producing a number of different products/services at the same point in time and deal with additions to and subtraction from the mix over time on a well established automation base in computer-aided process planning and material requirement plan. However, the company still faces uncertainty as to the machine/equipment downtime and with regards to the amount of customer demand for the product/services. The latter is crucial in establishing volume flexibility in operations which is one of the three fundamental factors in implementing the flexibility competence.

The fundamental determining factor of volume flexibility is the type of employment term employed. The employment terms relates to the type of labour capacity solutions that are used to achieve volume flexibility. The skill level of workers is a factor for achieving both mix and volume flexibility. For instance, a multiskilled workforce would be able to perform multiple tasks driven by changes in mix and volume requirements

Therefore, in designing a manufacturing process, attention must be paid to both its technical and social aspects which are based on the socio-technical systems theory where these two aspects are interdependent and hence, need to be designed simultaneously in order for a manufacturing process to be effective. Out of the study, it came out strongly that the social factors were not sufficiently addressed, hence a lot of observed gaps in the system.

CHAPTER ONE: INTRODUCTION

1.1 Background

Efforts to improve the performance of companies have been important since the start of the industrial era. The first known and well-documented practitioners in the area of performance improvement were Adam Smith (1776), Eli Whitney (1800), Baggage (1832), Frank B. and Lillian Gilbreth (1900), Taylor (1903), and Henry Ford (1913). Since the 1950s, competition between companies has increased as markets have become increasingly global and there are indicators that this competition is yet to be intensified. This increased competition creates an ever greater need for first-rate improvement methods that can sustain competitiveness. Zhang et al., (2006) confirm that firms are seeking ways to respond quickly to changes induced by customers, competitors, and technologists, and flexibility has become an important tool in this struggle for success.

Zhang et al., (2006) define organization's flexibility as an organization's ability to meet an increasing variety of customer expectations without excessive costs, time, organizational disruptions, or performance losses. They cite Upton (1995) as having defined flexibility as increasing the range of products available, improving a firm's ability to respond quickly, and achieving good performance over this wide range of products. Zhang et al. (2002) divide operations flexibility into flexible operations capability and competence. They then define flexible operations capability as an external dimension of competition that is valued by customers such as volume and mix flexibilities while Flexible Manufacturing Competence (FMC), which includes machine, labour, material handling, and routing flexibilities, is a key internal dimension of competition that is invisible to customers.

The issue of operations flexibility is assuming increasing importance in production management and this is due to the changing nature of competition, which is based more than ever on constantly improving the technical characteristics of products and being responsive to differing customer requirements. Similarly, flexibility is seen important as customers demand faster response on a wider variety of updated products and as competitors achieve levels of performance above that which was considered feasible a few years ago. More flexibility in manufacturing operations, it is held, means more ability to move with customer needs, respond to competitive pressures and being closer to the market (Slack, 2005).

1.1.1 Concept of flexible Operations Competence in Manufacturing

The internal ability to meet an increase variety of customer expectation with minimum or without excessive costs, time, organizational disruptions, or performance losses (Zhang et al., 2006) has been found out that from a strategic perspective, it supports a firm's business strategy, and it helps to offset uncertainty and maintain smooth production flow. Gerwin (2005) suggests that with the ability to offset uncertainty, the organisation will be able to achieve the flexibility to produce a number of different products at the same point in time; deal with additions to and subtractions from the mix over time, make functional changes in the product; improve the degree to which the operating sequence through which the parts flow can be changed; ease the changes in the aggregate amount of production; handle uncontrollable variations in the composition and dimensions of the parts being processed; and deal with uncertain delivery times of raw materials effectively and efficiently.

However, capability to augment flexibility has presumably been enhanced by many factors such as: the introduction and deployment of multi-skilled workers and flexible equipments to achieve small batch production; substantial product variety; and high efficiency as well as the deployment of continuous improvement techniques where a company's-wide process is focused and sustained on incremental learning and innovation process as well as the deployment of automation in the operation system Gerwin (2005).

Yet for all its new found popularity, Slack (2005) feels that Operations flexibility seems to be the least understood of in manufacturing context. The very word flexibility is used by different managers to mean different things. This difficulty has posed challenges in the implementation of operations flexibility in manufacturing process. Similarly, the nature of uncertainties faced by a factory is likely to shift over time implying a need to change the salient flexibility aspects. Each aspect should possess flexibility responsiveness, the ability to be increased or decreased through a redesign of the operations process.

1.1.2 Manufacturing Sector in Kenya

Manufacturing sector is divided into several broad sub-sectors according the Kenya Vision 2030 as shown in the table 1.0 below:

Table 1.1: Manufacturing Sector in Kenya

SUB-SECTOR	GDP KShs billions of the sector		EXPORTS KShs billions (of sector)		EMPLOYMENT KShs billions (of sector)	
	Value	*%*	*Value*	*%*	*Value*	*%*
Food processing, beverage & tobacco	43.1	28.7	13.0	19.7	85.3	34.5
Refined petroleum products	16.8	11.2	7.6	11.5	0.2	0.1
Textiles, appeal, leather and footwear	9.3	6.2	6.3	9.6	61.3	24.8
Forest products	7.8	5.2	3.8	5.8	18.1	7.3
Chemicals	7.7	5.1	25.4	38.5	15.0	6.1
Equipment	6.6	4.4	3.6	5.5	11.7	4.7
Fabricated metals	6.3	4.2	1.2	1.8	19.4	7.8
Rubber and plastic	4.9	3.3	00	0.0	9.6	3.9
Publishing and printing	4.3	2.9	1.1	1.7	8.6	3.5
Furniture	2.0	1.2	0.0	0.0	9.6	3.9
others	41.5	27.6	3.9	5.9	7.8	3.1

Source: Central Bureau of Statistics2006 cited in Kenya Vision 2030

From the above table, the top three manufacturing sub-sectors account for 50% of the sector GDP, 50% of exports, and 60% of formal employment. Locally-manufactured goods comprise 25% of Kenyan exports. However, the share of Kenyan products in the region is only 7% of US $ 11 billion regional market hence, the domination of imports from outside the region on the East African market. This indicates that there is a large potential to improve Kenya's competitiveness in the region by replacing external supplies gradually. However, manufacturing has been on the decline for considerable period of time and its contribution to the GDP has remained stagnant at about 10% since the 1960s (Kenya Vision 2030, 2008).

According to the Government's Economic Survey 2008, the Kenya Manufacturing sector, which is dominated by subsidiaries of multi-national corporations, grew at 8.1% (Total value output rose to KShs. 603.7 billion in 2007 from KShs. 558.3 billions in 2006) in 2007 with remarkable expansion in meat and diary products. The sector contributed approximately 10% of the Gross Domestic Product (GDP) in 2007 and created 2.3% increase in new jobs. This brought the total number of direct formal employment to 261.3 thousand persons from 254.9 thousand persons in 2006 which represents 13% of total employment in Kenya. In the Kenya Vision 2030, 2008 it is anticipated that the sector has a positive outlook in year 2008, but this will depend on the harmony within the coalition Government, access to credit and how the cost of production is addressed.

It is argued in the Economic survey 2008 and the Kenya Vision 2030 that despite the high competition from low priced manufactured imports, low productivity levels, inefficient flows of goods and services, unfavourable business environment and the high input costs the credit for manufacturing activities has been on the upward trend and the Government has purposed to continue with its reform programme to give the country an internationally competitive business environment. This sector is therefore expected to use state-of-the-art technology that is both efficient and environmentally-friendly in an effort to make Kenya a dynamic industrial nation.

Similarly the sector is expected to play a critical role in propelling the economy to 10% growth rate, in line with the aspirations of the vision 2030 and supporting the country's social development agenda through the creation of jobs, the generation of foreign exchange, and by attracting foreign direct investment. To meet these goals, the sector has to become more efficiency-driven, raising productivity per unit of input closer to those of Kenya's external competitors hence the question of operations competence in the sector.

1.1.3 Bidco Oil Refineries Ltd

Bidco Oil Refineries Ltd Company started over 35 years ago and it has asserted its position in East & Central Africa region as leader in most advanced edible oil and hygiene products manufacturing, marketing and in productivity improvement practices. The Company is the brainchild of Bhimji Depar Shah the grand patriarch of Bidco after whom the company is named. The company has gone through various stages of metamorphosis since its establishment as a clothing factory in 1970 (Gichira, 2007).

The Company from its initial inception has been committed to using the most efficient modern technologies to produce a superior range of products. Over the years, Bidco successfully won over the market, becoming the largest and fastest growing manufacturer of vegetable oils, fats, margarine and soaps. The firm's vision is "Produce high quality, popular products, and have the determination of becoming the Market Leader throughout Africa by 2030". The Company plans to achieve this not just through modern marketing, but through customers' delight. Hence, they are committed not just to winning customers, but to keeping their loyalty to Bidco products forever (http://www.bidco-oil.com/home/index.php 23/06/2008).

Bidco Oil Refineries Ltd believes in systems and has applied the latest technological and managerial systems to ensure that their production, distribution, marketing and strategic planning are all at world class standards. The adaptation include Global Management Practices such as: The 5s Good Shop-floor practices; The Kaizen Principle – "Zero Investment Improvement"; Gemba Kaizen – "Continual Improvement at the workplace"; Aligning company goals through Hoshin Kanri, Total Employee Involvement They have developed an ever-growing distribution network that ensures optimum communication and efficient delivery to their customers, with complete back up service, guaranteeing a true after sales partnership.

In today's rapidly liberalizing markets, the company's management practice is to improve its competitiveness as a critical factor to survive and grow rapidly as well as adopting and implementing a comprehensive strategy for continual improvements across its operations (http://www.bidco-oil.com/media/index.php.23/06/2008), this has earned the company many awards and recognitions over the last seven years, (Latest awards won in 2008 include; Winner in Market orientation, Company of the year award 2008, CEO of the year 2008 and Winner – Productivity improvement practices).

1.2 Statement of the Problem

Operations flexibility has never been a difficult attribute to justify and no one likes to be thought to be rigid, especially in a business function such as manufacturing that have traditionally suffered a reputation for its sometimes unbending attitude to change despite the observed circumstance where the markets are seen to be more turbulent, faster moving, more competitive. There is far less concern with defining what flexibility is, and more with its role as a core operations competence that, over the long-term, can be exploited in almost any market context. Slack, 2005 has urged out that flexibility has come to occupy a central position in how operations can be strategically developed to play an effective part in achieving competitive advantage

The Kenya Vision 2030, 2008 argues out that the Kenyan manufacturing sector is faced with the big challenge of coping with competition from low priced manufactured imports, and there is urgent need to transform the sector to increase there overall competitiveness.

Bidco Oil Refineries Ltd falls within the first top sub-sector of Food processing, beverage & tobacco that is ranked based on the sub-sector's contribution in manufacturing to the GDP. The Company's adaptations to Global Management Practices have ensured that their production, distribution, marketing and strategic planning are all at world class standards. The concentration on its core business and outsourced the non-core functions such as accounting/auditing and the management of its supply chain have enabled them to reduce their inventory levels across each stage of processing leading to reduction in working capital and space utilization. All these ensure quality goods and services at a price advantage to their customers and hence gearing to become the Market Leader throughout Africa by 2030.

There is therefore need to conduct a case study on Bidco Oil Refineries Ltd in order to establish the extent at which flexibility in operations has been implemented, how the company was able to implement this kind of flexibility, how flexibility has played a role in the competitiveness of the firm, the experienced challenges and how the company managed to manoeuvre through them and emerge the most outstanding company in the region.

A number of studies have been carried out addressing the issue of improvement methods adopted by firms in response to the changing business environment. However, findings from these studies indicate little emphasis on flexibility operations competence in manufacturing in Kenya and especially in relation to Bidco Oil Refineries Company Ltd.

1.3 Objectives of the Study

The study objectives will be as follows:

i. To determine the extent of implementation of operations flexibility in Bidco Oil Refineries

ii. To establish the role of operations flexibility in Bidco Oil Refineries Ltd competitiveness

iii. To determine challenges faced by the functional departments of Bidco Oil Refineries in initiating flexibility concept and applying these techniques.

1.4 Significance of the Study

a) Manufacturing firms in Kenya

The study will act as a guide to Bidco Oil Refineries Ltd managers and other manufacturing firms in their steps towards developing more competitive edge in the market and pursuing market leadership in the industry. The paper will demonstrate how it would be possible to have an in-depth understanding of the concept and hence create a basis on which the sector can develop measures for the same. Once measures exist then Operations/manufacturing functional managers can better understand the kind and extent of flexibility embedded in their production processes. They can make more informed choices on new equipment. At present, inability to quantify the benefits of programmable automation is a significant limitation on its purchase. Vendors of manufacturing processes would be better able to develop designs that meet the needs of users.

b) Researchers and Academicians

It will be a reference material for future researchers and academicians. The study will also highlight other important areas that need relational studies, these may include the testing of critical hypotheses apart from the above, the study will give direction for future research rather than a report of work already implemented or in the process of being implemented.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Zhang Q et al (2006) argue out that FMC is a set of resources that help firms achieve competitive advantage. If FMC is a way to achieve competitive advantage, a reasonable question is how do firms create FMC? Literature and theory help to explain the potential impacts of Operations Improvement Practices (OIP) and Use of Advanced Manufacturing Technology (UAMT) on Flexible Operations Competence.

Operations Improvement Practices (OIP) is the extent to which a firm implements plans and programs that focus on continuous improvement in manufacturing operations. Continuous improvement was a centerpiece as Japanese firms began to penetrate global automobile markets in the 1970s. From a customer's perspective, the attractiveness of Japanese products was based upon cost and quality. From a company perspective, success was based on flexibility and speed that eliminated waste and mistakes in the production system. Japanese companies' emphasis on repetitive manufacturing, timely production, and smooth workflows enabled them to increase productivity and enhance quality (Zhang Q et al., 2006).

OIP includes key techniques such as Just-In-time (JIT) principles, lean manufacturing, Time-based competition and Total Quality Management among others. The continuous improvement focuses on sustained incremental learning and innovation which requires that employees are motivated to initiate small, incremental improvements on the shop floor towards achieving manufacturing excellence. A defining principle for continuous improvement is that all employees are empowered to make decisions and should have the will and ability to contribute to the on-going refinement of existing activities (Monden, 1983 cited in Zhang Q et al. 2006).

Use of Advanced Manufacturing Technology (UAMT) is defined by Ettlie and Reifeis, (1987) cited by Zhang et al., (2005) as a set of tools that automate and integrate steps in product design, manufacturing operations, planning and control. UAMT is the application of manufacturing and information technology to increase responsiveness and create performance improvements in the production process. UAMT is recognized as an important element in building a competitive operations system that can deliver the product variety that customers demand. Advanced manufacturing technology can be adapted and customized to a variety of uses through software links and combinations. Thus, UAMT makes flexibility possible by programmable automation and integration.

2.2 Concept of Operations Flexibility in Manufacturing

There exists no rigorous method for identifying the domain of managerial concepts such as manufacturing flexibility. The approach advocated here, which has developed over the last few years, is based on the limited amount of relevant theory and on questionnaires with representatives of vendors and users of production equipment, and on the assumption that social systems facing uncertainty utilize flexibility as an adaptive response. In other words, flexibility is the ability to respond effectively to changing circumstances. It is, therefore, necessary to examine the uncertainty faced by manufacturing managers in order to understand the flexibility that is built into manufacturing processes. Since there are several kinds of uncertainty that typically need to be handled, flexibility should have a number of corresponding aspects (Gerwin D, 2005).

The following kinds of uncertainty mentioned by Gerwin represent an attempt to identify the domain by indicating seven different sets of uncertainties and associated flexibilities. These uncertainties include: *First,* the products that will be accepted by customers creates a need for mix flexibility which is the ability of an operations process to produce a number of different products at the same point in time. *Second* is the length of product life cycles leads to changeover flexibility which is the ability of a process to deal with additions to and subtractions from the mix over time. *Third*, the particular attributes the customers want may arise at the beginning of the life cycle for a standardized product or throughout the life cycle for a product that can be customized. It leads to modification flexibility which is the ability of a process to make functional changes in the product. *Fourth* is the machine downtime that makes for rerouting flexibility which is the degree to which the operating sequence through which the parts flow can be changed. *Fifth,* the amount of customer demand for the products offered leads to volume flexibility which is defined as the ease with which changes in the aggregate amount of production of a manufacturing process can be achieved. *Sixth* is whether the material inputs to a manufacturing process meet standards which give rise to the need for material flexibility. This is the ability to handle uncontrollable variations in the composition and dimensions of the parts being processed. It also encompasses the ability to handle more than one kind of substance either for the same component or different components and *lastly,* the sequencing flexibility being the ability to rearrange the order in which different kinds of parts are fed into the manufacturing process. It arises from the need to deal with uncertain delivery times of raw materials.

Gerwin (2005) emphasizes that the definition of flexibility also needs to be considered from a dynamic perspective. The nature of uncertainties faced by a factory is likely to shift over time implying a need to change the salient flexibility aspects. Each aspect should possess flexibility responsiveness, the ability to be increased or decreased through a redesign of the manufacturing process.

It has been argued by Suarez et al. (1996) cited by Oke et al, (2005) that the four proposed categories by Slack of new *product flexibility*, *Mix flexibility*, *Volume flexibility* and *Delivery flexibility* are to be referred to as first-order flexibility types, and argue that they are the flexibility types that directly affect the competitive position of a firm. These authors point out that other types of flexibility proposed in the literature such as routing, component, material and machine flexibility do not by themselves directly affect the competitive position of the firm but rather operate through the so-called "first-order" flexibility types. They called these enabling tools "lower-order" flexibility types. These types clearly relate to Slack's definition of resource flexibility – the flexibility of the individual resources that together make up the system. Although lower-order flexibility types are fundamental to the achievement of overall operations system flexibility, they are often far removed from their competitive impact. How they affect the competitive position of the firm is certainly not obvious, and customers do not and usually cannot, perceive them directly in the way that they perceive first-order types.

Oke et al., (2005) further argue out that, in competitive terms, volume and mix flexibility are the two most important manufacturing flexibility types. Delivery and new product flexibility are seen as subordinate in that they are simply consequences of a plant's capability in terms of volume and mix flexibility, respectively. Oke el al. cites slack (1991) having agreed with him in relation to delivery flexibility but also argues that there is a specific need to account for new product flexibility as a fundamental type.

Considering Slack's definition of volume flexibility which incorporates the response dimension of time to adjust production levels and the cost implications of changing aggregate production volumes, the implication of this definition is surely that a plant that cannot deliver varying volumes of orders to its customers when the orders are required cannot be said to possess volume flexibility at the operational level, even if it is able to meet the volume requirements at a later date (Oke, n.d). In Slack's terms, the plant would have range (long term) capability but not response (short term) capability. This definition of volume flexibility would, therefore, seem to automatically incorporate delivery time flexibility. In other words, a plant that possesses volume flexibility is, by definition, capable of delivery time flexibility. The critical issue would seem to be that volume flexibility is not an end in itself but only a means of creating competitive advantage and what the customer sees is not the volume flexibility itself but its consequences in terms of delivery capability. Thus, we would argue that there are in fact only three forms of operations system flexibility in manufacturing: new product flexibility, mix flexibility and volume flexibility.

2.3 Link between Flexibility and Competitiveness

Several studies suggest that FMC is a source of competitive advantage. It is proposed that production competence is a link between business strategy and manufacturing strategy and as a measure of the pooled effects of a manufacturer's resources and assets. Zhang et al., (2006) define production competence as the degree to which manufacturing performance supports a firm's business strategy. They view production competence as a function of fit between business strategy and manufacturing structure. FMC is a measure of a firm's ability to flexibly deploy resources to support its business strategy and enables firms to perform at high levels.

FMC is a set of internal abilities which customers cannot see and do not fully appreciate, but firms develop them to create responsive production systems. According to Zhang et al., (2006) FMC is the foundation for creating volume and mix flexibilities, which customers do value. This classification is echoed by other writers on cone model where operations flexibility in manufacturing has several components consisting of machine, routing, material handling, and labor flexibilities and an environmental perspective that includes mix and volume flexibilities. They contend that firms should focus on building core competencies that create competitive advantage.

2.4 Implementation of Operations Flexibility in Manufacturing

Zhi-guo, (2007) argues on the basis of the self-organization theory that holds that factors inside the system are mutual-restrictive, coordinate and enlargeable in the exchange of substance, energy and information, and this is a non-linear interaction mechanism which is the basic inner motive of the system's evolvement. Currently, the self-organizing operational mechanism of the enterprise's Flexible Manufacturing System (FMS) is realized mainly through the non-linear interaction among the auto-processing system, logistics system, information system, software system and the human resource system. Therefore, the key to improve the application of self-organization theory in Flexible Manufacturing System operational quality of the FMS is to improve the nonlinear interaction mechanism.

Similarly, Zhang Q et al (2006) argue that with a comparative potential interaction of subsystems within the firm's processes, and the use of information technology may be moderated by the degree (high vs. low) of Operations Improvement Practices (OIP). Some of the key OIP that could be used to moderated information technology include: Just-In-time (JIT) principle; which is the set-up reduction, preventive maintenance, cellular layout, pull production, total quality management, and continuous improvement. JIT identifies all sources of variability, uncertainty, or disturbances, and it eliminates them or reduces their magnitude. It provides cost-effective production and delivery of the necessary quality parts, in the right quantity, at the right time and place, while using a minimum of facilities, equipment, materials, and human resources. JIT practices help firms achieve flexibility by reducing impediments to change (Upton, 1995; Zhang et al., 2006).

The second technique is Lean manufacturing which creates a streamlined production system by synergistically implementing a bundle of management practices. This approach grew from the concept of JIT, and became the doctrine of manufacturers during the late 1980s and the 1990s. Lean manufacturing is characterized by an emphasis on quality, flexibility, and speed. Lean producers employ teams of multi-skilled workers and flexible equipment to achieve small batch production, substantial product variety, and high efficiency. Supplier relationships are based on trust and cooperative problem solving.

Thirdly, is the Time-based competition which attempts to improve responsiveness by squeezing time from every facet of the value-delivery system. It is suggests that JIT and its emphasis on manufacturing flexibility was the predecessor to time-based competition. Firms that redesign their processes to compress time can achieve higher productivity, increase market share, reduce risk, and improve customer service (Roger et al, 2006 cited in Zhang et al, 2006). The following set of time-based practices have been developed and have gone a long way in improving firm performance; shop-floor employee involvement, re-engineering set-ups, cellular manufacturing, preventive maintenance, quality improvement efforts, dependable suppliers, and pull production.

Lastly, Deming, 1986, as cited by Zhang et al, suggests that Total Quality Management (TQM) to be part of the OIP. TQM is an integrative approach strives to achieve customer satisfaction through high quality, value-added products. It links work groups so that they can exchange information about variability originating in one group (quality of incoming parts) and how it impacts other groups (production scheduling). Resolving these inter-group problems through improved communication and feedback among work groups can benefit the whole system (Crosby, 1979; and Ishiawa, 1985 cited in Zhang et al).

The use of advanced manufacturing technology abides to the concept that Advanced Manufacturing Technology is an important element in building a competitive manufacturing system that can deliver the product variety that customer demand while keeping operating costs low. Some of these advanced manufacturing technologies could be divided into three categories which include: First, use of stand-alone systems (Computer-Aided Design (CAD), Computer-Aided Process Planning (CAPP), etc.)), intermediate systems [Automated Guided Vehicles (AGVS), Automated Storage and Retrieval Systems (AS/RS), Automated Material Handling Systems (AMHS), etc); and integrated systems (Flexible Manufacturing Systems (FMS), Computer Integrated Manufacturing (CIM), etc). The other identified types of advanced manufacturing technology by Zhang et al., based on an empirical analysis of the patterns by which companies invest in advanced manufacturing technologies include: design (CAD, Computer-Aided Engineering (CAE), CAPP); manufacturing (Computer-Aided Manufacturing (CAM), FMS, group technology, AMHS), and administration (MRP, MRPII).

Secondly Design technologies, such as CAD, CAE, and the internet, support product design and engineering. They enable firms to work selectively with external designers, suppliers, and customers to compress product development and commercialization. The application of group technology and CAPP has improved process design, which enables firms to make a variety of related parts. Manufacturing technologies, such as CAM, and AMHS, make production easier and faster. FMS and robotics, which began to attract interest in the early 1970s, allow job shops to reduce batch sizes through short change-over and set-up times.

Lastly, Planning and control activities that are facilitated by the development of MRP, MRP II, electronic data interchange, and bar coding, which allow firms to manage material flow within the firm and between the firm and its suppliers. Integration technologies such as CIM, local area networking, and enterprise-wide resource planning allow a flow of information and coordinated decision-making between functions within a firm and between firms (Ettlie and Reifeis, 1987 cited by Zhang et al 2006).

Zhi-guo, (2007) suggested a few other aspects that require one to adapt to in promoting the efficiency of FMS and these are: *First,* the need to cultivate the flexible thinking on FMS: The flexible thinking on FMS is to pay attention to the whole operations process with a systematic perspective and to make the whole production process of the enterprise under control. In other words, it is to take the operations processes including market demands, processing raw materials on-line, producing the complete product and entering the market as a consecutive process to be investigated, to analyze the relationship between each procedure, to eliminate the waste between each procedure as far as possible, to reduce the quantity of the making products and to make the operation of the whole manufacturing process under certain controlling rules. Adopting this flexible thinking, will make the FMS be capable to gear a challenge from the manufacturing market, and also does a useful help to promote the enterprise's competence.

Secondly, the use of the complexity of the resources allocation to expand the creative Space: FMS does not only refer to the manufacturing process, but almost the whole enterprise. FMS requires the resources consumed in the production of enterprise that can satisfy the quest of the flexible operations. How to improve the flexibility of the resources and resource allocation is key management under the flexible operations conditions. The so-called resources are all the visible or invisible things that can be managed in the process of reaching its target for an enterprise. The flexibility of the resources is just the ability of resources to respond to changes so as to satisfy requests of different kinds of tasks. Therefore, using of the enterprise's resources should be diverse and applicable, not only need to keep and increase the present flexibility, but also to combine with the enterprise competence, to find new resources, and to promote the value of the present resources.

Thirdly, encourage the establishment of a flexible organization adapting to FMS: Flexibility of an organization includes the flexibility of the structure, and the management. FMS is an open and complex self-organizing system, which exchanges substance, energy and information continuously with outside environments. It requires the organizational structure not only satisfy the requests of the producing target, but also adapt to the environmental varieties, so as to promote the system function. Therefore, instead of being stable, organizational structure should be built up to match with the demand-oriental production mode, taking the process as the key, promoting effects and efficiency of the system, thus to adapt to the environmental varieties. The flexibility of the organization management reflects the competence or the efficiency of the organization innovation to a large extent.

Fourth, establish the coordinative mechanism of the self-organizing operation. The key for the system to change from confusion to order does not lie in equilibrium, non-equilibrium or the distance from the equilibrium state. It lies in the nonlinear interaction and mutual coordination among sub-system, through which the system will form a spontaneously ordered structure under certain condition. The coordination is the direct reason for the system to form an ordered structure, and it is also the fixed self-organizing ability for any complex system. To establish the coordinative operational mechanism, consideration need to be taken by the following aspects: the coordination and the competition between the manufacturing process and the management process of the manufacturer; the coordination between the market demands and the strategic targets of the FMS; and finally, the coordination between the systematic targets and the unit's targets.

Lastly, in promoting a flexible operations system, one needs to establish the corporate culture of flexibility that is geared to FMS: Corporate culture is the key of the enterprise's flexible management. Any strategy has to specify the mission or the vision of the organization and the operating cultural atmosphere. Corporation culture induces the location of the enterprise's strategy and instructs its implementation. How to reduce the obstacles brought by the corporate culture to the strategy and how to promote the realization of the corporate targets by making use of corporate culture are both important questions that must be solved in the management. Corporate culture is the thing that is most difficult to change in the enterprise system and it is difficult to be imitated. Once it is helpful to the formation of the organization's advantages, it will be a huge strength and become the core of the organization. The culture of flexibility is tolerance and adaptability. It can attain certain diapason with existing corporate culture. Meanwhile, it encourages innovation and organizational study, providing prior condition for the realization of the organization's strategic targets. In brief, self-organization theory provides new thinking mode and theory basis for us to improve the operational effects of the FMS

2.5 Conditions for a Flexible Operations Competence in Manufacturing

In relation to the traditional FMS theory, it is believed that the fulfillment of the flexible operations is mainly the process of applying computer-controlling technique, but also innovation of the management organization system and the management thoughts of enterprises which is more important. As a result, modern FMS should also include such aspects as follows: Paying attention to the market needs timely, understanding of customer's demand. Persisting in molds and standardization and strengthening the combination of designing and operations. Practicing continuous quality control system in production, establishing vividly the manufacturer, suppliers or customer of the firm. Producing in time with zero inventory management and finally, strengthening the integration of the supply chain management, reducing the distance in time or space between the manufacturer, supplier or customer. Thus, it is the substance of FMS that through the effective management and organization of work, organizations can eliminate waste, enhance efficiency and make a quick response to the market change (Zhi-guo, 2007).

In designing a flexible operations process in manufacturing, attention must be paid to both its technical and social aspects. Technical considerations include the nature of the hardware (and software if applicable) as well as the hardware's layout. Social factors involve the kind of supervision, the degree of task specialization for workers, and the amount of planning responsibilities possessed by workers. According to socio-technical systems theory, these two aspects are interdependent and therefore, need to be designed simultaneously in order for a manufacturing process to be effective. A potential purchaser of a manufacturing process could develop a flexibility profile depicting the amount of each type of flexibility desired if operational measures existed. The profile would aid designers in determining the technical and social characteristics required by the process. (Gerwin, 2005).

In general, the critical workforce characteristic is multi-skilling but its nature varies depending upon the type of flexibility. Gerwin (2005) research in auto assembly plants suggests one way in which the design framework above can be improved. It was found that understanding the flexibility of a computerized manufacturing system requires an investigation of its subsystems' flexibility. It appears that a computerized manufacturing process is only as flexible as its most rigid sub-system permits. Operations managers need to be aware of this design principle while designers need to properly balance rigid and programmable constituents to yield desired overall flexibility levels.

2.6 Summary

Schmenner et al., (2005) appreciates that Gerwin's seminal work added welcome rigor to a concept, operations flexibility, which had gained prominence during the previous decade. The computer age was upon us showing great promise with new software (e.g. CAD, CAM), enhanced machine tools (e.g. Robots, FMS), and expanded manufacturing information systems (e.g. MRP, MRP II). Gerwin (p. 48) aimed to set us on a path to "the study of Operations flexibility in manufacturing on a more scientific basis." His work succeeded notably in that regard, firmly placing "flexibility" into the set of operations choices and initiating significant scholarly research. He defined flexibility as "... the ability to respond effectively to changing circumstances" (p. 39), explaining that "one operations process is more flexible than another ... if it can handle a wider range of possibilities" (p. 41). In all, flexibility incorporates the range, achievability and effectiveness (performance and value) of the alternatives.

Gerwin believed that the need for flexibility is grounded in the need to cope with uncertainty in the operations environment. Different kinds of uncertainty directly drive the needs for different kinds of flexibility. Moreover, Gerwin led the way in specifying which aspects of flexibility might not be trade-offs with quality, presaging the whole "cumulative capabilities" debate. And, he rightly saw that automation might not always lead to increased flexibility, providing an early caution against super-machines and factory "monuments."

Schmenner et al., (2005) suggest that in the current times we need to extend Gerwin's "levels" to include the company's entire supply chain. For many companies today, operations means managing the supply chain and any contract manufacturing and outsourcing within it, as much as it means managing one's own factory. While the notion of a supply chain has long been well known, the importance of supply chains and their management has risen significantly in the past 20 years. Such supply chain flexibility can deal effectively with several of the uncertainties that Gerwin identified. In particular, an effective supply chain reduces the uncertainty of materials standards (e.g. conformance quality and functionality), and thus the need for material flexibility, as well as reducing the uncertainty of delivery times, and thus the need for sequencing flexibility. Moreover, supply chain flexibility can aid changeover flexibility. Increased contract manufacturing and outsourcing have limited the exposure of selected manufacturers to the vicissitudes of the market and have helped foster product experimentation. An effective supply chain reduces a firm's risk and increases its nimbleness.

They further argued that time-based competition and lean manufacturing are other critical developments that have flowered since the time Gerwin wrote. Reduced throughput time, for example, makes forecasting easier and this attenuates the need for both mix flexibility and volume flexibility. More attention to preventive maintenance has reduced the need for rerouting flexibility. Factories today are as flexible as they have ever been, but the advent of different thinking about manufacturing and how the manufacturing firm competes has reduced many of the uncertainties that underscored the need for the flexibilities Gerwin identified so well. Further, the new thinking has increased firms' abilities to achieve desirable forms of flexibility, including wide product variety (modification flexibility), location of production (volume flexibility), and rapid introduction of new products (changeover flexibility).

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Research Design

This case study design followed a structured format where the essential information needed to present a Bidco Oil Refineries Company Ltd flexibility situation was adopted. The research design therefore adopted a field-based data collection method, which gave the depth necessary to fully explore the sources of operations flexibility in manufacturing plants. Yin 1995 is cited by Oke et al., having argued that case studies are more suitable for answering "how" or "why" questions compared with other research strategies.

A field-based data collection method using: Qualitative methodology (unstructured questions for an in depth understanding of the study), quantitative methodology such as interviews and focus group discussion (to provide verification of qualitative data) and desk research that enabled me obtain documented evidence to verify the quantitative and qualitative responses received through the questionnaire were used.

3.2 Population

The population of this study was derived from all the 14 (fourteen) departments of Bidco Oil Refineries Ltd. The departments include Purchases, Internal Material Management, Research and Development, Production, Engineering, Group Internal Auditor, Corporate & Legal Affairs, Axis/Information and Communication Technology, Treasury, Sales & Distribution, Customer Response Team and Training & Human Resources Management, Exports and Corporate Strategy. The perceived needs of different department for flexibility as well as their perceived levels of flexibility may differ and they could be using different mechanisms to achieve operations system flexibility.

3.3 Sampling

The study covered all the departments in Bidco Oil Refineries Ltd, however, giving a lot of emphasis to seven departments which were Production, Sales & Distribution, Research & Development, Purchases, Training & Human Resources, Customer Response team and Axis/Information Communication Technology Departments. These departments were presumed to have crucial functional impact on the entire operations of the Organization. However, every department was given a questionnaire although the anticipated nature of response on operations in relation to flexibility was presumably to be homogeneous. Depending on the number of staff and their designation in the department, the number of respondents was selected. The targeted number was sixty from a total population of approximately six hundred day-time-staff. Approximately sixty percent of the entire population were non-technical.

3.4 Data Collection

A questionnaire (see appendix I) that is based on the literature review on operations flexibility in manufacturing was used. The questionnaire was self-administered. The format of the questionnaire was semi-structured and each questionnaire was predicted to last between half an hour and one hour.

Similarly, direct brief interviews and focus group discussions targeting the heads of department/Team leaders were utilized in collecting data especially in areas that required in-depth information about the operation of the system.

3.5 Data Analysis

The analysis was done on a case by case basis (within-case analysis) and applied the descriptive statistics which described the basic features of the data in the study. The within-case analysis helped in the process of progressively making sense out of the large amount of data collected. Similarly, I carried out a content analysis especially for the qualitative data. Together with simple graphics analysis, that will form the basis of virtually every quantitative analysis of data. A cross-case analysis was done by selecting the themes identified from the individual case analysis and then checked for similarities and differences across the cases. Data reduction was done through categorization. This helped in identifying abnormally large discrepancies and was resolved through rechecking at the particular department and then the cleansed data was averaged in order to conduct subsequent analysis.

Data collected from questionnaires was analyzed using SPSS as the narrative issues were picked from all questionnaires to isolate the dominant points. The study achieved seventy five percent response.

CHAPTER FOUR: ANALYSIS, FINDINGS AND DISCUSSION

4.1 Introduction

BIDCO market the largest and widest range of quality edible oil and hygiene products such as fats; Kimbo, Cowboy, Chipsy, Oils; Elianto, Sun Gold, Golden fry, Bahari fry, Korno Gold, Ufuta, Hygiene products; Gental, White star, Bull, Powerboy, Margarines; Gold Band, Biddy, Veebol pastry margarine among others in East and Central Africa.

4.2 Findings

The case study on Bidco Oil Refineries Ltd to establish the extent at which flexibility in operations has been implemented, how the company was able to implement this kind of flexibility, how flexibility has played a role in the competitiveness of the firm, the experienced challenges and how the company managed to manoeuvre through them and emerge the most outstanding company in the region established its finding by having the majority of the respondents from the technical staffs. It can be deciphered that the findings are precise for most of the respondents were in a better position to answer the questions from a know-how position as generally they were technical staff mostly from line operations. On duration that the respondents had worked for Bidco, majority of the respondents (37.1%) had worked for over 8 years, those who had worked for 2 to 4 years were 28.4%, 14.3% had worked for less than 2 years, 11.4% for 4 to 6 years and 8.6% had worked for 6-8 years. Therefore the majority of the respondents had a long time working experience in the company. This position was important to the study since technical staff are directly involved in the line operation.

4.2.1 Extent of flexibility implementation in the company

The respondents were asked if in there operations they do encounter frequent fluctuation in demand for your product/services. 88.6% of the respondents said they encounter frequent fluctuations in demand of the products or services that they offer and this was due to varying needs of both internal and external customers which are basically determined on a "PULL" system where supply is dictated by the demand from the customers despite facing it off with other competitors' products in the market. This has been caused by both the prevalence of uncertainty in operations and the difficulty in adjustment to operations ability.

Table 4.1: Extent of Prevalence of Uncertainty in Operation

Uncertainty	Mean	Std. Dev.
Uncertainty as to the machine/equipment downtime	3.0	1.1
Uncertainty with regards to the amount of customer demand for the product/service	2.9	1.2
Uncertainty as to which particular attribute customers want in a product/service	2.6	1.0
Uncertainty as to the length of product/service cycles	2.5	0.7
Uncertainty as to delivery times of inputs	2.5	0.9
Uncertainty as to whether the input to operations process meet standards	2.5	1.0
Uncertainty as to which products/service will be accepted by customers	2.3	0.9

Source: Research data

In order to determine the extent of prevalence of uncertainty, the respondents were asked to what extent they experience uncertainty in their operations. From table 4.1 above, showed that the uncertainty as to the machine/equipment downtime had a mean of 3.0 and a standard deviation of 1.1 on the likert scale where uncertainty that is prevalent in a very great extent was awarded 5 points and that which is not prevalent at all was awarded 1 point. It was followed closely with uncertainty with regards to the amount of customer demand for the product/services. This is confirmed in table 4.2 where rerouting flexibility had the lowest rating of 3.8 on the likert scale where 5 indicated the highest ability on the ease of adjustment of the operation process.

Table 4.2: Ease of adjustment to the operational ability

Ability	Mean	Std. Dev.
Ability to produce a number of different products/service at the same point in time.	4.3	0.6
The easy with which changes in the aggregate amount of production of an operations process can be achieved	3.9	0.5
Ability to deal with additions to & subtractions from the mix over time	3.9	0.6
Ability to handle uncontrollable variation in the composition & dimension of inputs being processed	3.8	0.7
Ability to make functional changes in the product/service.	3.8	0.8
The degree to which the operating sequence through which the inputs flow are changed	3.8	0.9
Ability to rearrange the order in which different kinds of inputs are fed into the operations process	3.7	0.7

Source: Research data

Uncertainty with respect to machine downtime affects the rerouting flexibility which is the degree to which the operating sequence through which the parts flow can be changed. However, with a high rating of uncertainty in machine downtime, the rerouting flexibility structure that foster cooperation when breakdowns occur is in jeopardy. Hence, the effort to avoid redundancy in equipment functions so that one machine can take the place of another which is down become wanting thereby affecting the operation flexibility. This is confirmed where rerouting flexibility had the lowest rating on the likert scale ability on easy of adjustment.

The 2.3 mean scored by the uncertainty as to which product/services will be accepted by customers was the lowest on the extent of prevalence of uncertainty in operation and was the highest score of 4.3 on the ease of adjustment to the operation ability. The uncertainty as to the length of product/service cycles and the ability to deal with additions to and subtractions from the mix over time which indicates factors relates to new product development. The concept of volume flexibility remains a challenge to the organization as the uncertainty with regards to the amount of customer demand for the product/service and the easy with which changes in the aggregate amount of production of an operations process is achieved did not record impressive scores on their respective likert scales.

The Company has been able to manage effectively the product/services acceptance by their customers as the uncertainty as to which product/services will be accepted by customers was the lowest on the extent of prevalence of uncertainty in operation as it demonstrated the ability to produce a number of different products/service at the same point in time. This indicates that with the wide variety of products and services the company will be able to attain mix flexibility in the operation system which is one of the three main fundamental and shared factors. These factors include new product development, mix and volume flexibility. The uncertainty as to the length of product/service cycles and the ability to deal with additions to and subtractions from the mix over time points to new product development and it has shown impressive results that relate to high achievement in operations flexibility in the organization.

Similarly, on the extent of use of automation technology in operations, Computer-Aided Process Planning had a mean of 4.3 and a standard deviation of 0.8 while automated material handling systems had the lowest mean of 3.2 with a standard deviation of 1.3. This depicts that computer-aided process plan is used to a very great extent followed by computer aided design, material requirement plan and computer integrated planning. Automated material handling systems is used to a little extent in the operations.

4.2.2 The implementation of flexibility in the company

The 88.6% of the respondents who encountered frequent fluctuations in demand of the products or services responded that the impact is are mainly monitored by the use of internal standards and least of consumer /market survey and bench marking as sources of information in establishing the best response to its product/services demand fluctuations when they were asked how they identify the extent of the impact of their response to the demand fluctuation of their products/services in their operations. From the table 4.3 below, internal standard had a mean of 4.4 and a standard deviation of 0.6 while consumer /market survey and bench marking had a mean of 3.6 and a standard deviation of 1.3 and 0.8 respectively as sources of information used to measure responsivess of services demand flactuation. Feedback statistics from the Customer and Demand response teams came second rated method of gathering information

Table 4.3: Sources of information used to identify the responsiveness of services demand fluctuations

Source of Information	Mean	Std. Dev.
Internal standards	4.4	0.6
Feedback statistics	3.8	0.7
Consumers survey/Market survey	3.6	1.3
Benchmarking	3.6	0.8

Source: Research data

Hence the challenges that accrue from frequent fluctuations in demand of the products or services are managed by the use of its internal standards and feedback statistics from the Customer and Demand response teams.

On further search for information in relation to extent of implementation of the flexibility, the respondents were asked to rank the levels of implementation of operations improvement processes in their operations. It was observed from the finding shown in table 4.4 below that the 5s Good shop-floor practices concept was well understood and implemented by the majority of the staff in the organization as it had the highest mean of 4.4 and a standard deviation of 0.5 and was closely followed by the continuous improvement concept which registered a similar mean but a slightly higher standard deviation of 0.6. The respondents viewed outsourcing of non-core functions, time-based competition as well as total-employee involvement and hoshin kanri principal as the least operations improvement processes being implemented in the organization as shown in the table 4.4 below.

As it is the company's management practice to adopt and implement comprehensive strategy for continual improvements across its operations. Despite the fact that the researcher was quite aware of these poorly rated processes as being implemented in the organization, it do occur to him that the implementation processes are not passed over efficiently to the staff for them to understand them in their operations.

The study noted that the Company has incorporated automation in its operations ranging from computer-aided process planning that was ranked highly by the respondents, followed closely by computer aided design, material requirement plan and computer integrated planning. Automated material handling systems is least used in the company

Table 4.4: The implementation level of the operations improvement processes

Operations Improvement Process	Mean	Std. Dev.
5s Good shop Floor Practices	4.4	0.5
Continuous Improvement	4.4	0.6
Embracing Latest Technology	4.2	0.9
Just-In -Time	4.1	0.7
Lean Manufacturing	4.1	0.7
Mutual Management of Supply Chain	4.1	0.8
Zero Investment Improvement	4.1	1.0
Total Quality Management	3.8	1.1
Hoshin Kanri Principals	3.7	0.7
Total Employee Involvement	3.7	1.0
Time-Based Competition	3.6	1.0
Outsourcing Non-Core Functions	3.4	1.0

Source: Research data

4.2.3 The role flexibility has played in the competitiveness of the firm

The table 4.5 below shows how different implementation processes are ranked by the respondents when they were asked to rank the implementation of the approaches in contributing towards competitiveness in their operations. Likert scale was used where the first rank was awarded 6 points while the implementation process that is regarded as contributing less is given 1 point. From the table therefore, the level of operations improvement practice had a mean of 5.0 and a standard deviation of 1.1. "Orders from above" had a mean of 3.7 and a standard deviation of 1.6. This implies that level of operations improvement practice is valued as the one that highly contributes to the organization competitiveness.

The automation in relation to computer-aided process planning, computer aided design, material requirement plan and computer integrated planning boosted the perception of the respondent confidence of the system in being competitive in their product and service provision.

Table 4.5: The implementation of the following approaches in contributing towards achieving competitiveness

Implementation Process	Mean	Std. Dev.
Level of Operations Improvement Practices	5.0	1.1
Level of use of Advanced Information Technology	4.6	1.2
Employees' small incremental improvements initiated on the shop floor	4.5	1.2
Personal intuition	4.3	1.6
Orders from above	3.7	1.6

Source: Research data

This is confirmed on the pretest that the automations are able to promote operations to have the ability to produce a number of different products/service at the same point in time, the easy with which changes in the aggregate amount of production of an operations process can be achieved and ability to deal with additions to & subtractions from the mix over time.

Similarly, the study showed that the impact on response to changes in the process is quite low on level of delivery time of products/service that had the mean of 3.6 and a standard deviation of 1.2, on likert scale where 5 meant low impact and 1 very high impact. It is followed closely by level of unit cost with a mean of 3.4.

Table 4.6: Level of Impact of Response to Changes in operation processes

Impact	Mean	Std. Dev
Level of quality defects	2.9	1.0
Level of Performance loss	2.9	1.0
Level of operation disruption in Organization	3.0	1.1
Level of not meeting our customer needs	3.0	1.3
Level of unit labour cost	3.4	1.1
Level of delivery time of products/service	3.6	1.2

Source: Research data

These responses were obtained when the respondents were asked to rank the level of impact that response to changes elicit in their operations. However, with the good rating of delivery and labour cost, the level of quality defects and performance loss was perceived to be high with a mean of 2.9 for both of them, as shown in the table 4.6 below, hence, contravening the concept of achieving flexibility in the operations.

4.2.4 The challenges in implementing flexibility in operations

From the findings, table 4.7 where the rating is from 1-5 (no challenge to very high challenge) indicates that the Company experienced a lot of challenges in establishing a flexible organization that adopts to flexible operations system which is closely followed by the use of the wide range of the resources allocation to expand the creative space.

Table 4.7: Challenges experienced when implementing flexibility programs

Challenges	Mean	Std. Dev.
Establishing of a flexible organization that adopts to Flexible operations system	3.9	0.7
Use of the wide range of the resources allocation to expand the creative space	3.7	0.7
Establishing the coordination mechanism of self organizing operations	3.6	0.8
Establishing of the corporate culture of flexibility that is geared to flexible system	3.6	1.0
Cultivating the flexibility thinking	3.0	1.4

Source: Research data

These challenges scored mean of 3.9 and 3.7 respectively with standard deviation of 0.7 to both of them. The organization experiences less challenge in cultivating the flexibility thinking due to high level of ability to produce a number of different products/service at the same point in time, the ability to deal with additions to & subtractions from the mix over time, the easy with which changes in the aggregate amount of production of an operations process and the use of automation in operation. This challenge scored a mean of 3.0 as shown in the table below. This was in response to a question asked to the respondents to rank the levels of challenges experienced when implementing flexibility in their operations.

Table 4.8: Extent of use of Automation Technology in Operations

Automation Technology	Mean	Std. Dev.
Computer-Aided Process Planning	4.3	0.8
Computer-Aided Design	3.6	1.3
Material Requirement Plan	3.6	1.3
Computer Integrated Manufacturing	3.6	1.4
Flexible Manufacturing Systems	3.5	1.2
Computer-Aided Manufacturing	3.5	1.2
Automated Storage & Retrieval Systems	3.5	1.3
Automated Material Handling Systems	3.2	1.3

Source: Research data

It is also observed that the establishing of automated material handling systems that had the lowest mean of 3.2 with a standard deviation of 1.3, computer-aided manufacturing and automated storage & retrieval systems that had mean of 3.5 each and standard deviation of 1.2 and 1.3 respectively pose challenges in the area of automated operations. See table 4.8 above.

On the research question on how often the equipment/staff/technology are upgraded in order to cope up with future demands, it was established that the upgrading of equipment had a mean of 2.6 with a deviation of 1.2 while upgrading of staff had a mean of 2.2 with a standard deviation of 0.7 as shown in table 4.9 below. Respondents were required to rate on a scale of 1-5 (not at all to less than a year). From the finding one can deduce that equipments are upgraded more frequently than technology, management system and staff is upgraded the least in that sequence.

Table 4.9: Period in upgrading equipments/staff/technology and Management systems in order to cope up with future demands

Systems	Mean	Std. Dev.
Equipment	2.6	1.2
Management system	2.4	1.0
Technology	2.4	1.1
Staff	2.2	0.7

Source: Research data

The frequency of upgrading equipment/technology/ staff that the company adopted in order to cope with future demand, shows that the upgrading of equipment is most frequent than any other capital resources in the company such as upgrading of staff. This posse challenges in being able to establish a flexible organization that adapts to flexible operations system and have employees' inspired to make small incremental improvement initiatives on the shop floor which is one important factor in the socio-technical system theory.

4.2.5 Way forward

The Organization is made of subsystems to the level of departments while others in much smaller than departments. With so many departments to the tune of 14, the respondents were asked to indicate the departments they frequently interact/involve in there operations and at what stages and if there is any need to improve on the issues raised. It was established that the Production department was the most interacted with by other departments in the company's operations, registering a mean of 4.2 and a standard deviation of 1.1. The sales and marketing department was involved the least, it had a mean of 3.5 with a standard deviation of 1.4. See table 4.10 below. Similarly, study found out on the second part of the question, what stage?, that most of the respondents preferred involving other departments throughout the process as this gives them smooth operations from the beginning to the end. This envolved 60% of the repondents.

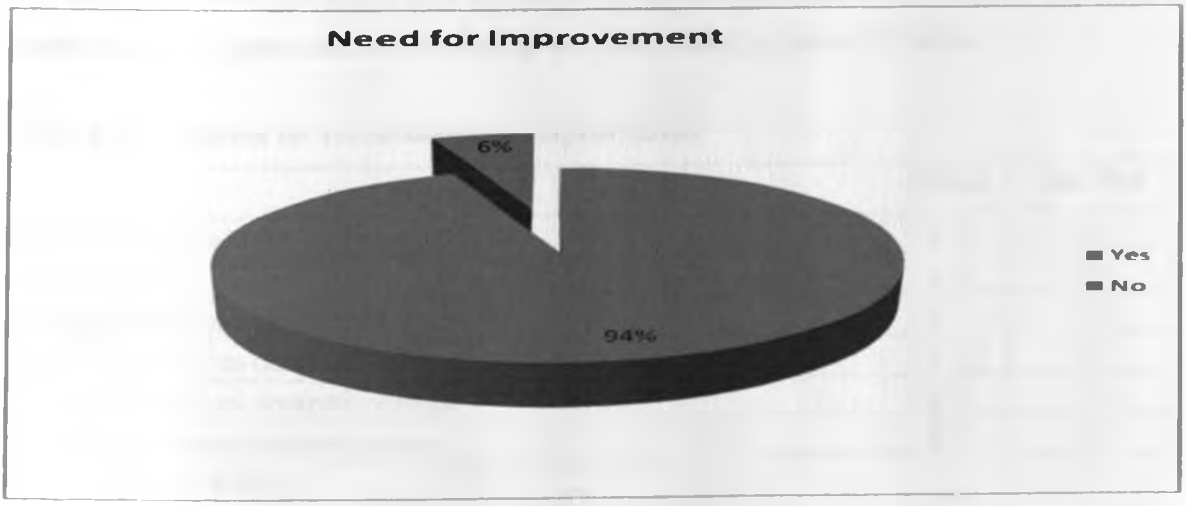
Table 4.10: Interdepartmental interaction and their extent

Departments	Mean	Std. Dev.
Production Department	4.2	1.1
Support Department – HR, IT, FIN, Engineering	4.0	1.0
Procurement Department	3.9	1.3
Sales & Marketing Department	3.5	1.4

Source: Research data

Those who preferred to working with other departments when the need arises (31.4%) which translates to less communication between the subsystems. However, the respondents feel there is need to improve in the level of involvement of other department in the operations as shown by the figure 4.1, where 94% of the respondents felt that it is necessary while the other six percent were comfortable with the situation.

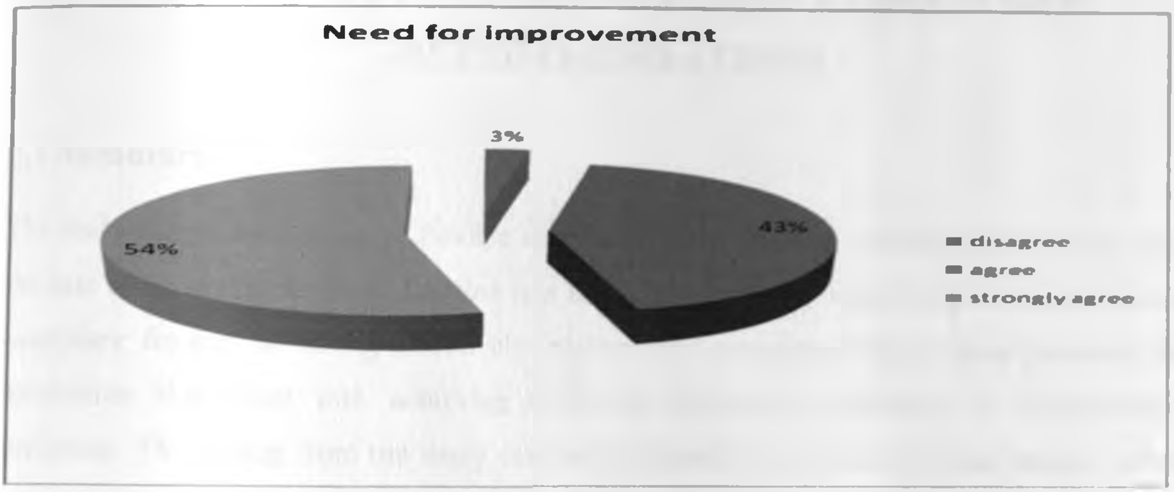
Figure 4.1: Need to improve in the level of involvement of other department in the operations



Source: Research data

The study also established that the operations system requires some improvement as evidenced by the figure 4.2 below where 97% of the respondents agreed (43% agreed and 54% strongly agreed). Only the remaining three percent felt that no improvement is needed by disagreeing with the statement that operations system requires some improvement.

Figure 4.2: Need for improvement in the operation system



Source: Research data

The respondents highly recommended the reduction of the operations unit cost per unit as it makes the products to be expensive in the market compared to the substitute/competitors' products. This recommendation scored a mean of 4.6 with a standard deviation of 0.5. Another recommendation that carried the same weight was to increase output. The least improvement was expected in operations responsiveness which scored a mean of 4.3 and a standard deviation of 0.9. This is a good indication that the system is quite responsive to the market and does not require so much improvement compared to the others listed in table 4.11 below.

Table 4.11: Reasons for recommending improvement

Results	Mean	Std. Dev
Reduce operations unit cost/output	4.6	0.5
Increase output	4.6	0.5
Increase operations timeliness	4.5	0.5
Increase operations output/input	4.4	0.5
Increase operations competitiveness	4.4	1.0
Increase operations responsiveness	4.3	0.9

Source: Research data

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The study sought to investigate flexible manufacturing operations competence in Kenya where the case of Bidco Oil Refinery Limited was taken. The company was picked because it showed exemplary features of having effectively implemented operations improvement processes and automation that blend with achieving flexibility operations competence in manufacturing processes. The finding from the study can be deciphered to be precise, for the majority of the respondents were senior personnel, technical in nature and have been in the Company's operations for long. They participated in giving their opinions to the questionnaires that were self administered. Most of the respondents too had encountered frequent fluctuations in demand of their product/services and this was claimed to have been caused by both the prevalence of uncertainty in operations and the ease in adjustment to operations ability hence inhibiting the Organization operations in achieving a flexible manufacturing competence.

5.2 Conclusion

From the study it can be concluded that Bidco Oil Refinery Ltd undertakes new product, mix flexibility so well, however, it still faces challenges in implementing volume flexibility in order to achieve flexible manufacturing operations. However, Oke et al., (2005) suggests that for any manufacturing systems, the main cause of the loss of efficiency inherent in achieving mix flexibility is set-up time. Bidco's machine downtime seems to be a challenge and this could posse a hindrance in their pursuit to operation flexibility. Similarly, Oke, 2005 argues out that the plant would, however, be thought to have comparatively high mix flexibility if its output could always be in the range 9,800-10,200 tonnes per week irrespective of the mix of products required.

The fundamental determining factor of volume flexibility, however, is the type of employment term employed. He states that the employment terms relates to the type of labour capacity solutions that are used to achieve volume flexibility. The skill level of workers is a factor for achieving both mix and volume flexibility. For instance, a multiskilled workforce would be able to perform multiple tasks driven by changes in mix and volume requirements

The use of very reliable sources of measuring such as internal standards extensively and the feedback statistics by the company to respond to demand fluctuation provides the company with a lot of precision as internal standards and feedback statistics are void of a lot of inconsistencies. The company is much endowed with flexibility thinking which is an important asset to any business. Though doesn't have enough resources to establish flexible organization that adopts flexible operation plan, it can use the knowledge it has to come up with more flexible manufacturing operations and the upgrade of systems ensures that inconveniences are not borne out of obsolesce and breakdowns that would have been otherwise avoided.

On flexibility and competitiveness, the company has developed the ability to produce a number of different products/service at the same point in time as well as ability to deal with additions to & subtractions from the mix over time. Flexibility has enabled the company to handle changes in its operations with less time and cost which are some of the requisite for achieving flexibility in operations, however, there is room to improve and achieve a full-prove of flexibility.

5.3 Recommendation

Gerwin, (2005) confirms that in designing a manufacturing process attention must be paid to both its technical and social aspects. Technical considerations include the nature of the hardware (and software if applicable) as well as the hardware's layout. Social factors involve the kind of supervision, the degree of task specialisation for workers, and the amount of planning responsibilities possessed by workers. According to socio-technical systems theory these two aspects are interdependent and, therefore, need to be designed simultaneously in order for a manufacturing process to be effective.

Out of the study, it came out strongly that the social factors were not efficiently addressed, hence a lot of observed gaps in the system. This could lead to the argument that the degree of automation of a manufacturing process is inversely related to its flexibility if social factors are ignored. (Hickson, 1969 quoted by Gerwin, 2005)

Otherwise, this paper offers a qualified yes in response to the Bidco Oil Refineries Company implementation of operations flexibility competence in its manufacturing system and the reaping of competitiveness benefit in the market.

5.4 Limitation of the study

Despite this study having received so much support it fell short of data that could have filled any anticipated gaps of doubt in the findings.

5.5 Suggestions for further research

The concept of flexibility operations competence in manufacturing has demystified and requires subsequent progress in understanding it. However, it could add much value if an integrated scientific framework for analysing flexibility and to investigate the applicability of this framework in manufacturing companies other than a subjective perspective is deployed.

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APPENDICES

Appendix I: Introduction letter and Questionnaire

Dear Sir/Madam,

REF: QUESTIONNAIRE ON STUDY OF FLEXIBLE MANUFACTURING OPERATIONS IN KENYA: A CASE OF BIDCO OIL REFINERIES LTD

Mr. Bernard Namiti Simiyu is a post-graduate student pursuing a Masters of Business Administration (MBA) program in the School of Business, University of Nairobi. One major requirement of this program is for the post graduate student to carry out a practical study in any area covered in the course and submit the result to the examiner for assessment. He has chosen to undertake a study on "FLEXIBLE MANUFACTURING IN KENYA – A CASE OF BIDCO OIL REFINERIES LTD"

Your company being one of the very vibrant and competitive organizations in this region for the last ten years has been chosen as the best place to carry out a study of this nature. We would therefore highly appreciate if you can grant him an opportunity to gather some specific information needed for this study by allowing him to administer the questionnaire to some of the staff.

Any information provided will be used strictly for academic purpose only and will be treated with strict confidence.

Thanks in advance.

Yours faithfully

Chairman Department of Management Science

Appendix: Questionnaire

PART A: PERSONAL DETAILS

1. (a) Position in the Company

Top Senior Manager:		**Head of Functional Dept:**	
Supervisory manger:		**Technical Staff:**	

(b) Department

Procurement Department		**Production Department**		**Sales & Marketing Department**		**Support Departments HR, IT,FIN**		**Other: Specify**	

(c) For how long have you been working for Bidco Oil Refineries Ltd?

Less than 2 yrs		**2-4yrs**		**4-6yrs**		**6-8 yrs**		**Above 8 yrs**	

PART B: THE EXTENT OF THE IMPLEMENTATION OF FLEXIBILITY IN THE OPERATIONS

2. (i) In your area of operations, do you encounter frequent fluctuation in demand for your product/services?

YES [ ] **NO [ ]**

(ii) If yes, what are the causes for the frequent fluctuation?

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3. (i) Operations Improvement Practises (OIP) is the extent to which a firm implements plans and programs that focus on continuous improvement in operations? To what level of implementation do you apply the below practises?

Operations Improvement Process	Not Applied	Very Low	Low	High	Very High
(a) 5s Good shop-floor practices					
(b) Zero Investment Improvement					
(c) Continuous Improvement					
(d)Hoshin Kanri principals of aligning Company goals					
(e)Total Employee Involvement					
(f) Just-in-time					
(g) Lean manufacturing					
(h) Time-based competition					
(i) Total quality management					
(j) Outsourcing non-core functions					
(k) Embracing latest technology					
(l) Mutual management of supply chain					
(m) Other (specify):					

(ii) How has/have the above OIP contributed to quick adjustment in your operations?

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(iii) What have been your challenges when implementing the OIP in your operations?

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(iv) How did you go about overcoming the above mentioned challenges?

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4. How do you identify the extent to which you are responsive to the demand fluctuations of your services in your operations?

Sources of information	Not Used	Least Used	Used Often	Mostly Used	Extensively Used
Consumers survey/Market survey					
Benchmarking					
Internal standards					
Feedback statistics					
Other source (Please specify)					

5. (i) To what extent are the following uncertainty prevail in your operations?

Uncertainty	Very great extent	Great extent	Some extent	Very little extent	Not at all
(a) Uncertainty as to which products/service will be accepted by customers					
(b) Uncertainty as to the length of product/service cycles					
(c)Uncertainty as to which particular attribute customers want in a product/service					
(d) Uncertainty as to the machine/equipment downtime					
(e)Uncertainty with regards to the amount of customer demand for the product/service					
(f)Uncertainty as to whether the input to operations process meet standards					
(g)Uncertainty as to delivery times of inputs					

(ii) What are usually the most common reasons for uncertainty in your operations?

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6. (i) Kindly rank the following in level of challenges you experience when implementing flexibility in your operations

Challenges	Very high	High	Low	Very Low	No Challenge
(a) Cultivating the flexibility thinking					
(b) Use of the wide range of the resources allocation to expand the creative space					
(c) Establishing of a flexible organization that adopts to Flexible operations system					
(d)Establishing the coordination mechanism of self organizing operations					
(e)Establishing of the corporate culture of flexibility that is geared to flexible system					
(f)Any other (Please specify):					

(ii) If noticeable, kindly list some of the improvements initiated by your employees in the operations process.

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7. (i) To what extent are the following automation technology used in your operations?

Automation Technology	Not at all	Very little extent	Same extent	Great extent	Very great extent
(a) Computer-Aided Design					
(b) Computer-Aided Process Planning					
(c)Automated Storage & Retrieval Systems					
(d) Automated Material Handling Systems					
(e)Flexible Manufacturing Systems					
(f)Computer Integrated Manufacturing					
(g)Computer-Aided Manufacturing					
(h) Material Requirement Plan					
(i) Other Specify:					

8. (i) How often do you upgrade your equipments/staff/technology in order to cope with future demands?

Systems	Not at all	When need arises	After a year	Annually	Less than a year
(a) Equipment					
(b) Staff					
(c) Technology					
(d) Management system					

(ii) Is there any particular reason why the equipments/staff/technology are upgraded at that particular rate?

Yes [ ] **No** [ ]

Why?____

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9. Which of the Departments do you involve in your operations and to what extent?

Departments	**Not at all**	**When need arise**	**To some extent**	**To a great extent**	**To a very great extent**
Procurement Department					
Production Department					
Sales & Marketing Department					
Support Department – HR, IT, FIN, Engineering					
Any other;					

10. (i) If you ever involve them, at what stage are they involved?

When need arise		**At the end**		**Middle stage**		**Initial Stage**		**Throughout the process**	

(ii) Do you think there is need to improve in the level of involvement of other department in your operations? **Yes** [ ] **No** [ ]

(iii) Why?

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PART C: FLEXIBILITY AND COMPETITIVENESS

11. (i) In your opinion how could your rank the implementation of the following approaches in contributing towards achieving competitiveness in your operations?

Implementation process	**Not Used**	**Fifth**	**Fourth**	**Third**	**Second**	**First**
(a) Level of Operations Improvement Practices						
(b) Level of use of Advanced Information Technology						
(c) Employees' small incremental improvements initiated on the shop floor						
(d) Personal intuition						
(e) Orders from above						
(f) Any Other, Specify						

(ii) Why do you regard the above choice as the first in contributing to competence in your operations?

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12. (i)To what level of ability do you experience easy adjustment in the operations below?

Ability	Not at all	Very Low	Low	High	Very High
(a) Ability to produce a number of different products/service at the same point in time.					
(b) Ability to deal with additions to & subtractions from the mix over time					
(c) Ability to make functional changes in the product/service.					
(d) The degree to which the operating sequence through which the inputs flow are changed					
(e) The easy with which changes in the aggregate amount of production of an operations process can be achieved					
(f) Ability to handle uncontrollable variation in the composition & dimension of inputs being processed					
(g) Ability to rearrange the order in which different kinds of inputs are fed into the moperations process					

(ii) What are the main causes/reasons of the said ability in your operations?

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13. (i) To what level of impact does the response to changes in your process have on the:

Impact	Very high	High	Low	Very Low	Not Applicable
Level of not meeting our customer needs					
Level of operation disruption in Organization					
Level of quality defects					
Level of unit labour cost					
Level of delivery time of products/service					
Level of Performance loss					

14. (i) Way forward

Improvement	I Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree
My operations system requires some improvement. E.g. Change over capacity, set-up time, new product/service designing, human manpower sourcing, multiskilling of my staff, improving standard, volume prediction etc					

(ii) Which specific area(s) do you recommend improvement?

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____

(iii) Why do you recommend improvement?

Results	I Don't Know	Strongly Disagree	Disagree	Agree	Strongly Agree
a) To increase output					
b) To increase operations timeliness					
c) To increase operations responsiveness					
d) To increase operations competitiveness					
e) To increase operations output/input					
f) To reduce operations unit cost/output					

15. (i) To what extent do you think these information gathered will assist/help the organization in improving in its operations and enhance its strategic competitiveness in its market industry?

I Don't Known		**Not Helpful**		**Fairly Helpful**		**Helpful**		**Very Helpful**	

(ii) If helpful, in which way will the organization benefit from the information gathered?

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THANKING YOU FOR YOUR COORPERATION AND PARTICIPATION