FACTORS CAUSING REVERSED BULLWHIP EFFECT ON THE SUPPLY CHAINS: A CASE STUDY OF KENYA PIPELINE CORPORATION.

BY:

OTIENO TOM OBONDI
D61/72311/08

A research proposal presented in partial fulfillment of the requirements for Master of Business Administration

University of Nairobi
School of Business

2010

Declaration

This management research project is my original work and has not been presented for a degree award in any other college or examination body.

Signed……………………………………….. Date…14/11/2010……………

Otieno Tom Obondi

This management research project has been submitted with my approval as the Nairobi university supervisor.

Signed………………………………………Date……14/11/2010………

Gerald Ondiek

Lecturer

Department of Management Science,

School of Business

University of Nairobi

Acknowledgement

Sincere gratitude goes to the almighty, He had known my academic fate before I decided to take a step. Many thanks to my wife Millicent Achieng and my daughter Vallerie Amondi, their support were essential for my success in this endeavor. I cannot fail to recognize the unwavering support and patience of my supervisor in helping me to realize my potential in academic work. All the lecturers of University of Nairobi who taught me, students and work place colleagues, and the University librarian at business school Kisumu Campus, may God grant you all your wishes in life.

Dedication

This research project is dedicated to my daughter Vallerie Amondi and my wife Millicent Achieng. Without their unrelenting support and continued cooperation this project could not have been done.

ABSTRACT

Effective supply chain management should eliminate variabilities in stocks at end sale points and supply points. Companies are trying to reduce these variabilities by employing different operations strategies to match demand forecasts with production. Success has been varied as this variability continues with shifting manifestations, at one point the variability is upstream and at the other point, the variability is downstream in the supply chain. This poses multiple challenges on the supply chain strategy. Variability of demand upstream has been described as bullwhip effect (Fransoo and Wouters, 2009), while variability of supply downstream is what has been described as reversed bullwhip effect (Svenson, 2003). While demand variability throughout the supply chain has received considerable attention in the literature, supply variability in the middle of a supply chain has not been adequately addressed in available literature.

The study sought to establish the underlying causes of middle chain supply variability i.e. reversed bull whip effect between KPC the supplier and the oil marketers; the wholesalers. The objective of the study was to find out the causes of supply variability on supply chain of KPC. The study narrowed down to supply chain structures, information flow, capacity challenges and effect of government regulation and customer business procedures as the principle causes. These perceived causes of supply variability were formulated into research questions which the study sought to answer. Case study was used and data for operations for the last two years was gathered through questionnaire. Purposive sampling was employed. From the population of seven (7) depots a sample of five (5) depots had been chosen for the study. The response rate was 100%. Data analysis was done using the social science statistical package of SPSS. The findings showed that capacity constraints are the main cause of supply variation along the supply chain of KPC. It was discovered that while storage capacity down stream is sufficient, the upstream availability of the product was not sufficient because of the pipeline network. All the respondents agreed that the government intervention through KRA delayed order processing since it created another layer within the supply chain. It was also discovered that extending the loading hours can improve the capacity constraints but security issue

was a major scare. However the business procedures of oil marketers, the supply chain structure of KPC and the extent of business information flow had very little effect on the varaibilities of supply along the supply chain of KPC. This implied that product and information movement routes had no meaningful impact on the speed of the product being transported. It is only the efficiency of the supply source that determined the variability at the end sale points.

The demand for the services of KPC is projected to continue on the upward trend. Given the ever increasing demand for these services, capacity enhancement strategies like more time, parallel supportive pipeline network, lean supply chain structures and reliable equipment need to be installed to eliminate the supply variation at points of sale. This study was limited to non value addition outbound logistics of the supply chain. There is need to also consider value addition within the supply chain to address the impacts of refining, storage allocation to customers from the down stream inventory facilities of the supply chain.

TABLE OF CONTENTS

Chapter 3: Research Methodology

Chapter four : Data Analysis, Presentation and Discussion

Chapter five : Summary of findings ,conclusions and recommendation

List of tables

Page

List of figures

List of abbreviations

KPC……….Kenya Pipeline Corporation

KRA………Kenya Revenue Authority

SGS……….Societe' General de Surveillance

JKIA…........Jomo Kenyatta International Airport located in Embakasi

MIA……..Moi International Airport located in Mombassa

CHAPTER ONE: INTRODUCTION

1.10 Back ground

Delivering products to consumers depends on complex tasks that require several companies working together as a supply chain or network (Budiman, 2004). The never ending quest for high quality products at economically competitive prices to be delivered or made available almost instantaneously places a heavy burden on the supply network (Mathias, 2005). The nature of competition in the post industrial era has seen the emergence of a new business model where the focus of competition has shifted from between organizations within a supply chain to between the supply chains themselves (Cox, 1999, Christopher & Towilll, 2009, Lambert & Cooper, 2000). Under this new business model, the viability of an individual organization is dependent on the ability of its management to integrate it into an appropriate supply chain where it can leverage its own sources of competitive advantage over those of its supply chain partners (Hamel, Doz, & Prahalad, 1989, Limerick, Cunnington, & Crowther, 2000, Lipparini & Lorenzoni, 1999, Kamauff, Spear & Spekman, 2002). Hau (2004) writing in the Harvard Business Review journal notes that only companies that build supply chains that are agile , adaptable and aligned get a head of their rivals. According to Srinivas, Kemal and Gardner (2004) companies are often faced with the challenge of determining optimal order quantities, optimal production quantities, safety stocks levels and other inventory policies that significantly affect supply chain costs and profitability. It is for this reason that inventory management has emerged as one of the key factors for effective supply chain management.

As firms successfully stream line their own operation, the next opportunity for improvement is through better coordination with their suppliers and customers. According to Felix, Chan, Luong and Wang (2009), effective coordination strategies will be of vital importance for the next generation supply chains. Cocks, Heap, Hubbard and Samuel, (2002) say that winning organizations see other organizations as extensions of their own businesses. They say that an organization sees the cooperation and coordination with other organizations as essential to its own success so it manages the business relationships with these organizations.

This systematic, strategic coordination of the traditional business functions and the tactics across businesses within the supply chain, for purposes of improving the long term performance of the individual companies and the supply chain as a whole is what has been referred to as supply chain management (Lummus, Mentzer & Vokurka, 2001). In a supply chain goods flow through a complex series of plants, intermediaries, warehouses and distribution centers and the flow can involve multiple modes of transport (Bradley, 2002)

Bradley (2005) says that missed transportation connection in the middle of a supply chain may cause a customer outage or a supplier shutdown. Kumar, Ogunlana, and Sitichai (2004) propose that while pipelines are one of the safest modes of transporting bulk energy and have failure rates much lower than rail roads or highway transportation, failures do occur and sometimes with catastrophic consequences.

In attempting to effectively coordinate the supply activities, firms are faced with unpredictable demand, intermittent supplies, mutating consumer tastes and preferences and advancements in technology. According to Tang (2006), as supply chains become more global, supply uncertainty becomes a more striking issue. He further notes that these uncertainties are brought about by the variabilities in the supply chain caused by stochastic demand and unreliable supplies. Svensson, (2005) notes that the dependencies between actors, activities, and resources cause negative consequences when stocking level variability occurs upstream and down stream in the supply chain.

1.11 Reversed bullwhip effect

The variability of demand is usually seen up the supply chain at the retail or whole sale level while the variability of supply is usually seen down the supply chain at the company warehouse (Fransoo & Wouters, 2009*)*. They describe this increasing variability of demand further upstream in the supply chain as the bullwhip effect. The term bullwhip was coined by managers of Proctor and Gamble when assessing the demand variation on their pampers but was first described by Forrester (1985), the term found its way into the literature courtesy of Lee, Tversky and Parlar (1997). Since its formal introduction and analysis by Lee et al (1997), the bullwhip effect has drawn extensive attention from both academia and industry.

However recent studies by for example Baganha and Cohen (1998) suggest that bullwhip effect does not prevail in general. Svenson (2003) introduces the term 'reversed bullwhip effect' which refers to the variability of supply down stream the supply chain. He notes that the reversed bullwhip effect occurs between suppliers and retailers. The detailed empirical study at the industry level by Cachon, Randall and Schmidt (2007) shows that only 47% of industries studied in the US exhibited bullwhip effect while the remaining 53% the reversed bullwhip effect. Studies done by Croson and Donohue (2003, 2006), Croson et al (2004), Kaminsky and Simchi-Levy (2000) and Wu and Katok (2006) find a substantial portion of trials in which the opposite effect of Bull Whip effect occurs ; that is reversed bullwhip effect. According to Svensson (2005) current explorations of the bullwhip effect ignore the fact that stocking level variability in the value systems is double edged and continuous. This means that stocking level variability is affected by upstream and down stream business operations in the value system.

1.12 The causes of Reversed bullwhip effect.

The theoretical studies on the rationing game by Rong et al (2008) and on the interactions among capacity, price and demand by Rong et al (2009) are the first studies of Reverse bullwhip effect in the literature to analyze the operational causes of the reverse bullwhip effect in the presence of supply uncertainty.

Information distortion

Lalonde (1985) writes about last minute orders, order changes, mechanical failures, picking and packing errors, outright lies about customer capacity, coordination errors and data corrections. All these he describes as information friction and he notes that they cause information distortions where information is needed in a timely fashion. These distortions cause supply variability along the supply chain. Mason-Jones and Towill (1997), advocate the 'enriched supply chain' in which point of sales data are communicated directly to all members in the supply chain, so they can base their decisions on accurate and current sales information, rather than possibly distorted information from the down stream chain members

Nature and type of supply chain structure

Bradley (2002) notes that the kind of supply chain structure determines the extent of information distortions that further support reverse bullwhip effect. Fisher (1997) defined two types of supply chains, one physically efficient and the other responsive. He notes that responsive chains stress effective and rapid response to actual customer demands. For these chains, accurate forecasting and consideration of market mediation costs are the keys to competitiveness. Christopher (2000) says agility is a kin to responsiveness since agile chains provide extremely rapid response to highly variable demand. Naylor, Mingzhou and Gereffi (1999) define a 'leagile' supply chain as a supply chain having a lean up stream and an agile down stream component. Fisher (1997) further notes that a physically efficient chain stresses least total cost. Lean supply chains (Christopher, 2000) operate on a paradigm closely a kin to physical efficiency. A physically efficient chain is better placed to mitigate against supply disruptions and is therefore better placed to eliminate reversed bullwhip effect.

Supplier capacity

In his interviews with the suppliers of aero construction materials, Budiman (2004) found out that the supply fluctuation was due to capacity adjustment lead time, production lead time, order processing delay and order wait time. Svenson (2005) writes that the reversed bullwhip effect is caused by factors such as deficient information sharing, insufficient market data, deficient forecasts and capacity issues. He further suggests that companies' 'atomistic considerations' (that is sub optimization of business processes) in a supply chain cause the reversed bullwhip effect to occur. He says that suppliers that have less responsive production processes or less adjustable warehousing facilities are likely to experience reversed bullwhip effect as a result of demand. According to Lee, Mason-Jones, and Fisher (1997) in their discussion of 'rationing and shortage gaming', where inventories are insufficient and supply consistency is not guaranteed, customers order so much further stretching the facilities' capacity as these orders have to be serviced and some could be duplicate orders.

Pricing regime

According to Rong et al (2009), when customers react not only to price itself but changes in the price, some pricing strategies implemented by the supplier may lead to reversed bullwhip effect. Taylor (2000) notes that volume discounts caused bunching of orders into specific batch quantities. This may encourage over purchasing that further depresses the supply points.

Company policy and nature of business regulation.

The project involving three companies done by David (2000) found out a strong pressure from senior management to minimize inventory for financial reasons rather than setting stocks to a calculated buffer against quantified demand and supply variability. Senior management had the view that in today's Just In Time (JIT) and customer service environment, it is up to the supplier to meet our demand no matter how variable that is. Unfortunately this approach fails to understand that in order for stockless/ JIT systems to operate properly supply and production systems that are both capable and reliable are necessary.

Business procedures and policies that have been internalized into organizational cultures may have influence on the nature and manner of reaction to market opportunities. These cultures may be reflected in the order processing duration, the payment procedures and transport vessels travel restrictions which may either increase or reduce delivery lead time. Equally government policy and regulation on certain businesses may encourage reversed bullwhip effect. An example is the sudden requirement by the tax authorities that all import products to meet a new quality threshold, or that all import declarations to be centralized and taxes to be paid upfront. These requirements once implemented have the ability to disrupt smooth flow of products or services.

1.13 Kenya Pipeline Corporation

The Kenya Pipeline Company was incorporated on 6th September 1973 under the companies act (Cap 486) and started commercial operations in 1978. The Company is a State Corporation under the Ministry of Energy with 100% government shareholding. The company operations are also governed by relevant legislations and regulations such as; the

Finance Act, The Public Procurement Regulations, amongst others. The overall objective of setting up the Company was to provide the economy with the most efficient, reliable, safe and least cost means of transporting petroleum products from Mombassa to the hinterland. Kenya Pipeline Company operates a pipeline system for transportation of refined petroleum products from Mombassa to Nairobi and western Kenya towns of Nakuru, Kisumu and Eldoret.

The Western Kenya Pipeline Extension is 8 Inches in diameter up to Burnt Forest where it reduces to a 6 Inch diameter pipe. From Sinendet Line 3 tee's off to Kisumu and is 6 Inches in Diameter. It was commissioned in early 1994. The Western Kenya depots (Kisumu and Eldoret) are equipped with loading arms for loading road tankers and rail wagons.

KPC has 7 storage depots strategically located in different parts of the country. The depots are located in Mombassa, Nairobi, Nakuru, Kisumu and Eldoret. The other two depots are designated for Jet A-1 fuel and are located conveniently next to Jomo Kenyatta International Airport in Nairobi and Moi International Airport at Mombassa (Kenya Pipeline Company [KPC], P.25).

1.2 Statement of the problem

Available literature shows that the problem of reversed bull whip effect actually occurs. Its exact location within the supply chain is what researchers have not been able to agree on. Initial contributions by for example Rong et al. (2008) suggest that it occurs at the extreme ends between the suppliers and retailers, however the business arrangement between KPC and its customers; the oil marketers suggests that reversed bull whip effect can occur at the middle of the supply chain. The supply chain process of KPC is such that product is shipped from central warehouse storage in Mombassa to respective depots country wide for final loading by oil marketers. This arrangement makes the interaction between the KPC and oil marketers to be more active at the middle of the supply chain. In the business arrangement KPC is the supplier after assuming full control of oil imported by oil marketers and oil marketers the wholesalers. KPC is supposed to load all orders from shippers on a daily basis. KPC is seen to run out of supplies frequently starving the local and exports market served by oil marketers. Orders servicing period frequently exceeds the lead time period of two days.

This supply variability has resulted in higher oil and other commodity prices, poor customer-supplier relationship and to some extremes loss of business. The variability has confounded the order processing and the customers have over weighted the supply chain leading to a frequent back log of unmet orders. Consequently transporters have been forced to pay the price of long night outs for tankers' drivers; customer stock out has been a frequent occurrence with oil marketers complaining about the services of KPC (Tinina, 2008). This study seeks to find out the underlying causes of reversed bullwhip effect between KPC and its customers.

The study therefore seeks to answer the following questions:

(i) Is KPC facing capacity challenges?

(ii) How are the operations of KPC affected by government/ its customers' business policies?

(iii) How is business information shared between KPC and its customers?

(iv) How is the supply chain of KPC structured?

1.3 The objectives of the study.

The general objective of the study.

To find out the underlying causes of reversed bullwhip effect in the supply chain of KPC

Specific objectives

(i) To assess the capacity utilization at KPC and its impact on the supply chain

(ii) To discover the supply chain structures at KPC.

(iii) To investigate the extent of business information flow between the members of the supply chain, KPC and its customers.

(iv) To find out the effects of government policies and company business procedures on the supply chain of KPC.

1.4 The importance of the study.

This study would be of importance to the following target groups

(i) Oil marketers need exact and rapid response to customer demands in order to stay competitive in the market. The study would help them to know the underlying causes of supply variability at KPC depots, how best to strategize in the market and how to mitigate default on supply by KPC.

(ii) This study would help energy policy makers to decide on capacity planning, designing and adjustments at KPC depots.

(iii) This study would help Kenya Pipeline Company to design a supply chain that is aligned to client demands and help improve on customer service in their operations.

(iv) The concept of reversed bullwhip and its manifestations has not been extensively researched, this study would help academicians and researchers to further understand the concept of reversed bullwhip effect and reconcile it with the existing inventory models particularly the Economic Order Quantity in the face of unpredictable supplies.

1.5 The scope and limitation of the study.

Supply chain management is a collaborative activity and therefore interaction between the members within and between the supply chains is necessary if a seamless supply chain is to be achieved. This study is limited to interactions at the intra-organizational echelons i.e. within KPC and therefore excludes the customers of KPC, the oil marketers and other suppliers of KPC. The study singles out non value added inbound and out bound activities of the supply chain. The study employs the following assumptions:

(i)No physical value addition within the supply chains of KPC that may impede the product flow.

(ii)Intentional disruptions are diarized and supply chain elements can plan in advance for the likely negative effects of the disruption.

(iii)No reverse logistics in the inbound and out bound logistics of the KPC supply chain.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

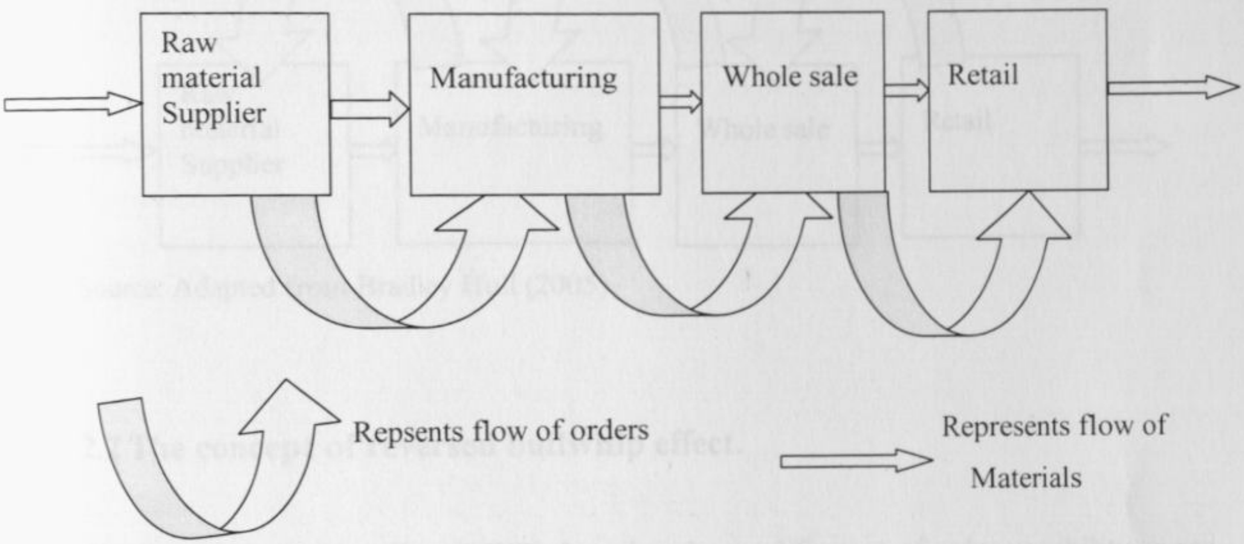
Types of supply chains.

According to Cavinato (1992), Lambert (1992) and Mentzer (2001), supply chain management addresses the supply chain from the point of origin to the point of consumption. Bradley (2005) categorizes supply chains into two based on structural and behavioral characteristics. He considers two categories, the demand driven and supply driven chains. He describes the demand driven behavioral characteristics as bullwhip effect which manifests itself in panic orders, and highly fluctuating inventories. Senge (1990) expresses this as 'structure influences behavior'. The structure referred to here is the backward flow of information and consequent behavior is reversed bullwhip effect. The backward flow of information here is such that it comes from the supply depressed end sale points. This order flow is not all smooth since some customers can reduce orders and take available quantity, or take other products. The study of Rong et al. (2008) shows that the human behavior creates an additional layer of variability to systems under supply disruptions.

In supply driven chains (Bradley, 2005), it is the supplier and not the customer who activates the flow. This means that information flows forward in the same direction as the product. A major concern is that the flow may encounter a bottle neck, or that customers may not buy the entire product. Either of these problems has the potential of compromising the full production of the supply source which can be costly. It can also lead to the supplier overselling his or her product, hoping that customers will cancel their orders last minute. Such a structure asserts the supremacy of the supply source with customers taking the secondary role. Viewed this way the supply driven supply chains may cause the reversed bullwhip effect. The order and information flow is depicted in the figure overleaf.

Figure 2.1

Supply driven supply chain, where the supplier activates the flow and variations are experienced at this source, this means that information flows in the same direction as the product; the assumption is that customers are there for the product. This is the case of reversed bullwhip:

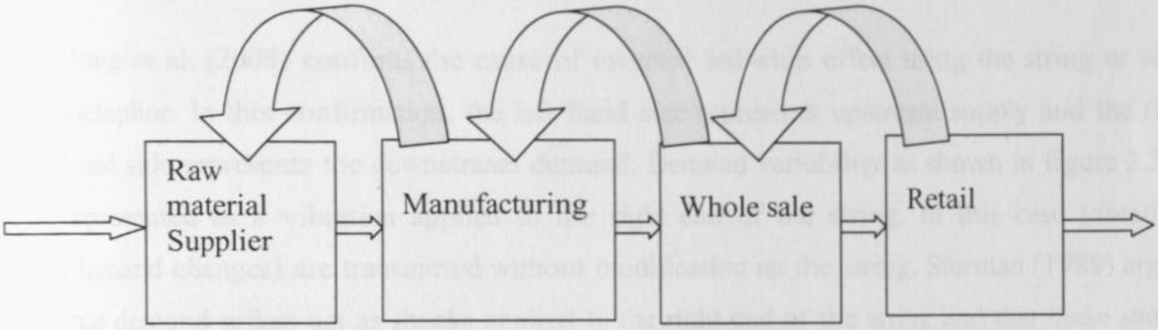


Source: Adapted from Bradley Hull (2005).

He further notes that in demand driven chains (as shown in figure 2.2) a customer activates flow by ordering from retailer, who orders from the wholesaler, who orders from the manufacturer, who reorders the raw materials. The activator can be either the actual customer demand or the forecasted customer demand. Orders flow backwards up the chain in this structure. The demand driven supply chains explain the essence of bullwhip effect. This bullwhip effect results from fear of demand limitations (too few customers or inability to access them) in an environment which emphasizes supply (maintaining flow).

Figure 2.2

Demand driven supply chain; where it is the customer or demand forecast which activates the flow and variations are experienced at the end sale point, orders flow backward up the supply chain: a case of bullwhip effect.



Source: Adapted from Bradley Hull (2005).

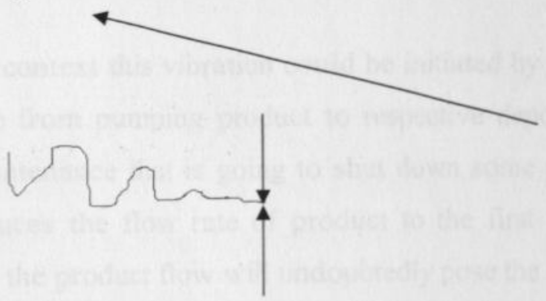
2.2 The concept of reversed bullwhip effect.

The classical bullwhip effect (BWE) describes the amplification of order variability as one moves upstream in the supply chain (Rong et al., 2009). According to him, bullwhip effect occurs between retailers and customers and reverse bullwhip effect occurs between retailers and suppliers when retailers compete for scarce supply under a standard mechanism used by the supplier to allocate the available supply. Rong et al. (2008) observed that when the reversed bull whip effect occurs, it raises a particular challenge for flexible supply chain design, since in this case the supply and demand processes are highly interdependent. In order to see the effect of supply variation, we maintain base stock to eliminate the bull whip effect (demand variation); in our case we have assumed fully refined stocks at KPC after value addition at the refinery in Mombassa. Svensson (2003) writes that where there is reversed bullwhip effect, the principle of speculation (maintaining higher levels of inventories) dominates a company's inventory management of business activities to a larger extent in the inbound logistics flows (i.e. inventories are higher) than in the outbound logistics flows (i.e. the inventories are lower). He further says that from the financial point of view, the inventory cost per unit is lower upstream than down stream which mitigates the effects or consequences of increased variability in the inventory management upstream in the supply chain.

2.3 Representing reversed bullwhip

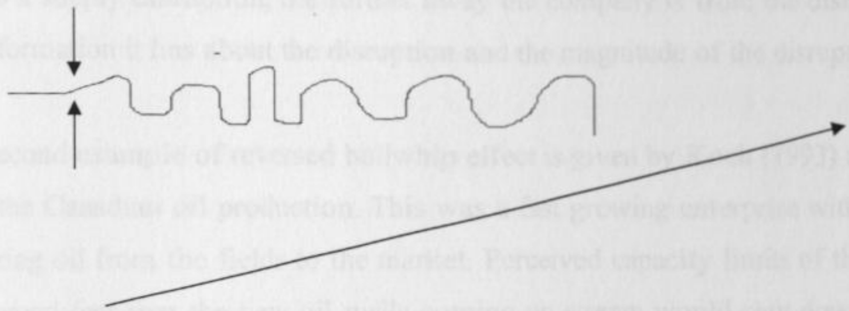
Rong et al. (2009) confirms the cause of reversed bullwhip effect using the string or whip metaphor. In this confirmation, the left hand side represents upstream supply and the right hand side represents the downstream demand. Demand variability as shown in figure 2.3, is represented as a vibration applied to the right end of the string. In this case vibrations (demand changes) are transmitted without modification up the string. Sterman (1989) argues that demand spikes act as shocks applied to the right end of the string and that these shocks amplify as they move up the string causing bullwhip effect as shown in the figure below.

Figure 2.3, string vibration with a demand vibration and bullwhip effect.



Source: Adapted from Rong et al. (2009 page 98).

Figure 2.4, string vibration with a supply shock and reversed bullwhip effect.



Source: Adapted from Rong et al. (2009 page 98.

In the above figure, suppose that a shock is applied to the left end of the string (the down stream-supply point) as above, the wave then initiates upstream and amplifies as it propagates down stream- the case of reversed bullwhip.

In the Kenyan context this vibration could be initiated by power disruptions which impedes Kenya pipeline from pumping product to respective depots, information about sudden but impending maintenance that is going to shut down some plants or a non functional booster pump that reduces the flow rate of product to the first destination schedule. Any small interruption on the product flow will undoubtedly pose the challenge on supply scheduling.

2.4 The real life manifestation of reversed bullwhip effect.

A simple phrase capturing the essence of reversed bullwhip goes as follows:

Customers walk to a retailer's joint to purchase a product; the retailer finds that there is a shortage of merchandise at his sources of supply, retailers place orders with the manufacturers, the manufacturers inform the retailers that it is with great regret that they cannot service the order, there has been an unaccounted for shortages of material that prevented them from producing the products to normal capacity and this shortage of material is to persist until the next season. This information on product unavailability creates panic among customers. Some inflate their orders so that other end point supply points are overwhelmed. Transport vessels are over booked. This supply variation picks up, demand forces on the retailers force prices up, serial supply shock sets in, malpractices like cheating, over ordering become part of the supply chain. According to Rong et al. (2008) reverse bull whip effect happens immediately after supply disruption. He says that in the real world, when there is a supply disruption, the further away the company is from the disruption source, the less information it has about the disruption and the magnitude of the disruption.

The second example of reversed bullwhip effect is given by Koch (1993) and Maciej (1996) about the Canadian oil production. This was a fast growing enterprise with a single pipeline delivering oil from the fields to the market. Perceived capacity limits of the pipeline created widespread fear that the new oil wells coming on stream would shut down, despite the fact that the pipeline worked assiduously to increase capacity. The producers' fear resulted in orders exceeding capacity of the main pipeline by a factor of two or three. Cooperative oil industry efforts to eliminate the inflated ordering always failed (cheating was rampant), as did efforts to penalize offending shippers, attempts to allot pipeline capacity based on historical usage failed.

2.4.1 The beer game experiment

The Beer Distribution Game (The Beer Game) is a simulation game created by a group of professors at MIT Sloan School of Management in early 1960s to demonstrate a number of key principles of supply chain management. The game involves a simple production/distribution system for a single brand of beer. There are three players in the game including a retailer, a wholesaler, and a marketing director at the brewery. Each player's goal is to maximize profit. The discoveries of this game were that:

i) Systems cause their own problems and that these problems are gradual and not realized until it is too late. People concentrate on individual decisions not knowing how these decisions affect other people else where in the system, neither do they learn from their mistakes because the consequences of their decisions occur else where in the system. Consequently they blame one another for the problems

ii) Proactivity in a supply chain should be moderated by systems thinking.

Rong et al. (2009) did an experiment on the beer game to prove the presence or absence of the bullwhip and reversed bull whip. This was after their conjecture that reversed bullwhip effect occurs immediately after supply disruptions. In this experiment the standard deviations of customer orders serviced were calculated during the down period (supply disruptions) as shown below. The findings were that 51.4% players exhibited reversed bullwhip effect during down periods confirming their conjecture that reversed bullwhip effect occurs after supply disruptions. The symbol † beside a number indicates the reversed bullwhip for that particular player.

Table 1.1; standard deviation of orders for each player for the down period:

			Down periods only	
TEAM				
	R	**W**	**D**	**M**
1	**0.00**	**29.17**	**16.12†**	**11.10**
2	**9.81**	**28.54**	**9.76†**	**2.07†**
3	**7.55**	**33.27**	**19.84†**	**6.58†**
4	**7.38**	**5.56†**	**8.77**	**3.11†**
5	**11.98**	**11.21†**	**21.65**	**8.22†**
7	**23.56**	**13.36†**	**12.14†**	**5.81†**
8	**12.95**	**7.16†**	**5.74†**	**4.79†**
13	**8.38**	**5.85†**	**10.66**	**8.58†**
14	**2.21**	**1.99†**	**1.86†**	**2.07**
15	**12.56**	**45.43**	**28.65†**	**14.28†**
16	**29.75**	**18.48†**	**7.77†**	**5.07†**
17	**18.62**	**38.95**	**40.49**	**9.62†**
18	**8.17**	**8.46**	**12.46**	**10.90†**
19	**10.53**	**8.26†**	**23.98**	**8.55†**
20	**3.19**	**3.78**	**3.35†**	**2.06†**
21	**6.04**	**4.64†**	**5.52**	**1.21†**
22	**4.64**	**23.16**	**18.87†**	**8.28†**
23	**22.72**	**12.90†**	**21.73**	**5.73†**
MEAN	**11.11**	**16.68**	**14.96**	**6.56**

Source: Rong et al. (2009 page 96).

Where R represents retailers, W represents wholesalers; D represents distributors and M Manufacturers.

2.5 Capacity

Capacity is defined as the maximum quantity of a product that a firm can produce in one planning period (Budiman, 2004). Naylor (2002) notes that in operations management, capacity is used to describe both stocks and flows. According to David (2000) supply variability may be due to machine reliability and or product quality problems. According to Rong, Snyder, Zuo-Jun (2007), when the supply chain uncertainties persists, the capacity level is a key piece of information to help retailers make order decisions and suppliers make supply decisions. They say that in the case where total orders received by the supplier exceed its capacity, the supplier applies a proportional allocation rule, which according to Cachon and Lariviere (1999) is to convert an infeasible set of orders into a feasible allocation that is based either on past sales or a fixed allocation. Budiman (2004) explains that adjusting capacity may be less costly than holding inventory particularly if one is taking into account the risk of obsolescence, cost of holding inventory including interest, and the benefit of having flexible supply afforded by capacity. According to him, for a supply chain to be effective, sharing forecast information should be accompanied by optimal production and capacity planning. Companies that trade in fast moving non perishable products need to enhance their storage capacities. The operation strategy conducive for such a product is make to stock since obsolescence is not part of the cost of holding inventory. The concept of platform manufacturing needs to be employed in the oil sector loading gantry. In this strategy, the gantry loading arm set up is such that it is very flexible for any loading vessel; that is bottom loading, top loading, loading valve reduction and metered loading volume control. Capacity enhancement strategies like tanking, pumping, and pipeline set up need to reflect the demand supply balance based on rational market demand projections. The industry players need to analyze the economic and operating factors that influence inventory levels and define the relationship patterns between inventory and price levels with the intention of creating a steady state.

2.6 Supply chain structure.

Supply chain structure influences the nature of the supply chain activities, the efficiency and effectiveness of the supply chain and relationships with other members of the entire supply chain. Ting, Kilduff and Gargeya (2009) identify three types of supply chain structures: lean, agile and hybrid.

2.6.1 Lean Structure.

A lean supply chain structure is organized to maximize operational efficiency and minimize overall cost. Typically lean organizational arrangements in a supply chain are used for higher volume product lines that have stable demands and standardized technologies.

2.6.2 Agile supply chain structures.

This is organized to achieve flexibility and speed in responding to dynamic market conditions and customer needs. These arrangements are used for lower volume product lines subject to more uncertain demand and innovative technologies (Naylor et al., 1999). Ting et al.(2009) says that flexibility is reflected in the following dimensions:-rapid design changes, Rapid volume changes, offer broad product variety, adjust product mix quickly, offer large number of product features, timely and correct product delivery.

Collin, Eloranta and Holmstrom, (2009), define responsiveness as being able to fill orders quickly. According to Budiman (2004), until recently, high responsiveness to consumer demand could be afforded by having sufficient supply in the form of inventory of products. However companies are finding it more difficult to meet increasingly personalized consumer demand by using inventory alone. According to Collin et al. (2009), the strategy of inventory stocking used by Nokia management at the turn of the millennium led to inventory creep, causing costs and obsolescence risks to soar.

2.6.3 Hybrid:

A hybrid supply chain structure combines the agile and lean. It has also been referred to as leagile supply chain structures. The loading gantries need to accommodate both bottom valve and top valve compartmentalized loading trucks.

Certain supply chain structures are more appropriate, given the particular characteristics of the business environment, and therefore supply chain structures implemented should be aligned with competitive priorities on which the firm is focused.

2.7 Information flow

Information sharing refers to activities that distribute useful information among multiple entities (people, systems or organizational units) in an open environment. According to Sun and Yen (2005) the following questions are considered in information sharing: What to share? Whom to share with? How to share? And when to share? If these questions are answered correctly, then information costs on the supply chain will be reduced, supply chain will be more responsive and information overload or deficiency will be eliminated. For supply chain information to flow smoothly we need technology to produce, manipulate, store, communicate and disseminate information. Fawcett, Osterhaus, Magnan, Brau and McCater (2007), explain that information technology plays a central role in supply chain management. It enables companies to collect, analyze and disseminate information among members of the chain to improve decision making. Equally we need functional connectivity. The unfortunate reality from the supply chain view point is that businesses regard information as power, not only is it withheld but it is often deliberately distorted so as to mask the true intent (Mason-Jones, Naim and Towill, 1997). David (2000) writes that where 'functional silo' exists between and within organizational supply chains, there is less concern about the potential adverse effects of the 'silo policies' else where in the supply chain.

Bradley (2005) suggests that information friction is reduced by bar coding, the internet, Electronic Data Interchange, point of sale systems and Enterprise Resource Planning systems. He however notes that technology does not eliminate distortions or identify good information to flow routes. Bradley (2002) suggests that bullwhip effect and reverse bullwhip effect can be dealt with through an information push and pull and timely shipping scheduling. Information push described here is the dissemination or diffusion of information in a timely fashion among the supply chain elements, while information pull is the relevant information and data gathering about demand, capacity and logistical constraints

2.8 Business procedures and regulation

Regulation is controlling human or societal behavior through a set of rules or restrictions. Regulation can take many forms: legal restrictions promulgated by a government authority, self-regulation by an industry such as through a trade association, social regulation (e.g. norms), co-regulation and market regulation. One can consider regulation as actions of conduct imposing sanctions such as a fine. Business regulation can be formulated in to procedures or policies. Where safety is concerned, parking, loading and dispatch can be restricted to specific times. In the oil industry for example Total Kenya Ltd has a safety regulation that bars its loaded or empty trucks from traveling between 6pm and 6am. The effect of this is that delivery lead time is likely to be adjusted due to this business policy. Policies and procedures lengthen the supply chain by creating another layer within the value chain. Other policies can also reduce the delivery lead time. Some companies require clients' orders to be serviced within 24 hours of order placement or payment depending on the trade arrangements.

2.9 The benefits of an efficient supply chain.

Cox (2004) notes that companies that are able to manage their long term business relationship by crafting mutually beneficial supply chains normally have high global volume, regular and standardized (predictable) demand and supply requirements and low switching costs. The primary objective of supply chain management is to fulfill customer demands through the most efficient use of resources, including distribution capacity, inventory and labour (Bradley, 2005). He further argues that by companies carefully selecting among all the options (rapid response, capacity adjustments, least cost approach and a combination of all these), a supply chain can be tailored to 'fit' the physical and market needs of the specific products it moves. Effective supply chain seeks to match supply with demand. Without any specific effort to coordinate the overall supply chain, each organization in the supply chain has its own agenda and operates independently from the others (functional silos), such an unmanaged network results in inefficiencies (David, 2000). However Fisher (1997) says that supply chain cannot cope with everything and therefore companies need a framework for designing supply chains according to different product characteristics. A stable supply chain results in rational price fluctuations and revenues are predictable. Lean and agile supply chains result in responsive and cost effective supply chains.

In situations of supply disruptions ordering malpractices like cheating on capacity, strength on sales, tend to amplify up the supply chain. This snarl up of orders creates a backlog which further stresses the capacity of the supplier. Just as Thietart and Forgues (1995) suggest that the 'butterfly effect' (I.e. a small variation at one point may cause a large variation of the whole system) can exist in organizations, so too can small disruption be amplified by the irrational decision makers within a supply chain. Rong et al. (2009) therefore suggests that studying human behavior under situations of disruptions is important. The most manifest disruptive influence of reverse bullwhip effect is seen in sudden product price increments, soaring supply costs, and poor relationship between the supplier and the customer. Collin et al. (2009), say that the imperatives that currently guide the design of supply chain are primarily cost reduction and fast delivery, recipes rooted in the realm of operations management.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

Kothari (1990) defines research methodology as a way to systematically solve the research problem.

This chapter presents the research design and methodology to gather and analyze data for the proposed research project. It includes the population of study, the samples to be studied, the type of data to be collected, method of data collection and analysis.

3.2 The Research Design

The researcher used case study. In explaining what a case is, Yin (1984) notes that the term case refers to an event, an entity, an individual or even a unit of analysis. Case study is an empirical inquiry that investigates a contemporary phenomenon within its real life context using multiple sources of evidence. Anderson (1993) sees case study as being concerned with how and why things happen, allowing the investigation of contextual realities and the differences between what was planned and what actually occurred.

3.3 Population

Mugenda and Mugenda (2003), define population as a complete set of individuals, cases, or objects with some common observable characteristics. KPC has 7 depots across the country in Mombassa, Nairobi, Nakuru, Eldoret and Kisumu. The other two depots are designated for Jet A-1 fuel and are located next to Jomo Kenyatta International Airport in Nairobi and Moi International Airport at Mombassa. All these depots have similar policy practices, business regulations and procedures. The locations of these depots support the idea of Sharman (1984) that customers' orders are allocated to the product supply at the order penetration point.

3.4) Sampling and Sampling frame.

Kothari (1990) defines sampling frame as the source list from which samples are drawn. It contains the names of all the items of a universe. These depots are Mombassa, Nairobi, Nakuru, Kisumu, Eldoret, JKIA, MIA.

3.5) The sampling design

Purposive sampling was preferred and in this case five depots of Mombassa, Kisumu, Nakuru, Eldoret and jet depot in JKIA were chosen. The justification was to gather data about supply operations at the source and the middle of the supply chain. Patton (1990) argues that the purpose of purposive sampling is to choose a set of people or objects (artifacts) that may not be the most representative of the overall population but will be best prepared or most appropriate to provide the data needed for your study. The researcher interviewed KPC operations managers at Mombassa, JKIA, Kisumu and Eldoret depots.

3.6 Data collection

Primary data collection was done by the researcher using a structured questionnaire in order to get brief but objective data. The study required 5 questionnaires to be administered to the identified personnel. The questionnaires were sent at least two days to interviews scheduled date. The questionnaire included open and closed ended questions. The questionnaires were designed to capture both qualitative and quantitative characteristics of the KPC facilities.

3.7 Data Analysis

Data gathered was verified for accuracy, consistency and completeness. Data collected was coded and analyzed using the statistical analysis tool known as Statistical Programme for Social Scientists (SPSS). Using this method, frequencies of responses from respondents were analyzed and interpreted to give the results of the study. The nature and csauses of deviation between the expected and the actual performance at KPC depots was also computed and tabulated.

CHAPTER FOUR: DATA ANALYSIS, PRESENTATION AND DISCUSSION

4.1Introduction

This chapter presents the analysis of data gathered. Five questionnaires were sent out to the operations managers in Eldoret, Kisumu, Nakuru, JKIA and Mombassa. All the questionnaires were received back from the intended respondents indicating a response rate of 100%.

4.2 The causes of reversed bullwhip effect on supply chain of KPC

4.2.1 Capacity

The study sought to find out the factors causing reversed bullwhip effect on the supply chain of KPC. The main cause identified was capacity challenges of KPC and the effect government involvement through KRA. Capacity was studied at two levels storage facilities vis a vis utilization facilities. Storage capacity was a major challenge at the downstream level due to inadequate pipelines supplying the upstream storage facilities. All the five respondents acknowledged that line extension would reduce the capacity challenges. The combined storage down stream was 703,533 metric tones against the upstream utilization of the seven depots of 323,293 metric tones, this represented only 45.97%. This implied that whereas the down stream storage always had product, the flow of this product to end sale points was less than half often causing supply variation at the upstream end sale points.

There are three lines 1, 2 and 3 with a pumping capacity of 880m3, 220m3 and 140m3 per hour respectively. On overage the pumping rate is 500m3/hr with a maximum pumpable volume of 12000m3/hr. It takes an average of 3 days to pump product to Nairobi, Kisumu and Eldoret while the lead time of servicing customer orders received by KPC is 2 days. This implies that addressing reversed bullwhip effect immediately after a stock out would require a lead time of 5 days assuming no further disruptive influences of equipment failure. The longer the lead time of delivery, the more likely disruptive influence of supply disruption. Another capacity challenge analysis was done between the upstream storage and upstream utilization. This was meant to assess the loading ability at the respective depots if the storage tanks are full. The storage was compared with the average daily throughput of the corresponding gantries. Standard deviation was calculated for the difference. The standard deviation is very wide as shown in the table below.

Upstream Storage	Capacity in m3	Loading gantry daily through put in m3	Difference
Mombassa	99109	3.7	99105.3
JKIA	100580	5	100575
Nakuru	30553	2.5	30550.5
Kisumu	45068	3	45065
Eldoret	47766	3	47763
Mean	64615.2	3.44	64611.76
Standard deviation	32823.4	0.97	32822.6

This shows that the loading gantries have no sufficient capacity to push out the entire product at the end sale point (upstream storage) were the tanks to be always full. While the respondents agreed that additional gantries may not be the solution, they indicated that the current ones need speed adjustment to improve on the throughput. These variations show that supply chain is a flow concept and any impediment to this flow at whatever level affects its availability in place, time and quantity. The last capacity comparison was done for the annual orders compared to the annual loadings for all the loadings in the selected depots. This is shown in the table below.

DEPOT	ANNUAL ORDERS (M3)	ANNUAL LOADINGS (M3)	UNMET ORDERS (M3)	% UN MET ORDERS m3
Mombassa	923467	734,567.00	188,900.00	20.46
JKIA	1123789	898,890.00	224,899.00	20.01
Nakuru	699898	497,456.00	202,442.00	28.92
Eldoret	789768	567,305.00	222,463.00	28.17
Kisumu	901567	663,504.00	238,063.00	26.41
TOTAL	4438489	3,361,722.00	1,076,767.00	24.26
MEAN	887697.8	672344.4	215,353.40	24.794
STD DEV	159741.87	155637.35	19518.44	4.26330036

In efficient conditions the service rate of orders is supposed to be 100% so that there are no unmet orders in order to exceed the expectations of customers. As confirmed by the results the performance of the facility as measured by order processing is an average of 75%. This translates into lost sales of 25%. Given that new orders enter into the system on a daily basis, the annual cumulative lost sales in unmet orders is substantial.

4.2.2 Information

The study sought to find out whether extent of information flow is a factor causing the reversed bullwhip effect in the supply chain of KPC. The communication gadgets used included two way radio calls and IP Phones. For external customers email and mobile phone usage were the means of relaying information with occasional letter writing to customers. The letters took less than one hour to deliver. The company also uses the German ERP soft ware of SAP which is real time to access customer trading accounts to monitor the transactions. Of the 5 depots 3 indicated having monthly operational meetings with customers for briefings on operational issues, the other two depots indicated meetings are not diarized but held as and when need arises since email and notice boards relayed the operational issues to the customers most of whom are housed within the premises of KPC. The results showed that oil marketers the KPC customers do not share sales data with their supplier the KPC. KPC therefore relied on scheduling instruction from their customers. All the respondents indicated that there are no delays in receiving scheduling instruction. All the respondents indicated that no complaints had been received from customers because of non communication. Information was therefore not a major factor causing the reversed bullwhip effect in the supply chain of KPC.

4.2.3 Supply chain structure

Supply chain structure was also studied at two levels; at the down stream and at the upstream. At the down stream storage tanks are located in Kipevu, Refinery and Moi International airport. The structure here is conceived of as the tanking, pipeline network and buster pumps located at strategic points along the pipeline. These booster pumps are located at Mombassa, Samburu, Maungu, Mtito Andei, Makindu, Konza and Nairobi. All the respondents indicated that the location of these boosters is convenient based on the distance to which the product is to be pumped. However all the respondents indicated that there is need for additional pipelines to further improve efficiency of the pipeline.

The second level of study was at the upstream where the order processing was considered. The study sought to know how the orders move within the chain, how the loading vessels (trucks, trains) move within the loading gantries. The results showed that there is a standard procedure of order movements. It was discovered that orders from the customers are received by the pipeline coordinator; Pipecor, then introduced into KPC system by Pipecor. Orders are then received into KPC system at fuel fax where fan tickets are generated against the products on order, verification of order capture is done before the order is forwarded to the loading gantry and assigned truck called in. Reverse logistics at this level was complex as the customer cannot access his/her purchase order except through pipecor. Timely error correction therefore depended on the speed of the coordinator, Pipecor. For truck movements it was discovered that each gantry has three product islands with varying numbers of loading arms. There are isolated islands for special loadings for trucks with foot valves. This structure poses no challenges on the supply chain, however the requirement that all orders are booked at Kenya Revenue Authority(KRA) before queuing at KPC and clearance at KRA after loading at KPC has brought in inefficiency in the supply chain.

4.2.4 Other factors

Using the likert scale the respondents were required to indicate their level of agreement or disagreement with factors shown overleaf. The likert scale was only to capture qualitative data. The responses indicated varied opinions on the factors causing reversed bullwhip effect on the supply chain of KPC.

FACTORS	Mean	STD DEVIATION
Regulatory bodies like KRA delay order processing at KPC	1	0
If daily loading time can be extended, KPC can have zero un met orders	0.8	0.45
KPC loading facilities are fully utilized	0.4	0.55
Adding other loading arms/gantries will increase capacity	0.4	0.55
Compliance bodies like SGS, Pump Inspection services delay order processing at KPC	0.2	0.45
There is space for extension of loading arms/gantries	0.2	0.45
Business procedures of customers delay order processing at KPC	0.2	0.45
Government safety policy on KPC delays order processing time	0.2	0.45

From the table above table it is evident that regulatory bodies like KRA delay order processing. All the respondents agreed that KRA's presence in the system contributed to delays of order processing. The presence of KRA was perceived of as another time consuming process further delaying product movement along the supply chain. The respondents agreed that if loading time can be extended then the unmet orders can be reduced significantly. Equally all the respondents agreed that as at now additional gantries would not improve significantly the capacity challenges. Three of the respondents agreed that as at now KPC upstream storage facilities are not fully utilized. However business procedures of customers, the government policy on safety and the presence of compliance bodies had very little effect on supply variation.

CHAPTER FIVE: SUMMARY OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of findings

The objective of the study was to find out the underlying causes of reversed bullwhip effect on the supply chain of KPC. The study was to find out the extent of capacity utilization and its impact on the supply chain of KPC, to find out the supply chain structures of KPC, to find out the extent of business information flow between the members of the supply chain and the effect of government policies and company business procedures on the supply chain of KPC.. A case study was used and data gathered through semi structured questionnaire conducted through interviews. The respondents were KPC depot operations managers at the depots in Mombassa, JKIA, Nakuru,Kisumu and Eldoret. Data analysis was done using the Statistical Package for Social scientists, SPSS.

The findings show that lack of pipeline capacity is the major cause of supply variation in the supply chain of KPC. Respondents indicated that the presence of KRA within the supply chain particularly at the order processing level greatly contributed to the delay of order processing thereby causing supply variation. It was also found out that capacity enhancement was necessary at the down stream supply facilities. The research findings also indicated that if the daily loading time can be extended, the daily unmet orders can be reduced and therefore supply variation controlled.

The research found out that the supply chain structure of KPC has two levels, the down stream supply chain structure and the upstream supply structure. The upstream supply chain structure was complex and agile but could allow order loss for products requiring test certification like exports Jet. While the downstream supply chain structure was lean. However the respondents said that the supply chain structure was not a major cause of supply variability.

The research found out that business procedures of customers, government safety requirements, the presence of quality compliance bodies and extent of business information flow among the supply chain elements had no significant effect on the supply chain of KPC.

5.2 Conclusions

From the research findings it can be concluded that capacity constraints at KPC is the main cause of supply variability in the supply chain of KPC. Increasing pipeline network and extending loading time will reduce supply variability. While available literature indicate that information sharing among the supply chain elements, business procedures of customers and the supply chain structure of the supplier cause supply variation, in this research it was discovered that these have very little or no significant effect on the supply chain.

5.3 Recommendations

With the ever growing demand for its services alternative storage facilities strategically placed and enhanced pipeline network need to be a priority investment for KPC. While pipeline transport is relatively safer compared to other modes of transport like road transport, the lead time for product delivery to the furthest end sale point is considerably longer. KPC needs to explore other faster and economical means of delivering this product in record time. Equally the government needs to minimize its intervention in the supply chain of KPC to ensure no delays of deliveries to customers. An efficient supply chain ensures just in time supplies and this ensures seamless operations.

5.4 Areas for Further Research

The study considered reversed bullwhip effect on the supply chain without value addition along the chain. In order to further understand the reversed bullwhip effect the study recommends future research on reversed bullwhip effect as a result of value chain. In the Kenyan context this could include refining and storage allocation for imported product. Reverse logistics is a normal supply chain problem, further research is needed to understand the extent to which reverse logistics cause reversed bullwhip effect.

References

Alderson, W. (1950), *Marketing efficiency and the principle of postponement, cost and profit outlook* vol.3 no.4. Homewood. IL: Richard D. Irwin.

Anderson, G.(1993). *Fundamentals of educational research*: London. Falmer publishers.

Bradley, H (2002). Logistics Information Management: A structure for supply chain information flows and its application to the Alaskan crude oil supply chain. *Logistics Information Management* 15*(1)*, 8-23
DOI:10.1108/0957559870556702.

Brau, J., Fawcett, S., Magnan,G., McCater, M., & Osterhaus, P. (2007). *Information sharing and supply chain performance: The role of connectivity and willingness.* Journal of supply chain management 12(5) 358-368
DOI: 10.1108/13598540710776935

Budiman, B. (2004).*Optimal capacity adjusted for supply chain control.* Un published doctoral dissertation, Massachusetts Institute of Technology, MIT
Retrieved from http://cell1.mit.edu/theses/budiman-phd-2004.pdf.

Bullow, J. & Shapiro, C. (2003) *Alaskan Crude oil: The British petroleum/ARCO merger.* The Antitrust Revolution: Economics, Competition and Policy pp 22.

Cachon, R.,Gerard, P., Martin, A. & Lariviere. (1999c). An equilibrium analysis of linear, proportional and uniform allocation of scarce capacity. *IIE Transactions* 31 835-849.

Cachon, R., Gerard, P. , Taylor, R. , Glen, M. & Schmidt. N. (2007). In search of the bullwhip effect. *Manufacturing & Service Operations Management* 9(4) 457-479.

Cavinato, J. L. (1992). A total value/ cost model for supply chain competitiveness. *Journal of Business Logistics.* 13(2) 285-301

Christopher, M & Towill, D. (2001). An integrated model for design of agile supply chains..*International Journal of Physical Distribution &Logistics Management.31 (4),* 235-46.

Collin, J,. Eloranta, E & Holmstrom, J. (2009). How to design the right supply chains for your customers: insight from industry. *Journal of supply chain management* 14(6) 411-417 DOI: 10.118/13598540910995174.

Cooper, D & Schindler, P. (2006) (Ed 10).*Business research methods*. Singapore: Mc Graw-Hill

Cox, A .(2004). The art of the possible: relationship management in power regimes and supply chains. *Journal of Supply chain management*. 9(5) 345-356.
DOI: 10.1108/13598540410560739.

Cox, A (1999). Supply chain management: Power value and supply chain management. *Journal of Supply Chain Management*. *4(4)*, 167-75. Retrieved from Emerald Group Publishing Limited.

Eric, White. (2003**).** Lean enterprise distribution tactics with customer supply chains integration. *Science Management and Mechanical Engineering*: MIT 1*(1)* 1-116.

David, T. (2000). Demand amplification: has it got us beat? *Journal of Supply chain management*. 30*(6),* 515-533.

Felix .S., Chan., K., Lee.,S, Luong, C & Wang, W .(2009). *Flexibility and adaptability in supply chains: a lesson learnt from a practitioner*. Journal of supply chain management, 14(6), 407-410
DOI: 10.1108/13598540910995165

Fernie, J. (1994). Quick response: an international perspective. *International Journal of Physical Distribution & Logistics Management 24(6)* 38-46

Fransoo, J, & Wouters, M (2000). Measuring the bullwhip effect in the supply chain. *Supply Chain Management 5(2)* 78-89. Retrieved from Emerald Group Publishing Limited.

Gardner, A. , Srinivas ,T & Kemal, C .(2004). Integrating demand and supply variability into safety stock evaluations. *International Journal of Physical Distribution & Logistics Management 34(1)* 62-69.
Doi: 10.1108/09600030410515682

Hau, L. (2004). Triple –A supply chain. *Supply chain Management*: Harvard Business Review, 1*(1)*, 1-10. Retrieved from **http://www.kpc.co.ke/inside.php?articleid**

Hubbard, G., Samuel, D., Heap, S. & Cocks, G. (2000). *The first xi: Winning organizations in Australia,* John Wiley & Sons, Brisbane.

Koch, G.(1993). Cheaters prosper. *Alberta Report Newsmagazine, 20(37)* 23-26,[Albeta, Georgia]

Kothari, C.R (Ed.). (1990). *Research Methodology: methods and techniques.* (2nd ed.) New Dehli, Wishwa, Prakashan.

Kumar, P. , Ogunlana, S. , & Sitichai, N .(2004). Risk based maintenance model for offshore oil and gas pipelines: a case study. *Journal of maintenance in quality engineering* 10(3) 169-183,
DOI: 10.1108/13552510410553226.

Kurt Salmon Associates (1993) *Efficient Consumer Response: Enhancing Consumer Value in the Grocery Industry*, Food Marketing Institute, Washington DC.

Lalonde, B (1985). Warehousing forum: Cost reduction in warehouse management. *Journal of Supply Chain Mangement.*1 (1), 1-6.

Lambert, D, M. & Cooper, M.C.(2000). Issues in supply chain management. *Industrial marketing management, 29(1)* 65-83.

Lee, H. 1997a. The bullwhip effect in supply chains. *Sloan Management Review 3(4)* 45-67.

Limerick, D., Cunnington, B & Crowther, F. (2000). Managing the new organization, 2nd ed, Business & Professional Publishing, Warriewood.

Lorenzoni, G. & Lipparini, A. (1999). The leveraging of inter-firm relationship as a distinctive organizational capability: a longitudinal study. *Strategic Management Journal, 20(4)* 317-338.

Lumus, R., Vokurka, R & Menzer, M.(2001).Strategic Supply Chain Planning. *Production and Inventory Management Journal. 39(3)* 49-58.

Mathias, H. (2005). The three dimensions of responsiveness. *Judge Institute of Management, University of Cambridge*, 25(7), 603-622
DOI: 101108/01443570510605063.

Maciej, H. (1996). Solid reasons for optimism. *World oil 217(8)* 37-45.

Mason-Jones, R. , Naylor, B. & Towill, D.(2000). Engineering the leagile supply chain. . *International journal of Agile Management Systems 2(1)* 54-61.

Mugenda, O. & Mugenda, A. (2003). *Research Methods, quantitative and qualitative approaches*. Nairobi: Acts Press.

Mingzhou, J., Wu, D., Katok, P. (1999). Modelling capacity reservation in high-tech manufacturing. Department of Industrial and Systems Engineering, Lehigh University, Bthlehem, PA

Patton, M. Q. (Ed). (1990). *Qualitative evaluation and research methods* (2nd Ed.). Newbury Park, CA: Sage Publications.

Rong, Y., Zuo-Jun, M. & Snydaer, L. (2008, 2009). The impact of ordering behaviour on order quantity variability: a study of forward and reverse bullwhip effects. *Department of Industrial Engineering and Operations Research, 20(1), 95-124*
DOI: 10.1007/S10696-009-9054-3

Senge, P.(1990). *The fifth discipline, the art and practice of the learning organization, D*ouble day, New York, NY

Sharman, G. (1984). The rediscovery of logistics, *Harvard Business Review* 1(1) 71-79.

Spekman, R., Spear, J & Kamauff, J.(2000). Supply chain competency: learning as a key component. *Supply chain management 7 (1)* 41-55.

Sterman, J. D .(1989). Modeling managerial behaviour: misperceptions of feedback in a dynamic decision making environment. *Management science* 35(3) 321-339.

Stern, L, W., El-Ansary, A, I & Coughlan, A, T. (1996). *Marketing Channels,* Prentice-Hall International, Upper Saddle River, NJ.

Sugimore, Y., Kusunoki, K., Cho, F. & Uchikawa, S. (1977). Toyota production system. *International Journal of Production Research*, 15(6) 553-564.

Sun., S & Yen. J (2005). Information supply chain: a unified framework for information sharing. PA, (1-7). Retrieved from http://agentlab.psu.edu/lab/publication/sun-pdf.

Svenson, G (2005). The multiple facets of the bullwhip: refined and re-defined. *International Journal of Physical Distribution & Logistics Management* 35(10) 762-777
DOI: 10.1108/09600030510634607

Svenson, G (2003). *The bullwhip effect in the intra-organisational echelons*. International Journal of Physical Distribution & Logistics Management 33(2) 103-131
DOI: 10.1108/09600030310469135.

Tang, H & Christopher.S (2006). Perspectives in supply chain risk management. *International journal of production Economics*. 103(2) 451-488. Retrieved from http://IJPE.sc.ups.ab.psu.edu/publication

Ting, C, Kilduff, P & Gargeya, V (2009). Alignment between business environment characteristics, competitive priorities, supply chain structures, and firm business performance. *International journal of productivity and performance measurement* 58(7) 645-669

DOI: 10.1108/17410400910989467

Tinina, R (Producer). (2008). Oil shortages in Kenya [Television series episode]. Prime news. Nairobi, Kenya: NTV.

Toyoda, E (1987) *Toyota*: *First fifty years in motion*, Kodansha International, Tokyo.

Yin, R., (1984).Case study research: design and methods. *American journal of applied sciences* 5(11), 1602-1604
DOI.10.1108/07984092340235434

Appendix 1

QUESTIONNAIRE

RESEARCH TITLE: THE FACTORS CAUSING REVERSED BULLWHIP EFFECT ON THE SUPPLY CHAINS: A CASE STUDY OF KENYA PIPELINE COMPANY.

Reversed bullwhip effect is the supply variation as one moves down the supply chain.

Please insert a tick (√) or fill in the appropriate response in the spaces provided.

Part one:

The views of KPC operations manager on the supply issues at KPC

i. Bio data

1) Your name……………………………………

2) Sex: Male □ Female □

3) Name of your organization (optional) ……………………

4) Position title……………………………………………………

5) How long have you worked at this depot? ....

ii. **Capacity of the supplier**

1. Kindly fill in the table below for tank capacities

MOMBASA STORAGE		UTILIZATION	
	TANKS VOLUME	DEPOT STORAGE	TANKS VOLUME
		MOMBASA	
		NAIROBI	
		NAKURU	
		KISUMU	
		ELDORET	
TOTAL		TOTAL	

2. Are there occasions where these facilities are idle because oil marketers have not imported fuel? Yes □ No □

3. If yes, how many incidences were recorded in the year?

2008?…………………

2009?...………………

4. What are the challenges associated with pumping the product to respective destinations?...

....

5. Kindly fill in the table below for the combined industry imports and sales for 2008 and 2009 for all the oil marketers.

Year	imports in metric tones	industry sales in metric tones	Variance
2008			
2009			

6. What caused the variances?..

7. On average what is the flow rate of products pumped from Mombassa?.......

8. What is the maximum pumpable volume?..........................

9. How long does it take to pump product from Mombassa to Nairobi..?.................Nakuru?………….Eldoret?…………Kisumu?……………

10. Kindly indicate the number of loading gantries and their combined through puts

Depot	no. of loading gantries	Combined throughput
Mombassa		
Nairobi		
Nakuru		
Kisumu		
Eldoret		

11. Is there enough space for adjustment of storage facilities in your depot?

Yes □ No □

12. What were the combined annual orders and loadings in volume for all the oil marketers?

Year	Selected Annual orders	Selected Annual loadings	variance	explanation of variance
2008				
2009				

13. Do you have reserve tanks/pumps, when are they used?.......................

14. How flexible are your loading operations?..

i)Time taken in switching to a different product………………

ii)Time taken in switching to a different tank………

iii) On average how long does it take to load a1000 liters truck?................

iv) Can the loading speed be adjusted for any product? Yes □ No □

15. Indicate whether you strongly agree, agree or strongly disagree or disagree with the following statements. Put a tick.

	Strongly Agree	Agree	Disagree	Strongly disagree
Compliance bodies like SGS, Pump Inspection services delay order processing at KPC				
There is space for extension of loading arms/gantries				
Regulatory bodies like KRA delay order processing at KPC				
Business procedures of customers delay order processing at KPC				
Government safety policy on KPC delays order processing time				
KPC loading facilities are fully utilized				
If daily loading time can be extended, KPC can have zero un met orders				
Adding other loading arms/gantries will increase capacity				

16. What improvements would you like to see in the operational activities to further facilitate operational efficiency?..

Information

1. What information technology does your company use to disseminate information to your customers?...

2. How fast is this technology? Less than 1 hr □. More than 1 hr □

3. Do your customers share with you their sales data to guide you on delivery organization? Yes □ No □

4. How frequent do you communicate with your customers on operational issues?..

Supply chain structure

1. Please briefly describe your supply chain structure (how do the orders move before final delivery)?..

2. What is the lead time between receipt of orders from customers and loading of the orders?..

3. Briefly describe the locations of loading gantries for products loading? ....

4. How convenient is the location of booster pumps based on the distance to which the product is to be pumped..

5. What guides your decision on product scheduling to respective depots country wide?..