KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

INSTITUTE OF DISTANCE LEARNING

USING REVENUE SHARING TO ACHIEVE SUPPLY CHAIN COORDINATION FOR ANGEL HERBAL MIXTURE: A PRODUCT OF ANGEL HERBAL INDUSTRY

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DECLARATION

I hereby declare that this submission is my own work towards Master of Science degree and that, to the best of my knowledge, it contains no material previously published by another nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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DEDICATION

This work is dedicated to my mother Mrs Jocelyn Hanna Kwadzokpo (late)

"A man loves his sweetheart the most, his wife the best, but his mother the longest." ~ Irish Proverb

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To God Almighty be all glory, praise and honour for His continuous protection and sustenance of my life. Never could I have come thus far without God's abundant grace and mercy.

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Finally to all those in diverse ways helped me I thank you all.

May God richly bless you

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ABSTRACT

Fierce competitions in today's global markets and the heightened expectations of consumers have forced business enterprises to invest in and focus attention on, the relationships with their customers and suppliers. While the need for increased efficiency in enterprise operations persists, modern management thinking advocates the collaboration among business partners and the responsiveness to client needs as additional thrusts towards a successful competitive strategy. It is within this context that Supply Chain Management (SCM) has become part of the senior management agenda since the 1990s, particularly in the manufacturing and retailing industries. For the improvement of the supply chain led to channel coordination which aims at improving supply chain performance by aligning the plans and the objectives of individual enterprises.

The objective of the thesis is to show conditions under which it is optimal for a vendor to only purchase the item (Angel Herbal Mixture) outright, or only obtain the item on consignment, or both and also show that a consignment scheme can be used to achieve channel coordination and present pricing formulas that a manufacturer can use to "force" the vendor to order, in total and in the best interest of the channel.

The supply chain channel coordination was achieved using models developed by developed by Lawrence, J. A. and Pasternack, B. A. (1998) to Angel Herbal Mixture, where we consider a single period inventory (newsboy) problem in which a Angel Herbal Industry will both sell Angel Herbal Mixture to a vendor outright as well as offer the item to a vendor on a revenue sharing (consignment) basis. In the latter case, the amount of money the vendor pays per unit is less than if the item is purchased by the vendor, but the vendor must share some of the revenue with the Angel Herbal Industry.

From the application of the model, revenue sharing is an intriguing method for a manufacturer to achieve channel coordination which shows both the retailer and the manufacturer gaining which brings about a win-win situation.

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CHAPTER ONE

1.0 Introduction

Fierce competitions in today's global markets and the heightened expectations of consumers have forced business enterprises to invest in and focus attention on, the relationships with their customers and suppliers. While the need for increased efficiency in enterprise operations persists, modern management thinking advocates the collaboration among business partners and the responsiveness to client needs as additional thrusts towards a successful competitive strategy. It is within this context that Supply Chain Management (SCM) has become part of the senior management agenda since the 1990s, particularly in the manufacturing and retailing industries.

1.0.1 Supply Chain

A supply chain is a global network of organizations that cooperate to improve the flows of material and information between suppliers and customers at the lowest cost and the highest speed. The objective of a supply chain is customer satisfaction. (Govil et al., 2002)

Long-term competitiveness therefore depends on how well the company meets customers [references in term of service, cost, quality and flexibility, by designing the supply chain, which will be more effective and efficient than the competitors'. Optimization of this equilibrium is a constant challenge for the companies, which are part of the supply chain network, shown in Figure 3.1.

To be able to optimize this equilibrium, many strategic decisions must be taken and many activities considered. This requires careful management and design of the supply chain. The design of supply chain represents a distinct means by which companies innovate, differentiate, and create value. The challenge of supply chain design and management is in the capacity to design and assemble assets, organizations, skills, and competences. It encompasses the team, partners, products, and processes.

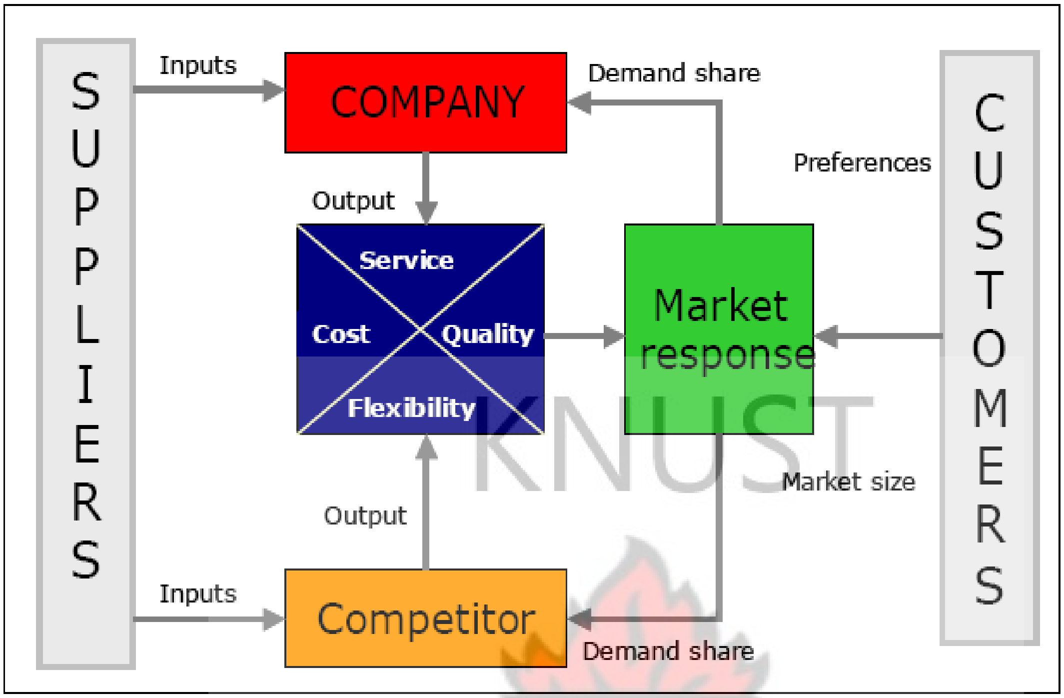

Figure 3.1 Competitive Framework in the Supply Chain (Ernst, 2002).

Businesses depend on their supply chains to provide them with what they need to survive and thrive. Every business fits into one or more supply chains and has a role to play in each of them.

The pace of change and the uncertainty about how markets will evolve has made it increasingly important for companies to be aware of the supply chains they participate in and to understand the roles that they play. Those companies that learn how to build and participate in strong supply chains will have a substantial competitive advantage in their markets (Hugos, 2003).

A supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves as well as it is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers (Ganeshan et al., 1995).

1.0.2 Supply Chain Management (SCM)

Although industry and academia have investigated the concept of SCM for the last decade, there is still no consistence of the concept. As a result, there is generally a lack of consistency in the meaning and clarity across the diverse definitions of supply chain management available in the literature.

Supply Chain Management is the integrated planning, co-ordination and control of all logistical business processes and activities in the SC to deliver superior consumer value at less cost to the SC as a whole whilst satisfying the requirements of other stakeholders in the SC. The development and integration of people and technological resources are critical to successful supply chain integration (Vorst, 2000).

Supply chain management is the integration and management of supply chain organization and activities through cooperative organizational relationships effective business processes, and a high level of information sharing to create high performing value systems that provide member organizations sustainable competitive advantage (Handfield, 2002).

Supply chain management is the coordination of production, inventory, location, and transportation among the participants in a supply chain to achieve the best mix of responsiveness and efficiency for the market being served (Hugos, 2003).

There is a basic pattern to the practice of supply chain management. Each supply chain has its own unique set of market demands and operating challenges and yet the issues remain essentially the same in every case. Companies in any supply chain must make decisions individually and collectively regarding their actions in five areas:

1.0.3 Production

Production refers to the capacity of a supply chain to make and store products. The facilities of production are factories and warehouses. The fundamental decision that managers face when making production decisions is how to resolve the trade-off between responsiveness and efficiency. If factories and warehouses are built with a lot of excess capacity, they can be very flexible and respond quickly to wide swings in product demand. Facilities where all or almost all capacity is being used are not capable of responding easily to fluctuations in demand. On the other hand, capacity costs money and excess capacity is idle capacity not in use and not generating revenue. So the more excess capacity that exists, the less efficient the operation becomes.

Factories can be built to accommodate one of two approaches to manufacturing:

Product focus— A factory that takes a product focus performs the range of different operations required to make a given product line from fabrication of different product parts to assembly of these parts.

Functional focus — A functional approach concentrates on performing just a few operations such as only making a select group of parts or only doing assembly. These functions can be applied to making many different kinds of products.

A product approach tends to result in developing expertise about a given set of products at the expense of expertise about any particular function. A functional approach results in expertise about particular functions instead of expertise in a given product. Companies need to decide which approach or what mix of these two approaches will give them the capability and expertise they need to best respond to customer demands.

As with factories, warehouses too can be built to accommodate different approaches. There are three main approaches to use in warehousing:

Stock keeping unit (SKU) storage—In this traditional approach, all of a given type of product is stored together. This is an efficient and easy to understand way to store products.

Job lot storage—In this approach, all the different products related to the needs of a certain type of customer or related to the needs of a particular job are stored together. This allows for an efficient picking and packing operation but usually requires more storage space than the traditional SKU storage approach.

Crossdocking—An approach that was pioneered by Wal-Mart in its drive to increase efficiencies in its supply chain. In this approach, product is not actually warehoused in the facility. Instead the facility is used to house a process where trucks from suppliers arrive and unload large quantities of different products. These large lots are then broken down into smaller lots. Smaller lots of different products are recombined according to the needs of the day and quickly loaded onto outbound trucks that deliver the products to their final destination.

1.0.4 Inventory

Inventory is spread throughout the supply chain and includes everything from raw material to work in process to finished goods that are held by the manufacturers, distributors, and retailers in a supply chain.

Again, managers must decide where they want to position themselves in the trade-off between responsiveness and efficiency. Holding large amounts of inventory allows a company or an entire supply chain to be very responsive to fluctuations in customer demand. However, the creation and storage of inventory is a cost and to achieve high levels of efficiency, the cost of inventory should be kept as low as possible.

There are three basic decisions to make regarding the creation and holding of inventory:

Cycle Inventory—This is the amount of inventory needed to satisfy demand for the product in the period between purchases of the product. Companies tend to produce and to purchase in large lots in order to gain the advantages that economies of scale can bring. However, with large lots also come increased carrying costs. Carrying costs come from the cost to store, handle, and insure the inventory. Managers face the trade-off between the reduced cost of ordering and better prices offered by purchasing product in large lots and the increased carrying cost of the cycle inventory that comes with purchasing in large lots.

Safety Inventory — Inventory that is held as a buffer against uncertainty. If demand forecasting could be done with perfect accuracy, then the only inventory that would be needed would be cycle inventory. But since every forecast has some degree of uncertainty in it, we cover that uncertainty to a greater or lesser degree by holding additional inventory in case demand is suddenly greater than anticipated. The trade-off here is to weigh the costs of carrying extra inventory against the costs of losing sales due to insufficient inventory.

Seasonal Inventory—This is inventory that is built up in anticipation of predictable increases in demand that occur at certain times of the year. For example, it is predictable that demand for anti-freeze will increase in the winter. If a company that makes anti-freeze has a fixed production rate that is expensive to change, then it will try to manufacture product at a steady rate all year long and build up inventory during periods of low demand to cover for periods of high demand that will exceed its production rate. The alternative to building up seasonal inventory is to invest in flexible manufacturing facilities that can quickly change their rate of production of different products to respond to increases in demand. In this case, the trade-off is between the cost of carrying seasonal inventory and the cost of having more flexible production capabilities.

1.0.5 Location

Location refers to the geographical siting of supply chain facilities. It also includes the decisions related to which activities should be performed in each facility. The responsiveness versus efficiency trade-off here is the decision whether to centralize activities in fewer locations to gain economies of scale and efficiency, or to decentralize activities in many locations close to customers and suppliers in order for operations to be more responsive.

When making location decisions, managers need to consider a range of factors that relate to a given location including the cost of facilities, the cost of labor, skills available in the workforce, infrastructure conditions, taxes and tariffs, and proximity to suppliers and customers. Location decisions tend to be very strategic decisions because they commit large amounts of money to long-term plans.

Location decisions have strong impacts on the cost and performance characteristics of a supply chain. Once the size, number, and location of facilities is determined, that also defines the number of possible paths through which products can flow on the way to the final customer. Location decisions reflect a company's basic strategy for building and delivering its products to market.

1.0.6 Transportation

This refers to the movement of everything from raw material to finished goods between different facilities in a supply chain. In transportation the trade-off between responsiveness and efficiency is manifested in the choice of transport mode. Fast modes of transport such as airplanes are very responsive but also more costly. Slower modes such as ship and rail are very cost efficient but not as responsive. Since transportation costs can be as much as a third of the operating cost of a supply chain, decisions made here are very important.

There are six basic modes of transport that a company can choose from:

Ship: This is very cost efficient but also the slowest mode of transport. It is limited to use between locations that are situated next to navigable waterways and facilities such as harbors and canals.

Rail: This is also very cost efficient but can be slow. This mode is also restricted to use between locations that are served by rail lines.

Pipelines: Can be very efficient but are restricted to commodities that are liquids or gases such as water, oil, and natural gas.

Trucks: Is a relatively quick and very flexible mode of transport. Trucks can go almost anywhere. The cost of this mode is prone to fluctuations though, as the cost of fuel fluctuates and the condition of roads varies.

Airplanes: Is a very fast mode of transport and are very responsive. This is also the most expensive mode and it is somewhat limited by the availability of appropriate airport facilities.

Electronic Transport: is the fastest mode of transport and it is very flexible and cost efficient. However, it can only be used for movement of certain types of products such as electric energy, data, and products composed of data such as music, pictures, and text.

Someday technology that allows us to convert matter to energy and back to matter again may completely rewrite the theory and practice of supply chain management.

Given these different modes of transportation and the location of the facilities in a supply chain, managers need to design routes and networks for moving products. A route is the path through which products move and networks are composed of the collection of the paths and facilities connected by those paths. As a general rule, the higher the value of a product (such as electronic components or pharmaceuticals), the more its transport network should emphasize responsiveness and the lower the value of a product (such as bulk commodities like grain or lumber), the more its network should emphasize efficiency.

1.0.7 Information

Information is the basis upon which to make decisions regarding the other four supply chain drivers. It is the connection between all of the activities and operations in a supply chain. To the extent that this connection is a strong one, (i.e., the data is accurate, timely, and complete), the companies in a supply chain will each be able to make good decisions for their own operations. This will also tend to maximize the profitability of the supply chain as a whole. That is the ways that stock markets or other free markets work and supply chains have many of the same dynamics as markets.

Information is used for two purposes in any supply chain:

Coordinating daily activities related to the functioning of the other four supply chain drivers: production; inventory; location; and transportation. The companies in a supply chain use available data on product supply and demand to decide on weekly production schedules, inventory levels, transportation routes, and stocking locations.

Forecasting and planning to anticipate and meet future demands. Available information is used to make tactical forecasts to guide the setting of monthly and quarterly production schedules and timetables. Information is also used for strategic forecasts to guide decisions about whether to build new facilities, enter a new market, or exit an existing market.

Within an individual company the trade-off between responsiveness and efficiency involves weighing the benefits that good information can provide against the cost of acquiring that information. Abundant, accurate information can enable very efficient operating decisions and better forecasts but the cost of building and installing systems to deliver this information can be very high.

Within the supply chain as a whole, the responsiveness versus efficiency trade-off that companies make is one of deciding how much information to share with the other companies and how much information to keep private. The more information about product supply, customer demand, market forecasts, and production schedules that companies share with each other, the more responsive everyone can be. Balancing this openness however, are the concerns that each company has about revealing information that could be used against it by a competitor. The potential costs associated with increased competition can hurt the profitability of a company.

The sum of these decisions will define the capabilities and effectiveness of a company's supply chain. The things a company can do and the ways that it can compete in its markets are all very much dependent on the effectiveness of its supply chain. If a company's strategy is to serve a mass market and compete on the basis of price, it had better have a supply chain that is optimized for low cost. If a company's strategy is to serve a market segment and compete on the basis of customer service and convenience, it had better have a supply chain optimized for responsiveness. Who a company is and what it can do is shaped by its supply chain and by the markets it serves.

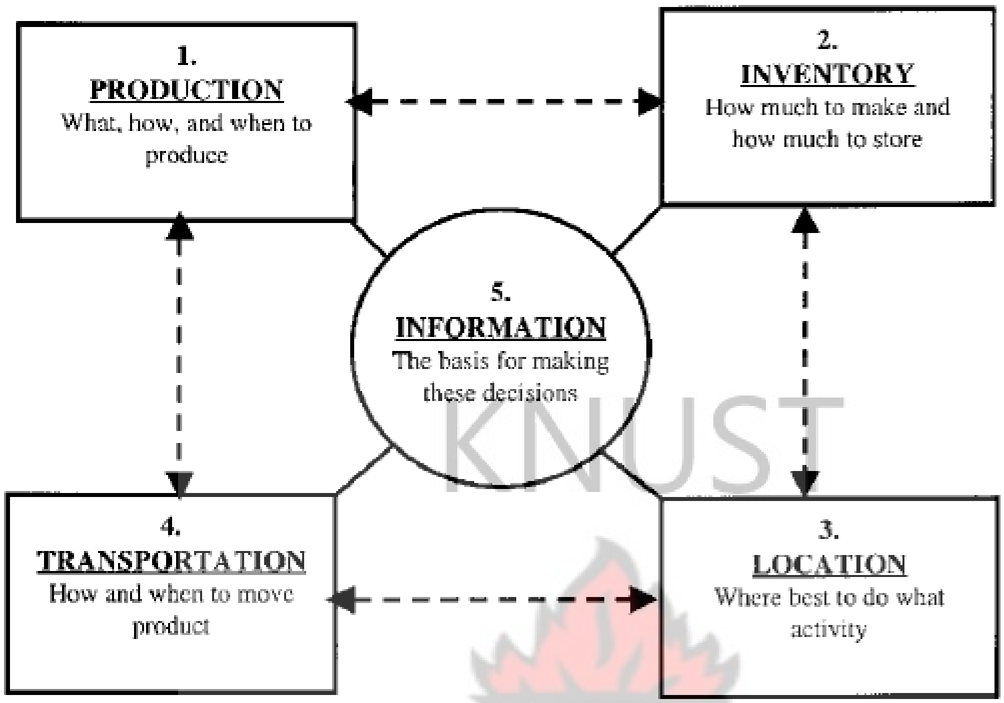

Figure 3.2 Major Supply Chain Drivers (Hugos, 2003).

1.1 Scope

We investigate the situation in which a vendor, in a newsboy-type situation, has the option of purchasing the item outright and/or obtaining the item through a revenue sharing agreement with the manufacturer. Of specific interest is whether revenue sharing can be used to achieve channel coordination.

The focus of this work is on the vendor's optimal procurement strategy and on the manufacturer's pricing strategy for offering items on consignment in order to achieve channel coordination. We allow the vendor to obtain the item through two different costing schemes. In particular, we assume that the manufacturer has been selling the item to the vendor on a conventional basis and now wishes to also offer the good to the vendor on a revenue sharing (consignment) basis. Hence, the vendor will have the choice of purchasing the item outright, obtaining the item on consignment, or doing a combination of both. As with much of the literature on channel coordination, we will assume that the manufacturer behaves like a Stackelberg leader and that the vendor acts to maximize its expected profits. Our analysis will examine the vendor’s procurement strategy and how a consignment scheme can achieve channel coordination.

In the thesis, theoretical framework is used to evaluate the channel coordination between Angel Herbal Industry and its vendors. Angel Herbal Industry is a wholly owned Ghanaian Limited Liability Company and a subsidiary of Angel Group of Companies. It was set up by the Group as a means to diversify into the production of Angel Cream and Angel Soap. Thus through thorough research, Angel Natural Capsules and Angel Herbal Mixture were introduced into the market with the testing and approval by the Mampong Akuapem Centre for Scientific Research into Plant Medicine and the Ghana Food and Drugs Board. As a result of the efficacy of the products, the patronage was high all over the country as well as across Africa, the United States and Europe. The industry has an annual turnover of little over $224,000,000 and has a work force of about two hundred and thirty people, comprising of fifty-eight females and one hundred and seventy-two males.

The factory sources its herbal products materials from various sources viz: local and foreign. Among the four products produced, the cream requires a major raw material which is the petroleum jelly which is imported from India and Korea. The capsule also requires gelatine which is also imported from the United Kingdom. Apart from the materials mentioned above the remaining one are acquired locally which are Shea butter, wood barks, leaves, and other additives.

The factory has a storage facility of about $326x364$ square meters which houses the finished products and the raw materials. The distributions of the finished products are mainly on demand. But there are other means of distribution which is done through over two hundred outlets across the country and outside as well. The company has mapped out some strategies in the marketing of the products through so many interesting ways and notable among the marketing strategies is the use of mini-vans. The vans run across the country to take care of the distribution aspect as well as direct sales to retailers and consumers. Just recently it did rebranding of its products thus making the packaging attractive. It occasionally does promotional sales and also did some radio promotional programs where loyal customers are awarded attractive prizes. The rebranding was done to add value and meet the emerging competition in the market.

Supplier will send the materials ordered by the purchaser according to the delivery date given. In this process, communications between customers and suppliers will become very important because all the ordered items must be received at right time and in the right quantity.

1.2 Problem Statement

Channel coordination is desirable to a manufacturer since if total channel profits are maximized while the retailer's expected profit remains constant, the manufacturers expected profit will be maximized. Most production units in Ghana do at a point in time over produce or under produce due to lack of channel coordination. It is thus imperative to investigate how a revenue sharing scheme can be used to achieve channel coordination.

1.2 Objectives

The aim of this study is to:

(i.) Show conditions under which it is optimal for a vendor to only purchase the item (Angel Herbal Mixture) outright, or only obtain the item on consignment, or both.

(ii) Show that a consignment scheme can be used to achieve channel coordination and present pricing formulas that a manufacturer can use to "force" the vendor to order, in total, what is in the best interests of the channel.

1.3 Justification

The success of an enterprise is measured not only by the size of an organization, but in its ability to quickly respond to market changes with more efficient methods of production, improved levels of customer service and ability in harnessing its supply chain more efficiently to respond to its customer when they demand it.

1.4 Methodology

Data was collected from Angel Herbal Industry and analyzed using our model.

1.6 Organization of the Thesis

The thesis is made up of three main five main chapters. Chapter One is the introduction. This chapter introduces the project and discusses the problems to be solved in detail. The purpose of the chapter is to provide a deeper understanding of the project objectives, justification as well as problem statement.

Chapter Two provides intensive work that people have done in the field of Supply Chain Management, Channel Coordination, Newsvendor Model and its various applications. Chapter Three discusses the research environment of Supply Chain Coordination, Newsboy problem and Supply Chain Management.

In Chapter Four we talk about data collection and analysis and in Chapter Five we conclude and give recommendation.

1.7 Summary

This chapter introduces the project and discusses the problems to be solved in detail. The purpose of the chapter is to provide a deeper understanding of the project objectives and scope. The next chapter we shall put forward literature review of newsboy model, channel coordination in supply chain.

CHAPTER TWO

2.0 Literature Review

Researchers have already researched extensively into various aspects of channel coordination in supply chain management. We take a look at some of their work relevant to this work.

Choi et al., (2004) analyzed the impact of channel coordination on supply chain profitability for a single-product supply process involving a supplier, a buyer and a transporter with concave transportation cost functions. The buyer purchases the product from the supplier and then sells in the market. The market demand was assumed to be sensitive to the buyer's selling price and the supplier's (or manufacturer's) product quality. They establish the dominance relationship between the profitability achieved by a totally centralized coordination and the sum of individual partner's maximum profitability in a decentralized business environment. The effect of transporter's coordination is analyzed. Policies to jointly optimize the buyer's market selling price, the supplier's quality level, and the shipping quantities handled by the transporter are proposed. Empirical observations that show the improvement on supply chain profitability by using the optimal policies assuming a market demand function that is decreasingly convex to the buyer's (retailer's) selling price and increasingly linear to the supplier's (manufacturer's) product quality are reported.

Evren et al., (2008) studied the newsboy duopoly problem under asymmetric cost information. We extend the Lippman and McCardle (1997) model of competitive newsboys to allow for private cost information. The market demand is initially split between two firms and the excess demand for each firm is reallocated to the rival firm. They showed the existence and uniqueness of pure strategy equilibrium and characterize its structure. The equilibrium conditions have an interesting recursive structure that enables an easy computation of the equilibrium order quantities. Presence of strategic interactions creates incentives to increase order quantities for all firm types except the type that has the highest possible unit cost, who orders the same quantity as he would as a monopolist newsboy. Consequently, competition leads to higher total inventory in the industry. A firm's equilibrium order quantity increases with a stochastic increase in the total industry demand or with an increase in his initial allocation of the total industry demand. Finally, They provided full characterization of the equilibrium, corresponding payoffs and comparative statics, for a parametric special case with uniform demand and linear market shares.

Linh and Hong (2008), stated that, channel coordination through revenue sharing contract between a single retailer and a single wholesaler in a two-period newsboy problem. Two models were discussed, a single-buying-opportunity model and a two-buying-opportunity model. They discussed how the revenue sharing ratio and the wholesale prices are to be determined in order to achieve channel coordination and a win-win outcome. They found out that the wholesale prices are set to be lower than the retail prices and the optimal revenue sharing ratio is linearly increasing in the wholesale prices. The proposed revenue sharing contract has more flexibility than price protection, in that the optimal revenue sharing ratio can be settled reasonably through negotiation between the retailer and wholesaler.

Wei and Chen (2007), stated that supply chain management (SCM) is seen as a set of practices aimed at managing and coordinating the whole supply chain from raw material suppliers to end customers and develops greater synergy through collaboration along the whole channel. Traditionally, a newsboy model can be employed in a single period and single product ordering model of a retailer. In their paper, they extended the classical newsboy model to solve a multiple period ordering policy between a manufacturer and a retailer. They considered a single product which is subject to uncertain demand which is a function of price. The proposed model can determine the quantity of the retailer ordering from the manufacturer by considering maximizing the profit of the channel. A numerical study is conducted to attend qualitative insights into the structures of the proposed policy. The numerical results show that the solutions generated by the proposed policy outperform that by the independent policy or fix ordering quantity policy in the profits of the retailer and overall channel.

Dekker et al., (1997), analyzed the effect of a cutoff transaction size in a simple newsboy setting. It is assumed that customers with an order larger than a pre-specified size are satisfied in an alternative way, against additional cost. For compound Poisson demand with discrete order sizes, we show how to determine the average cost and an optimal cutoff transaction size. Because the computational effort to calculate the exact cost is quite large, they also considered an approximate model. By approximating the distribution of the total demand during a period by the normal distribution one can determine an expression for the average cost function that depends on the cutoff transaction size only. A main advantage of this approximation is that they could solve problems of any size. The quality of using the normal approximation is evaluated through a number of numerical experiments, which show that the approximate results are satisfactory.

Barry Pasternack (2005), stated that considering a single period inventory (newsboy) problem in which a manufacturer will both sell the item to the vendor outright as well as offer the item to the vendor on a revenue sharing (consignment) basis. In the latter case, the amount of money the vendor pays per unit is less than if the item is purchased by the vendor, but the vendor must share some of the revenue with the manufacturer. The purpose of the analysis is to investigate the effect of such a strategy on the vendor's purchasing decision and demonstrate how such a revenue sharing scheme can be used to achieve channel coordination.

Coordination between supply chain partners is critical to effective supply chain management. In this paper, we consider two cases of decision-making structure for a simple supply chain consisting of two players: the first case in which a supply chain partner dominates the decision-making process, and the other in which two players share the decision-making process equally. According to the literature, we know *a priori* that the balanced decision making forges a better (financial) outcome than the dominating case does. Therefore, our primary research objective is to analyze detailed dynamics of resource allocation and sources of the benefit of the balanced decision making. Our analysis indicates that the value of the balanced decision making arises from more effective resource utilization than the dominating case does: each of the cooperative partners knows how to optimize its resource utilization better than the other does

Fitzgerald et al., (2007) stated that in a competitive business environment that requires strategy and innovation to improve the bottom line, supply chain management has been vital in creating competitive advantage. Increasingly, companies are also identifying sustainability as an opportunity to create competitive advantage. They explore supply chain as a leverage point in advancing sustainable development. Corporations have developed different tools to interact with their suppliers on sustainability. Three of these devices were analyzed against a framework for strategic sustainable development to identify some of their strengths and weaknesses. A general set of criteria for sustainable supply chain management devices that employs a strategic, whole-systems perspective was then developed.

Markarand and Syal (2003) proposed that manufactured housing industry represents approximately 20 percent of the total housing market share. However, in the past years, the manufactured housing industry has faced many different types of problems including industry specific financial aspects to national economic recession. In order to overcome this situation, advanced technologies for building process optimization should be investigated and applied in this industry. Thus, they summarizes the current state of the art in the manufactured housing industry, describes major industry challenges and opportunities, and suggests future research direction that will contribute to increase the value and performance of manufactured housing. They focused on three sub-areas: building process optimization, whole house redesign, and supply chain management for the manufactured housing industry which facilitates the industrialized housing construction process.

Meixall and Gargeya (2005) reviewed decision support models for the design of global supply chains, and assess the fit between the research literature in this area and the practical issues of global supply chain design. The classification scheme for this review was based on ongoing and emerging issues in global supply chain management and includes review dimensions for (1) decisions addressed in the model, (2) performance metrics, (3) the degree to which the model supports integrated decision processes, and (4) globalization considerations. They conclude that although most models resolve a difficult feature associated with globalization, few models address the practical global supply chain design problem in its entirety. We close the paper with recommendations for future research in global supply chain modeling that is both forward-looking and practically oriented.

Guiffrida and Nagi (2004) addressed strategies for improving delivery performance in a serial supply chain when delivery performance was evaluated with respect to a delivery window.

Contemporary management theories advocate the reduction of variance as a key step in improving the overall performance of a system. Models were developed that incorporate the variability found in the individual stages of the supply chain into a financial measure that serves as a benchmark for justifying the capital investment required to improve delivery performance within the supply chain to meet a targeted goal.

Vrijhoef ans Koskela (1999) addressed Supply chain management (SCM) as a concept that has flourished in manufacturing, originating from Just-In-Time (JIT) production and logistics. They also stated that today, SCM represents an autonomous managerial concept, although still largely dominated by logistics. SCM endeavors to observe the entire scope of the supply chain. All issues are viewed and resolved in a supply chain perspective, taking into account the interdependency in the supply chain.

They stated also that, SCM offers a methodology to relieve the myopic control in the supply chain that has been reinforcing waste and problems. Construction supply chains are still full of waste and problems caused by myopic control. Comparison of case studies with prior research justifies that waste and problems in construction supply chains are extensively present and persistent, and due to interdependency largely interrelated with causes in other stages of the supply chain. The characteristics of the construction supply chain reinforce the problems in the construction supply chain, and may well hinder the application of SCM to construction. Previous initiatives to advance the construction supply chain have been somewhat partial.

The generic methodology offered by SCM contributes to better understanding and resolution of basic problems in construction supply chains, and gives directions for construction supply chain development. The practical solutions offered by SCM, however, have to be developed in construction practice itself, taking into account the specific characteristics and local conditions of construction supply chains.

Sun and Yen (2005), addressed the balance of demand and supply of information, they propose a framework called “information supply chain” (ISC). This framework is based on supply chain management (SCM), which has been used in business management science. Both ISC and SCM aim to satisfy demand with high responsiveness and efficiency. ISC uses an information requirement planning (IRP) algorithm to reason, plan, and satisfy needers with useful information. They believed that ISC can not only unify existing information-sharing methods, but also produce new solutions that enable the right information to be delivered to the right recipients in the right way and at the right time.

Trkman and Groznik (2006), dealt with business renovation, effective utilization of information technology and the role of business process modelling in supply chain integration projects. The main idea was to show how the performance of the supply chain can be improved with the integration of various tiers in the chain. Integration is prerequisite for effective sharing and utilization of information between different companies in the chain. Simulation-based methodology for measuring the benefits combines the simulation of business processes with the simulation of supply and demand. The theoretical findings were illustrated with the case study of procurement process in a petrol company. Old and renewed business process models were shown. The changes in lead-times, process execution costs, quality of the process and inventory costs are estimated.

Jain (2004) proposed that Supply chain management involves understanding complex interactions between many factors and using the understanding to achieve balance between conflicting objectives. Simulation is a very useful technique to evaluate the impact of changes in factors such as inventory control and business process parameters. He described a simulation based study for analyzing the tradeoffs among service level, inventory and lead times for a large logistics supply chain. The study highlighted the use of simulation in understanding seemingly non-intuitive results and guiding the effort for performance improvement.

Fawcett et al., (2005) stated that information integration is a leading aim for many supply-chain managers. Although the benefits of successful information integration are desirable, the barriers are quite daunting. Their study benchmarks the current status of information integration in supply chain management using in-depth case study methodology at five channel positions. The study reveals two main dimensions to information integration: connectivity and willingness. We discuss both of these dimensions' implications for managers and academics and provide prescriptive direction where research and development should be channelled to facilitate information integration success.

Zhou et al., (2008) introduced and demonstrated how an Internet based supply chain simulation game (ISCS). Different from other games and extended from the Beer Game, a comprehensive set of supply chain (SC) management strategies can be tested in the game, and these strategies can be evaluated and appraised based on the built-in Management Information System (MIS). The key functionalities of ISCS were designed to increase players' SC awareness, facilitate understanding on various SC strategies and challenges, foster collaboration between partners, and improve problem solving skills. It is concluded that an ISCS can be used as an efficient and effective teaching tool as well as a research tool in operations research and management science. Problems and obstacles have been observed while engaging in the SC business scenario game. The actions proposed and implemented to solve these problems have resulted in improved SC performance.

Vanpoucke et al., (2009) identified different information flow strategies to enhance integration in strategic alliances and studied these strategies with respect to contextual factors and the impact on performance. They examined empirical data gathered from 56 manufacturing companies, describing 112 supply chain relationships. An empirical taxonomy is created based on cluster analysis. Their Findings was based on a parsimonious description of inter-firm information flows and three empirical types of alliances were found: Silent, Communicative and IT intensive alliances. While Silent alliances have the poorest overall performance, substantial similarities are found between Communicative and IT intensive alliances. In particular, the analysis suggests that IT intensive alliances, albeit performing better on operational capabilities, are not performing better on relationship satisfaction compared to Communicative alliances. Additional analyses indicate that partners of an IT intensive alliance are substantially more interdependent and larger in size. They also presented taxonomy of information flow strategies in a supply chain context. They found out that the best practice is for Managers to selectively invest in IT according to an overall supply chain integration strategy, which also takes softer, less technological forms of integration into consideration

Beheshti et al., (2007) proposed that the Internet has become an integral part of business activities of most corporations today. Electronic supply chain management (SCM) can improve the operational efficiency of the firm by streamlining processes between the company and its suppliers, business partners, and customers. The research explores the extent and the degree of Internet application in Swedish small- and medium-sized enterprises (SMEs). The analyses of the data show that the Swedish SMEs use the Internet in their supply chain activities to a large degree. The study establishes some differences between smaller and larger organizations as well as between manufacturing and service companies.

Maacada et al., (2007) proposed that, Supply Chain Management (SCM) is recognized as an important area for innovation and investment in Information Technology (IT). IT investments continue being a central strategic issue for companies seeking to gain competitive advantage in a dynamic environment, even though the impact of such investments may not be fully understood. The objective of this research was to identify and analyze the impacts of IT in the process of SCM and to validate the set of selected variables found in the Information Systems (IS) literature. Research based on a multiple case study was conducted in Metal Mechanical, Petrochemical and Retail organizations. The interviews with executives highlighted the strategic importance that IT plays in the process of Supply Chain Management. The findings reveal the positive impacts of IT in the set of selected strategic variables.

Trienekens et al., (2003) presented a research agenda on innovation through (international) food supply chains and networks in developing countries. It derives major topics from a multi-perspective view on international food chains (economic, technology, social/legal and environment) and from different theoretical streams dealing with chains and networks (Supply Chain Management, Industrial Organization theory and Network Theory). Three agric-supply chain projects in developing countries (Thailand, South-Africa, Ghana) are analyzed to identify focus areas in supply chain development projects and important gaps. These projects were collaborative actions between companies and research institutes to initiate international supply chain development.

Schneller and Smeltzer (2004) proposed that, Health sector supply and value chain management has only recently been recognized as a fertile area for health services research. An effective supply chain clearly has implications for improvement in clinical outcomes, cost containment, and increased safety. They identified the opportunities that supply chain management can make available to the health sector and clearly delineates a systematic program for health sector supply chain research. The presentation draws on our recent research analyzing strategic fit in health care delivery organization, purchasing, and supply organizations (especially group purchasing organizations/collaborative in the US and the multi-level purchasing organizations servicing the National Health Service in the UK. Health sector purchasers (integrated delivery networks (IDNs) in the US and trusts in the UK must solve a number of very specific problems related to procurement including (1) product and service selection, (2) integration with the various purchasing organizations that are available in their markets, (3) strategic sourcing and, (4) distribution and inventory. The methodology consisted of analysis of data collected during visits to integrated delivery systems and group purchasing organizations throughout the US, information gathered during visits to trusts in the UK and information collected from the NHS Purchasing and Supply Agency (NHS PASA). Building on the work in strategic management, we have identified the organizational and environmental contingencies that contribute to strategic fit or strategic misfit in purchasing practices. In solving problems pertaining to standardization in purchasing, organizations seek and utilize purchasing models and strategies that are consistent with their cultures, goals and the idiosyncrasies within their markets. In both nations, the mix of emergent technologies and partnership opportunities available also affect purchasing and materials management strategies. Health services research has not recognized the value of supply chain management, especially clinical product preference standardization, as making a strong contribution to the improvement of quality and safety enhancement. Indeed, the health care supply chain is not an organizing concept in vogue by researchers in the health sector. This is quite different from approaches outside health where materials take a centre stage. As the costs of materials exceed 20% of the average hospital admission, the contributions of materials requires careful scrutiny by health services researchers.

Kim et al., (2006) explored how innovations surrounding supply chain communication systems (SCCS) affect channel relationships and market performance. Drawing on the resource-based view of the firm, the study hypothesizes that certain SCCS innovations can be viewed as firm resources that enhance channel capabilities, which in turn affect a firm's market performance. The empirical research is based on 184 responses from a survey with U.S. supply chain and logistics managers using structural equation modeling as the analytic method. The results suggest that the effect of applied technological SCCS innovations on channel capabilities is mediated by inter-firm systems integration. In contrast, administrative SCCS innovations enhance information exchange and coordination activities directly. Furthermore, the influence of applied technological innovations for SCCS is not strong enough to affect either responsiveness of the partnership or firm performance, whereas administrative innovations for SCCS affect both.

Subramanian and Iyigungor (2006) proposed that Supply Chain Management (SCM) is recognized as a core competitive strategy for businesses in almost every industry. A strong supply chain provides products and services to consumers faster, cheaper, and better. They discussed SCM and information systems in the supply chain. Case studies of Wal-Mart, Amazon.Com and United Parcel Services (UPS) and their use of information systems in the supply chain are presented. Wal-Mart and Amazon have established critical and timely strategies in their supply chains through huge investments in Information Technology (IT). While Wal-Mart and Amazon are offering their products to consumers, UPS offers logistics solutions to clients. These companies use a variety of information technologies which include satellite systems, barcodes, web-based Electronic Data Interchange (EDI), Radio Frequency Identification (RFID), data warehousing, and e-commerce in their supply chain. The supply chain and use of these technologies in SCM are reviewed and compared for these three organizations.

Tavassoli et al., proposed that supply chain management, is one of the most important usable ways by modern companies to earn competitive benefit. Information technology has had very important effect on its development. Also, supply chain, is one of the management substructure bases in electronic business. Since supply chains may be long, complicated and including a lot of foreigner, partners are faced with problems that carelessness to them will cause dissatisfaction of customers and losing sale. This management widely is supported by information technology. After a brief discussion on different parts of supply chain management, this paper tries to turn existing problems in this chain and presents a classification of the different ways in which companies use IT in SCM(Supply Chain Management) and usage of information technology in it for instance, different applications of RFID (Radio Frequency Identification) are mentioned. Next section is dedicated to the definition of CPFR (Collaborative Planning Forecasting and Replenishment) systems.

Borgman and Wilfred (2007) proposed that becoming Agile and Lean in manufacturing necessitate that we revisit the way we handle our factors of productions (i.e. man, machine and materials). Most current literature acknowledges that of all the production factors, Inventory is the "low hanging fruit" for improvement. Whilst Inventory has been labelled a liability, why has so little been achieved to managing Inventory and realising the benefits in practice? Our findings guided us towards a proposition for Replacing Inventory with Information. By applying ICT (Information Communication Technology) based solution to the "Response Time Delay" and "Risk of Uncertainty of Demand" problems, seen here as a dynamic Inventory problem. We were able to develop a framework to determine when Inventory can be replaced with information and when it should not be attempted.

Chen et al., (1999) proposed that supply chain is a network of suppliers, factories, warehouses, distribution centers and retailers, through which raw materials are acquired, transformed, produced and delivered to the customer. A supply chain management system (SCMS) manages the cooperation of these system components. In the computational world, roles of individual entities in a supply chain can be implemented as distinct agents. The functions and procedures of a company in the real market are complicated and include information collection, policy making and actions. Therefore, it is impossible to describe software agent behaviors for an uncertain e-commerce environment such as supply chain management in the traditional single threaded model. To solve the problem, we introduce the concept of negotiation into software agent design for supply chain management and present our ideas to solve the problem of communication and decision-making for negotiating agents.

Shih et al., (2002) proposed that, to gain and sustain competitive advantage, health-care providers have to continuously review and renovate their operational and information technology (IT) strategies through collaborative and cooperative endeavours with their supply chain channel members. They explored new ways of enhancing a health-care organization's responsiveness to changes and increasing its competitiveness through implementing strategic information technology alliances among channel members in a health-care supply chain network. An overview of issues and problems (e.g. bullwhip effect, negative externalities and free-riding phenomenon in multichannel supply chains) presented in the health-care supply chains is first delineated. This paper further goes over the issues of health-care supply chain coordination and integration for strategic IT alliances, followed by the discussion of the spillover effect of IT investments.

A number of viable IT practices (such as information sharing and Internet-enabled supply chain portal) for effective health-care supply chain collaboration and coordination are then examined in this research. Finally, the paper discusses how strategic IT alliances can help improve the effectiveness of health-care supply chain management.

Zhang and Li (2006) proposed that, information sharing is a key element in any Supply Chain Management (SCM) system and is critical for improving supply chain performance and enhancing the competitive advantage of an organization. However, many organizations are reluctant to share information with their supply chain partners because of lack of trust, the fear of information leakage and security attacks from malicious individuals or groups. Through an extensive literature review, this paper examines the possible security threats/attacks in a SCM system. Then the key technologies and techniques for securing the information shared in SCM are identified with the goal of improving organizations' capabilities in sharing.

Yuan et al., (2003) proposed the focus of supply chain management has been shifted from production efficiency to customer-driven and partnership synchronization approaches. To implement this strategic shift requires high-level collaboration between supply chain partners. Software agent technology will have great potential in supporting collaboration in supply chain management. In this paper, we review the trend of supply chain management and analyze how agent technology can be applied to support collaboration in information sharing, operation cooperation, and dynamic chain configuration. They also review existing agent systems that support supply chain management at operational and strategic levels. Finally, they analyze the limitations of the agent approach and suggest future research directions.

Marincas (2008) proposed that Supply chain management SCM is the integration and management of supply chain organizations and activities through collaboration, effective business processes and high levels of information sharing. The supply chain concept has become a concern due to global competition and increasing customer demand for value. Thus, the information must be available in real time across the supply chain and this cannot be achieved without an integrated software system for supply chain management. Supply chain members have to collaborate, sharing information for improving customers' satisfaction. Web technologies enable enterprises to become more effective, to trade with suppliers and customers over the Internet in real time. For this, businesses have to integrate their information systems and applications with those of their suppliers and customers. First, companies have to redesign their supply chain to create an integrated value system and afterwards, companies can develop business to business applications across supply chain structure for the optimization of the supply chain. The implementation of the supply chain information systems in companies facilitates an increase in their competitiveness and their profits.

Li (2002) examined the incentives for firms to share information vertically in a two-level supply chain in which there are one upstream firm, a manufacturer, and many downstream firms, retailers. The retailers are engaged in a Cournot competition and are endowed with some private information. Vertical information sharing has two effects: "direct effect" due to the changes in strategy by the parties involved in sharing the information and "indirect effect" (or "leakage effect") due to the changes in strategy by other competing firms (who may infer the information from the actions of the informed parties). Both changes would affect the profitability of the firms. We show that the leakage effect discourages the retailers from sharing their demand information with the manufacturer while encouraging them to share their cost information. On the other hand, the direct effect always discourages the retailers from sharing their information. When voluntary information sharing is not possible, we identify conditions under which information can be traded and show how price should be determined to facilitate such information exchange. We also examine the impact of vertical information sharing on the total supply chain profits and social benefits.

Lee et al., (2000) stated that many companies have embarked on initiatives that enable more demand information sharing between retailers and their upstream suppliers. While the literature on such initiatives in the business press is proliferating, it is not clear how one can quantify the benefits of these initiatives and how one can identify the drivers of the magnitudes of these benefits. Using analytical models, this paper aims at addressing these questions for a simple two-level supply chain with non-stationary end demands. Their analysis suggests that the value of demand information sharing can be quite high, especially when demands are significantly correlated over time.

Anderson et al., (1997) suggested that there are seven basic principles in managing a supply chain. They are:

i) Segmenting the customers according to their demands and providing them with a tailored set of products and services that will have maximum impact on them.

ii) Customizing the logistics network through more robust logistics planning, enabled by real time decision support tools that can handle flow-through distribution. More time sensitive approaches to managing transportation will result in significant increase in revenues and return on investment.

iii) Listening to signals of market demand and planning the production according to them helps the organizations to avoid situations like over stocking and out of stock during peak seasons.

iv) Differentiating products closer to the customer avoids product obsolescence and increases the impact on the customers.

v) Sourcing strategically from suppliers who share the common goals improves the supply chains efficiency as it reduces inventory and gives way to concepts like vendor managed inventory.

vi) Developing supply chain wide common technology strategy improves interaction between the supply chain partners.

vii) Adopting a common supply chain wide performance measure directs all the supply chain partners to work towards a common goal and facilitates comparisons across organizational boundaries.

Radhakrishnan et al., (2009) suggested inventory management is considered to be an important field in Supply chain management. Once the efficient and effective management of inventory is carried out throughout the supply chain, service provided to the customer ultimately gets enhanced. Hence, to ensure minimal cost for the supply chain, the determination of the level of inventory to be held at various levels in a supply chain is unavoidable. Minimizing the total supply chain cost refers to the reduction of holding and shortage cost in the entire supply chain. Efficient inventory management is a complex process which entails the management of the inventory in the whole supply chain and getting the final solution as an optimal one. In other words, during the process of supply chain management, the stock level at each member of the supply chain should account to minimum total supply chain cost.

The dynamic nature of the excess stock level and shortage level over all the periods is a serious issue when implementation was considered. In addition, consideration of multiple products leads to very complex inventory management process. The complexity of the problem increases when more distribution centers and agents were involved.

Harland et al., (1997) suggests that there are six pillars that have to be built for the success of a global supply chain planning process. They are:

i) Integrating supply chain planning activities, wherein the organization integrates all the activities crossing functional boundaries, so that all the activities are done so as to attain the organizational goals.

ii) Establishing uniform business policies and rules for all the business units on issues like sales incentives and pricing, forecasting etc, wherever possible. Standardizing on common supply chain planning information systems within and across the business units can increase adaptability.

iii) Unified supply chain planning information systems help in reducing the costs involved in interpreting the data from different systems and helps the company to sell the products at a higher profit

iv) Establishing planning centers of excellence, with the core staff responsible for coordinating the supply chain planning process co-located in central or regional planning centers, helps in identifying new capabilities whenever needed and they will be able to identify opportunities to convert supply chain innovations into distinct competitive advantages

v) Shared performance measurements facilitate evaluating partner contributions and worker skills across the organizational boundary and helps in directed progress.

vi) A process based organizational structure supports global supply chain planning by improving communication and stream lining reporting hierarchy throughout the supply chain.

Mileff et al., (2006) suggested that inventory control has been considered an essential problem in the management of supplier companies for several decades. In recent years numerous new supply chain and inventory control models have been developed to support management decisions. They investigated the classical one-customer and one-supplier (news vendor) problem with an analytical, event-oriented model. Their basic aim was to extend the classical news vendor model to n periods, which means that management decisions will be made only once at the beginning of a predefined time horizon based on demand forecast information. A new heuristic method was developed to determine the optimal length of the time horizon. They examined the problem by means of their own simulation method and discussed the results.

2.1 Summary

This chapter provided intensively works people have done in the field of Supply Chain Management, Channel Coordination and Newsvendor Model and its various applications. In the next chapter we shall put forward the relevant information concerning Supply Chain Management, Channel Coordination and Newsboy Problem.

CHAPTER THREE

3.0 Introduction

This chapter focuses on the detail and comprehensive understanding of the topic. The main contributions of this chapter are

i) Channel Coordination
ii) Newsboy Problem

3.1 Channel Coordination

Channel coordination (or supply chain coordination) aims at improving supply chain performance by aligning the plans and the objectives of individual enterprises. It usually focuses on inventory management and ordering decisions in distributed inter-company settings. Channel coordination models may involve multi-echelon inventory theory, multiple decision makers, asymmetric information, as well as recent paradigms of manufacturing, such as mass customization, short product life-cycles, outsourcing and delayed differentiation. The theoretical foundations of the coordination are based chiefly on the contract theory.

The decentralized decision making in supply chains leads to a dilemma situation which results in a suboptimal overall performance called double marginalization. Recently, partners in permanent supply chains tend to extend the coordination of their decisions in order to improve the performance for all of the participants. Some practical realizations of this approach are Collaborative Planning, Forecasting, and Replenishment (CPFR), Vendor Managed Inventory (VMI) and Quick Response (QR).

The theory of channel coordination aims at supporting the performance optimization by developing arrangements for aligning the different objectives of the partners. These are called coordination mechanisms or schemes, which control the flows of information, materials (or service) and financial assets along the chains. In general, a contracting scheme should consist of the following components:

- local planning methods which consider the constraints and objectives of the individual partners,
- an infrastructure and protocol for information sharing, and
- an incentive scheme for aligning the individual interests of the partners.

The appropriate planning methods are necessary for optimizing the behavior of the production. The second component should support the information visibility and transparency both within and among the partners and facilitates the realization of real-time enterprises. Finally, the third component should guarantee that the partners act upon to the common goals of the supply chain.

The general method for studying coordination consists of two steps. At first, one assumes a central decision maker with complete information who solves the problem. The result is a first-best solution which provides bound on the obtainable system-wide performance objective. In the second step one regards the decentralized problem and designs such a contract protocol that approaches or even achieves the performance of the first-best.

A contract is said to coordinate the channel, if thereby the partners' optimal local decisions lead to optimal system-wide performance. Channel coordination is achievable in several simple models, but it is more difficult (or even impossible) in more realistic cases and in the practice. Therefore the aim is often only the achievement of mutual benefit compared to the uncoordinated situation.

Another widely studied alternative direction for channel coordination is the application of some negotiation protocols. Such approaches apply iterative solution methods, where the partners exchange proposals and counter-proposals until an agreement is reached. For this reason, this approach is commonly referred to as collaborative planning. The negotiation protocols can be characterized according to the following criteria:

- The initial proposal is most frequently generated by the buyer company which is called upstream planning. By contrast, when the initiator is the supplier, it is referred to as downstream planning. In several cases there already exists an initial plan (e.g., using rolling schedules or frame plans). There are also some protocols where the initial plan is generated randomly.

- In order to guarantee finite runtime, the maximal number of rounds should be determined. In addition, the protocol should also specify the number of plans offered in each round. When the number of rounds or plans is high, the practical application necessitates fast local planner systems in order to quickly evaluate the proposals and generate counter-proposals.

- Generally, the negotiation protocols cannot provide optimality, and they require some special conditions to assure convergence.

- The counter-proposals usually define side-payments (compensations) between the companies in order to inspire the partner deviating from its previously proposed plan.

An also commonly used instrument for aligning plans of different decision makers is the application of some auction mechanisms. However, "auctions are most applicable in pure market interactions at the boundaries of a supply chain but not within a supply chain", theref ore they are usually not considered as channel coordination approaches.

3.2 Newsboy Problem

The classical newsboy problem is to find order quantity for a single period that maximizes the profit under uncertain demand. It is assumed that at the end of the period, product can be sold back at a discounted (salvage) price which is strictly less than the cost price. If the order quantity is less than the realized demand, the newsboy forgoes certain amount of profit.

The newsboy problem also known as newsvendor or single-period problem is a well-known inventory management problem. In general, the newsboy problem has the following characteristics. Prior to the season, the buyer must decide how many units of goods to purchase. The procurement lead-time tends to quite long relative to the selling season, so the buyer can not observe demand prior to placing order. Due to the long lead-time, there is no opportunity to replenish inventory once the season has begun. Excess products cannot be sold (or price is trivial) over season. As well known that Newsboy problem derives its name from common problem faced by persons selling newspaper on the street, interest in such a problem increased over the past 40 years partially because the increased dominance of service industries for which newsboy problem is very applicable in both retailing and service organization. Also, the reduction in product life cycles makes newsboy problem more relevant. Many extensions have been made in the last decade, such as different objects and utility function, different supplier pricing policies, different new-vendor pricing policies. Almost all of the extensions have been made in the probabilistic framework that is, the uncertainty of demand and supply is characterized by the probability distribution, and the objective function is used to maximizing the expected profit or probability measure of achieving a target.

3.3 Mathematical Model

In this section we introduce the general model and investigate the retailer's optimal strategy. We assume that there are no limits on the funds the retailer has available for procurement and that either the cost of capital is low or the time horizon under consideration is short. We note that because a retailer does not have to obtain the item on consignment, in order for any consignment scheme to be attractive to a retailer, it must result in a higher expected profit than if the retailer obtains all units through outright purchase.

The notation we use is as follows:

- $c_1 =$ the retailer's cost per unit if the retailer obtains the item from the manufacturer through outright purchase.
- $p_1 =$ the retail price per unit and therefore the retailer's revenue per unit if the retailer obtains the item from the manufacturer though outright purchase.
- $s =$ the retailer's salvage value per unit if the retailer obtains the item from the manufacturer through outright purchase.
- $g =$ the retailer's goodwill cost per unit if the retailer is out of stock of the item.
- $m =$ the manufacturer's production cost per unit.

- $c_2 =$ the retailer's cost per unit if the retailer obtains the item from the manufacturer on consignment
- $p_2 =$ the retailer's revenue per unit if the retailer obtains the item from the manufacturer on consignment. (Note that $p_1 - p_2$ equals the revenue paid to the manufacturer if an item purchased on consignment is sold by the retailer.)
- $Q_1 =$ the number of units the retailer obtained from the manufacturer through outright purchase.
- $Q_2 =$ the number of units the retailer obtains from the manufacturer on consignment.
- $Q =$ the number of units ordered if the supply channel is coordinated.
- $EV(Q_1, Q_2) =$ the retailer's expected profit if it purchases Q_1 units and obtains Q_2 units on consignment.
- $EM(Q_1, Q_2) =$ the manufacturer's expected profit if the retailer purchases Q_1 units and obtains Q_2 units on consignment.
- $EP(Q) =$ the total expected channel profit if the channel is coordinated and the order quantity is Q.
- $Q_1^* =$ the optimal number of units the retailer should obtain from the manufacturer through outright purchase if the retailer wishes to maximize its expected profit.
- $Q_2^* =$ the optimal number of units the retailer should obtain from the manufacturer on consignment if the retailer wishes to maximize its expected profit.
- $Q^* =$ the optimal number of units ordered for a coordinated supply channel.
- $f(x) =$ the probability density function of demand.

3.3.1 First Model

We will assume that due to competitive pressure, the values of $c_1, p_1, s, g,$ and m are fixed, however the manufacturer has control over setting the values of c_2 and p_2. Given the cost structure set by the manufacturer, the retailer will then determine the order quantity that maximizes its expected profit.

Following this notation, we see that if the retailer purchases the item outright from the manufacturer, the retailer earns a gross profit of $p_1 - p_2$ for each unit sold and the manufacturer earns a gross profit of $c_1 - m$ for each unit ordered by the retailer. If however, the retailer orders the item from the manufacturer on a consignment basis, the retailer would pay the manufacturer c_2 per unit plus an amount equal to $p_1 - p_2$ for each unit sold. As a result, for each unit purchased on consignment and sold by the retailer, the retailer earns a gross profit of $p_2 - c_2$ and manufacturer earns a gross profit of $p_1 - p_2 + c_2 - m$.

We further assume that if the retailer purchases the item outright from the manufacturer the salvage value s , from each unsold unit accrues to the retailer, whereas if the item is obtained from the manufacturer on a consignment basis the salvage value accrues to the manufacturer. In all cases the goodwill cost per unit due to shortage, g , is assumed to accrue to the retailer.

The following conditions are assumed to hold regarding $p_1, p_2, c_1, c_2,$ and s

- $p_1 > p_2$ (The retailer's revenue per unit is greater if it purchases the item than if it obtains the item on consignment.)

- $c_1 > c_2$ (The retailer's cost per unit is greater if it purchases the item than if obtains the item on consignment.)

- $c_1 > s$ (The retailer's cost per unit for purchasing the item is greater than its salvage value)

- $p_1 > c_1$ (For items purchased, the retailer's revenue per unit is greater than the cost per unit.)

- $p_1 - p_2 > c_1 - c_2$ (For it to be worthwhile for the manufacturer to offer the item to the retailer on a consignment basis, the manufacturer's gross profit per unit from consignment should be greater than the gross profit from outright sale to the retailer. This also states that the retailer's gross profit per unit from outright purchase is greater than if it obtains the item on consignment.)

Note that we will not require $p_2 > c_2$. That is, for items obtained on consignment, the retailer's revenue per unit may be less than the cost per unit. While such a situation would rarely arise, it is conceivably possible that it may be worthwhile for the retailer to obtain goods on consignment even if they would be sold at a loss in order to avoid the potential of incurring extremely high goodwill costs.

Operationally, because a retailer earns a larger gross profit on the units it obtains through outright purchase than on consignment, we assume that the retailer will first sell the units it purchases outright and will only sell those it obtains on consignment after all purchased units have been sold. The basis for our analysis is to investigate the Karush-Kuhn-Tucker (KKT) conditions in order to determine optimal strategies. Based on the above notation, we have:

$$EV(Q_1,Q_2) = \int_0^{Q_1} \left[p_1 x + s(Q_1 - x)\right] f(x)\,dx + \int_{Q_1}^{Q_1+Q_2} \left[(p_1 - p_2)Q_1 + p_2 x\right] f(x)\,dx + \int_{Q_1+Q_2}^{\infty} \left[p_1 Q_1 + p_2 Q_2 - g(x - Q_1 - Q_2)\right] f(x)\,dx - c_1 Q_1 - c_2 Q_2 \qquad (3.3.1)$$

and

$$EM(Q_1,Q_2) = \int_0^{Q_1} s Q_2 f(x)\,dx + \int_{Q_1}^{Q_1+Q_2} \left[(p_1 - p_2)(x - Q_1) + s(Q_1 + Q_2 - x)\right] f(x)\,dx + \int_{Q_1+Q_2}^{\infty} (p_1 - p_2) Q_2 f(x)\,dx + (c_1 - m)Q_1 + (c_2 - m)Q_2 \qquad (3.3.2)$$

The first term in equation (3.3.2) arises due to the fact that any items ordered by the retailer on consignment and unsold are returned to the manufacturer who will then dispose of them for their salvage value.

The problem faced by the retailer is therefore:

$$\begin{aligned}
&\textit{Maximize } EV\left(Q_1, Q_2\right) \\
&\quad s.t. \qquad -Q_1 \leq 0 \\
&\qquad\qquad\quad -Q_2 \leq 0
\end{aligned}$$

The partial derivatives of $EV\left(Q_1, Q_2\right)$ are as follows:

$$\frac{\partial EV\left(Q_1, Q_2\right)}{\partial Q_1} =$$

$$F\left(Q_1\right)\left(s - p_1 + p_2\right) - F\left(Q_1 + Q_2\right)\left(p_2 + g\right) - c_1 + p_2 + g \qquad (3.3.3)$$

and

$$\frac{\partial EV\left(Q_1, Q_2\right)}{\partial Q_2} = \left[1 - F\left(Q_1 + Q_2\right)\right]\left(p_2 + g\right) - c_2 \qquad (3.3.4)$$

The following conditions (see Hillier and Lieberman [2001]) are as therefore required for optimality:

(1) $Y_1 Q_1^* = 0$

(2) $Y_2 Q_2^* = 0$

(3) $F\left(Q_1^*\right)\left(s - p_1 + p_2\right) - F\left(Q_1^* + Q_2^*\right)\left(p_2 + g\right) - c_1 + p_1 + g = -Y_1$

(4) $\left[1 - F\left(Q_1^* + Q_2^*\right)\right]\left(p_2 + g\right) - c_2 = -Y_2$

(5) $Y_1 \geq 0, Y_2 \geq 0, Q_1^* \geq 0, Q_2^* \geq 0$

where Y_1 and Y_2 are the Lagrange multipliers (dual variables) for this problem.

We also see that:

$$\frac{\partial^2 EV(Q_1,Q_2)}{\partial Q_1^2} = f(Q_1)(s-p_1+p_2) - f(Q_1+Q_2)(p_2+g) \quad (3.3.5)$$

$$\frac{\partial^2 EV(Q_1,Q_2)}{\partial Q_2^2} = -f(Q_1+Q_2)(p_2+g) \quad (3.3.6)$$

and

$$\frac{\partial^2 EV(Q_1,Q_2)}{\partial Q_1 \partial Q_2} = -f(Q_1+Q_2)(p_2+g) \quad (3.3.7)$$

By looking at the second-order partial derivatives for $EV(Q_1,Q_2)$ we note that if $p_1 - p_2 - s \geq 0$, then $EV(Q_1,Q_2)$ is concave.

Our interest lies in determining the structure of the optimal strategy for the retailer. This gives rise to the following three theorems.

Theorem 3.3.1 *It is impossible for* $Q_1^* = 0$ *and* $Q_2^* > 0$

Proof: If $Q_2^* > 0$ then from KKT condition (2) $Y_2 = 0$ Hence, from KKT condition (4) we have:

$$F(Q_1^* + Q_2^*) = \frac{(p_2 + g - c_2)}{(p_2 + g)} \quad (3.3.8)$$

Substituting equation (3.3.8) into KKT condition (3) gives:

$$F(Q_1^*)(s - p_1 + p_2) + (p_1 - p_2 - c_1 + c_2) = -Y_2 \quad (3.3.9)$$

Theorem 3.3.1 states that it would never pay for the retailer to obtain the item from the manufacturer only on a consignment basis.

Theorem 3.3.2 *if* $\frac{p_2 + g}{c_2} > \frac{p_1 + g - s}{c_1 - s}$*, then it is impossible for* $Q_1^* > 0$ *and* $Q_2^* = 0$

Proof: Suppose $Q_1^* > 0$. Then from KKT condition (1) we have $Y_1 = 0$.

If we also assume that $Q_2^* = 0$ from KKT condition (4) we have:

$$F\left(Q_1^*\right)=\frac{p_2+g-c_2+Y_2}{p_2+g} \qquad (3.3.10)$$

while from KKT condition (3) we have:

$$F\left(Q_1^*\right)=\frac{p_1+g-c_1}{p_1+g-s} \qquad (3.3.11)$$

But, if $\frac{p_2+g}{c_2}>\frac{p_1+g-s}{c_1-s}$, then $\frac{p_2+g-c_2+Y_2}{p_2+g}\geq\frac{p_2+g-c_2}{p_2+g}>\frac{p_1+g-c_1}{p_1+g-s}$

Since we know from Theorem 3.3.1 that obtaining the good only on consignment cannot be optimal, Theorem 3.3.2 gives conditions under which it is optimal to both purchase the item outright and obtain it by consignment. In essence, what Theorem 3.3.2 states is that if the ratio of revenue to cost for goods obtained on consignment is high enough; it will never be optimal for the retailer to only purchase the good. Such a condition will occur if the salvage value is low and the goodwill cost is high. In such cases the optimal amount for the retailer to purchase and to obtain on consignment can be determined by recognizing that $Y_1=Y_2=0$ and solving for KKT conditions (3) and (4). This gives the following relationships for Q_1^* and Q_2^*.

and

$$F\left(Q_1^*\right)=\frac{p_1-p_2+c_2-c_1}{p_1-p_2-s} \qquad (3.3.13)$$

Theorem 3.3.3 *if* $s>c_1-c_2$, *then* $F\left(Q_1^*\right)=\frac{p_1+g-c_1}{p_1+g-s}$ *and* $Q_2^*=0$

Proof: We show in this case that it is impossible for both $Q_1^*>0$ and $Q_2^*>0$ In particular, if $Q_1^*>0$ and $Q_2^*>0$ then KKT conditions (1) and (2) imply that $Y_1=Y_2=0$. Hence, equations (3.3.12) and (3.3.13) must be satisfied. But if $s>c_1-c_2$ then from equation (3.3.13) we would have $F\left(Q_1^*\right)>1$, which would be impossible. Also, we know from Theorem 3.3.1 that it is impossible for $Q_1^*=0$ and $Q_2^*>0$. Hence $Q_1^*>0$ and $Q_2^*=0$. The result follows from the KKT condition (3).

Theorem 3.3.3 states that if the salvage value per unit is greater than $c_1 - c_2$,then the retailer would obtain all items through outright purchase. The purchase amount would be identical to the amount the retailer would purchase if there were no consignment option.

Given this as a background we now turn our attention to how the manufacturer can set the values of p_2 and c_2 to achieve channel coordination. This is examined in the next section.

3.3.2 Second Model

The idea of channel coordination is that a manufacturer, through its pricing strategy, will ensure that an independent retailer will order the same amount as if the manufacturer controlled the retailer. In such cases the total expected profit for the channel is maximized.

Channel coordination is desirable to a manufacturer since if total channel profits are maximized while the retailer's expected profit remains constant, the manufacturer's expected profit will be maximized. Of course, one difficulty that can occur with channel coordination is that the retailer's expected profit may increase to such an extent that the manufacturer receives a lower expected profit. In such cases, however, channel coordination can still be desirable to the manufacturer if the manufacturer can obtain a side payment from the retailer equal to a substantial enough portion of the retailer's expected gain.

We will again assume that the retailer has no restrictions on the funding available for obtaining the goods. We make this assumption because a manufacturer would generally not know if a retailer has any limitations on funding and if such limitations existed they would be retailer specific by their nature. Also, if the retailer has limitations on funding, channel coordination may be impossible to achieve. Even if coordination could be achieved, it is doubtful in such cases whether a manufacturer could develop a pricing plan for multiple retailers that would meet the guidelines of the Robinson-Patman act.

We will also assume that the retailer's purchase price and sales price under outright purchase does not change as a result of the manufacturer offering the good through revenue sharing.

Instead, channel coordination will be achieved by the manufacturer selecting appropriate values for and p_2 under c_2 a revenue sharing plan. We make this assumption since the manufacturer may have multiple means of distribution, not all of which would be subject to a possible revenue sharing scheme. For example, a video tape manufacturer would sell video tapes not only to video tape rental chains interested in participating in revenue sharing, but also to discount stores, e-commerce retailers, and independent video tape rental stores not wanting to engage in revenue sharing. Our objective is to evaluate the impact that revenue sharing will have on the total channel expected profit as well as the expected profits for both the manufacturer and the retailer.

Let us first focus on the conditions on c_2 and p_2 that will be necessary in order to achieve channel coordination. These are given in the following theorem.

Theorem 3.3.4 *If the manufacturer wishes to achieve channel coordination then it will be necessary to set* $c_2 = \frac{(p_2+g)(m-s)}{p_1+g-s}$

Proof: Clearly, if the manufacturer wishes to achieve channel coordination, it must set the price for the goods obtained on consignment at an attractive enough level so that that $Q_2^* > 0$. We know from theorem 3.3.1 that it is impossible for $Q_1^* = 0$ and $Q_2^* > 0$ and from Theorem 3.3.3 that if $s > c_1 - c_2$ then $Q_2^* = 0$. Hence, c_2 must be set such that $c_1 - c_2 \geq s$ and we will focus on the case where $Q_1^* > 0$ and $Q_2^* > 0$. If the channel is coordinated, from the results of the standard newsboy model it must be true that Q_1^* and Q_2^* satisfy the following relationship:

$$F\left(Q_1^* + Q_2^*\right) = \frac{p_1+g-m}{p_1+g-s} \qquad (3.3.14)$$

Also, we know from KKT condition (4) that:

$$F\left(Q_1^* + Q_2^*\right) = \frac{p_2+g-c_2}{p_2+g} \qquad (3.3.15)$$

Equating the two expressions for $F\left(Q_1^* + Q_2^*\right)$ results in the relationship for c_2.

Corollary 3.3.5 *It is necessary to set* $c_2 < (m-s)$ *in order to achieve channel coordination.*

Proof: Equating (3.3.14) and (3.3.15) gives:

$$(m-s)(p_2+g) = c_2(p_1+g-s) \qquad (3.3.16)$$

The result follows since $p_1 - p_2 > c_1 - c_2 \geq s$ and therefore $p_1 - s > p_2$

The implication of Theorem 3.3.4 and Corollary 3.3.5 is that for the manufacturer to achieve channel coordination, it would have to offer consigned goods to the retailer at a cost that is less than the manufacturer's production cost minus the good's salvage value.

Let us assume that the manufacturer selects values of c_2 and p_2 that satisfy the conditions for achieving channel coordination. In such situations we wish to analyze the effect that achieving channel coordination will have on the retailer's and manufacturer's expected profit.

It should be clear that under channel coordination, the retailer's expected profit will never decline relative to that without channel coordination. This is because the retailer could always adopt a strategy in which $Q_2^* = 0$. Hence, while under channel coordination the total expected profit for the manufacturer and retailer increases over the case where the good is not offered on consignment, if the manufacturer does not receive a side payment from the retailer its expected profit might actually decrease. The next theorem gives formulas for the retailer's and manufacturer's expected profit under channel coordination. These formulas can then be used to determine the effect that channel coordination has on the expected profit of the retailer and manufacturer.

Theorem 3.3.6 *If the manufacturer sets* c_2 *and* p_2 *to achieve channel coordination, then:*

$$EV(Q_1^*, Q_2^*) = \int_0^{Q_1^*} (p_1 - s)\, xf(x)\, dx$$
$$+ \int^{Q_1^*+Q_2^*} p_2 xf(x)\, dx - \int^{\infty} gxf(x)\, dx \qquad (3.3.17)$$

and

$$EM\left(Q_1^*,Q_2^*\right)=\int_{Q_1^*}^{Q_1^*+Q_2^*}\left(p_1-p_2-s\right)xf\left(x\right)dx \qquad (3.3.18)$$

Proof:

$$EV\left(Q_1^*,Q_2^*\right)=$$
$$\int_0^{Q_1^*}\left[p_1x+s\left(Q_1-x\right)\right]f\left(x\right)dx+\int_{Q_1^*}^{Q_1^*+Q_2^*}\left[\left(p_1-p_2\right)Q_1^*+p_2x\right]f\left(x\right)dx$$
$$+\int_{Q_1^*+Q_2^*}^{\infty}\left[p_1Q_1^*+p_2Q_2^*-g\left(x-Q_1^*-Q_2^*\right)\right]f\left(x\right)dx-c_1Q_1^*-c_2Q_2^*$$
$$=Q_1^*\left(s-p_1+p_2\right)F\left(Q_1^*\right)-\left(p_2+g\right)\left(Q_1^*+Q_2^*\right)F\left(Q_1^*+Q_2^*\right)$$
$$+\int_0^{Q_1^*}\left(p_1-s\right)xf\left(x\right)dx+\int_{Q_1^*}^{Q_1^*+Q_2^*}p_2xf\left(x\right)dx-\int_{Q_1^*+Q_2^*}^{\infty}gxf\left(x\right)dx$$
$$+p_1Q_1^*+p_2Q_2^*+g\left(Q_1^*+Q_2^*\right)-c_1Q_1^*-c_2Q_2^* \qquad (3.3.19)$$

Substituting $F\left(Q_1^*\right)=\dfrac{p_1-p_2-c_1+c_2}{p_1-p_2-s}$ and $F\left(Q_1^*+Q_2^*\right)=\dfrac{p_2+g-c}{p_1+g}$ into equation (3.3.19) gives the resulting formula for $EM\left(Q_1^*,Q_2^*\right)$.

To show the result for $EM\left(Q_1^*,Q_2^*\right)$ we note that:

$$EM\left(Q_1^*,Q_2^*\right)=sQ_2^*F\left(Q_1^*\right)+\int_{Q_1^*}^{Q_1^*+Q_2^*}\left(p_1-p_2-s\right)xf\left(x\right)dx$$
$$-\left(p_1-p_2-s\right)Q_1^*\left[F\left(Q_1^*+Q_2^*\right)-F\left(Q_1^*\right)\right]$$
$$+sQ_2^*\left[F\left(Q_1^*+Q_2^*\right)-F\left(Q_1^*\right)\right]+\left(p_1-p_2\right)Q_1^*\left[1-F\left(Q_1^*+Q_2^*\right)\right]$$
$$+\left(c_1-m\right)Q_1^*+\left(c_2-m\right)Q_2^* \qquad (3.4.20)$$

Substituting $F\left(Q_1^*\right)=\dfrac{p_1-p_2-c_1+c_2}{p_1-p_2-s}$ into equation (3.3.20) gives the following:

$$EM\left(Q_1^*,Q_2^*\right)=\int_{Q_1^*}^{Q_1^*+Q_2^*}\left(p_1-p_2-s\right)sf\left(x\right)dx$$
$$-\left(p_1+g-s\right)\left(Q_1^*+Q_2^*\right)F\left(Q_1^*+Q_2^*\right)$$
$$+\left(p_2+g\right)\left(Q_1^*+Q_2^*\right)F\left(Q_1^*+Q_2^*\right)$$
$$+\left(p_1-p_2+c_2-m\right)\left(Q_1^*+Q_2^*\right) \qquad (3.4.21)$$

Substituting $F\left(Q_1^*+Q_2^*\right)=\dfrac{p_1+g-m}{p_1+g-s}$ and $F\left(Q_1^*+Q_2^*\right)=\dfrac{p_2+g-c_2}{p_2+g}$ into equation (3.3.21) results in the formula for $EM\left(Q_1^*,Q_2^*\right)$.

To illustrate the consequences of Theorems 3.3.4 and 3.3.6, let us consider the case of a uniform demand distribution, $f\left(x\right)=1/\left(B-A\right)$ for $A\le x\le B, 0$ elsewhere, and examine the effect that the manufacturer's choice of has on its expected profit. We select the uniform distribution for demand since it will enable us to generate closed-form expressions for Q_1^*,Q_2^* and the resulting expected profits for the retailer and the manufacturer.

For a uniform demand distribution the formulas for $EM\left(Q_1^*,Q_2^*\right)$ and $EV\left(Q_1^*,Q_2^*\right)$ are as follows:

$$EV\left(Q_1^*,Q_2^*\right)=$$
$$\left[\frac{\left(p_1-p_2-c_1+c_2\right)^2}{p_1-p_2-s}+\frac{\left(p_2+g-c_2\right)}{p_2+g}-g\right]\frac{\left(B-A\right)}{2}$$
$$+A\left(p_1-c\right) \qquad (3.3.22)$$
$$EM\left(Q_1^*,Q_2^*\right)=$$
$$\left[\frac{\left(p_1+g-m\right)\left(c_1-m\right)}{p_1+g-s}-\frac{\left(c_1-m\right)^2}{2\left(p_1-p_2-s\right)}\right]\left(B-A\right)$$
$$+A\left(c_1-m\right) \qquad (3.3.23)$$

(See the appendix for the proof of these two expressions.)

We therefore see from equation (3.3.23) that the manufacturer's expected profit is monotonically decreasing in p_2 and the manufacturer's optimal strategy would be to set as p_2 low as possible.

Unfortunately, if p_2 is restricted to being nonnegative, it may not be possible for the manufacturer to set p_2 low enough to ensure that its expected profit will increase over the case in which revenue sharing is not offered. The conditions required for the manufacturer's profit to not decline under channel coordination are given in the next theorem.

Theorem 3.3.7 *If demand follows a uniform distribution and the manufacturer wishes to set consignment pricing to achieve channel coordination, the manufacturer will need to set* c_2 *to be less than or equal to* $(m-s)/2$ *in order for its expected profits to not decline.*

Proof: Without channel coordination, the manufacturer's expected profit will be:

$$EM(Q_1^*) = \left(\frac{p_1 + g - c_1}{p_1 + g - s}\right)(c_1 - m)(B - A) + A(c_1 - m) \qquad (3.3.24)$$

Comparing equation (3.3.24) with equation (3.3.23) gives the desired result.

Corollary 3.3.8 *If demand follows a uniform distribution and the manufacturer sets consignment pricing to achieve channel coordination so that its expected profits do not decline, a necessary condition for* $p_1 \geq 0$ *is that* $p_1 \geq g + s$

Proof: The result follows from Theorems 3.3.4 and 3.3.7.

Summary

This chapter discussed the research environment of Supply Chain Coordination, Newsboy problem and Supply Chain Management. The next chapter introduces the mathematical model used in solving the problem being discussed.

CHAPTER FOUR

4.0 Data Analysis

Visited Angel Herbal Industry, had an interview with the marketing manager where the following prices were obtained.

The prices as it stands now at the industry is the cost of manufacturing (m) a bottle of the Angel Herbal Mixture is Gh¢1.50p and thus a carton goes for Gh¢37.50p which contains 25 bottles, when it's been retailed the retailer gets it for Gh¢1.70p per bottle when he/she buys more than 20 cartons or Gh¢2.00p when he/she buys less than 20 cartons. So the cost price (c_1) will be Gh¢42.50p using the retailer who bought more than 20 cartons. The retailer then sells a bottle for Gh¢2.50p thus the selling price (p_1) of a carton will be Gh¢62.50p. We consider the following two examples. In the first example we deal with a case in which $p_1 \le g + s$. Suppose:

$p_1 = Gh¢62.5, c_1 = Gh¢42.5, g = Gh¢50, s = Gh¢20, m = Gh¢37.5p, \text{ and } f(x) = U(0,80)$

If the retailer does not have the option of obtaining items through consignment, we know from the newsboy problem solution that the retailer's optimal purchase quantity would be $Q_1^* = 60$. In this case the retailer would earn an expected profit of:

$$
\begin{aligned}
EV(60) &= \int_0^{60} \left[62.5x + 20(60 - x)\right] \frac{1}{80} dx \\
&\quad + \int_{60}^{80} \left[62.5 \cdot 60 - 50(x - 60)\right] \frac{1}{80} dx - 42.5 \cdot 60 \\
&= Gh¢118.75p
\end{aligned}
$$

and from equation (3.3.24) we have that the Angel Herbal Industry would earn a profit of $60 \cdot (Gh¢42.5 - Gh¢37.5p) = Gh¢300$. Total channel expected profit in this case would therefore be $Gh¢418.75p$.

Under channel coordination, the optimal order quantity would satisfy the relationship: $F(Q^*) = \dfrac{p_1 + g - m}{p_1 + g - s}$, which for this example, results in a value of would be: $Q^* = 65$. The total channel expected profit in this case would be:

$$EP(65) = \int_0^{65} \left[62.5x + 20(65 - x)\right] \frac{1}{80} dx$$
$$+ \int_{65}^{80} \left[62.5 \cdot 65 - 50(x - 65)\right] \frac{1}{80} dx - 37.5 \cdot 65$$
$$= Gh¢432.42p$$

Thus, by coordinating the channel, total channel expected profits would increase by $Gh¢13.67p$ or 3.16%.

Now, let us assume that the manufacturer offers the good on consignment to the retailer at a cost of Gh¢15, e.g. $c_2 = 15$. We know from Theorem 3.3 that p_2 should be set equal to satisfy the relationship:

$$p_2 = \frac{c_2\left(p_1 + g - s\right)}{m - s} - g$$

Hence p_2 should be set equal to 29.29.

In this case, we can use equations (3.3.12) and (3.3.13) to determine the Q_1^* and Q_2^*. Solving the relationships:

$$F\left(Q_1^* + Q_2^*\right) = 0.8108 \text{ and } F\left(Q_1^*\right) = 0.4322 \text{ gives } Q_1^* = 30 \text{ and } Q_2^* = 35$$

For these values the retailer's expected profit would be:

$$EV(30,35) =$$
$$\left[\frac{(62.5 - 29.29 - 42.5 + 15)^2}{62.5 - 29.29 - 20} + \frac{(29.29 + 50 - 15)^2}{29.29 + 50} - 50\right]\frac{(80 - 0)}{2}$$
$$= Gh¢183.83$$

the manufacturer's expected profit would be:

$$EM(30,35) =$$
$$\left[\frac{(62.5 + 50 - 37.5)(42.5 - 37.5)}{62.5 + 50 - 20} - \frac{(42.5 - 37.5)^2}{2(62.5 - 29.29 - 20)}\right](80 - 0)$$
$$= Gh¢248.62p$$

Thus, we see that even though channel coordination is achieved, this is at the expense of the manufacturer seeing a Gh¢51.38 decline in expected profit.

In fact, from the above illustrations, unless Angel Herbal Industry selects a value of less than or equal to Gh¢8, their expected profit would be less than if it did not offer the goods on consignment. If, however $c_2 \leq Gh¢8$, then $p_2 \leq -Gh¢8$. Since Angel Herbal Industry would have great difficulty convincing a retailer to take goods on consignment if $p_2 < 0$, revenue sharing in this case would result in a lower expected profit to them. As mentioned earlier, one possible way around this dilemma would be for Angel Herbal Industry to require the retailer to make a side payment to them. This side payment would have to be equal to a large enough portion of the retailer's expected increase in profit so that both the retailer and Angel Herbal Industry show some gain from revenue sharing. While such an approach has appeal, Angel Herbal Industry may also face difficulty in convincing the retailer to make such a side payment.

Now let us consider a case in which $p_1 \geq g + s$. In particular, suppose

$p_1 = Gh¢62.5, c_1 = Gh¢42.5, g = Gh¢30, s = Gh¢20, m = Gh¢37.5p, \text{ and } f(x) = U(0,90)$

In this case, without revenue sharing the vendor's optimal order quantity would be $Q_1^* = 68$, the retailer's expected profit would be Gh¢210.58p, and the resulting profit of Angel Herbal Industry would be Gh¢340. If the channel were coordinated, the total channel expected profit would be Gh¢553.62p, representing a potential increase of Gh¢3.04p. If Angel Herbal Industry sets $c_2 = Gh¢9$ for example, then p_2 would need to set at Gh¢7 in order to achieve channel coordination. Using these values, Angel Herbal Industry's expected profit would increase to Gh¢229.09p and the vendor's expected profit would increase to Gh¢144.44p. Here we see that since $p_1 \geq g + s$, channel coordination can be achieved in a manner that increases both the vendor's and Angel Herbal Industry's expected profits.

CHAPTER FIVE

Conclusions And Recommendation

The main purpose of this thesis is to show the effect of Newsboy model and channel coordination in supply chain management is to merit the transition from the traditional ordering policy to a revenue-sharing policy design to fully integrate manufacturer-retailer distribution channel in a standard newsboy setting. In most cases the traditional order policy favours the retailer more in terms of profit that brings us to the revenue sharing policy. A necessary demand-distribution-dependent condition is derived under which the transition to revenue sharing benefits the manufacturer as well. The manufacturer also benefits indirectly from the market development spurred by the full integration of channel under the proposed revenue-sharing policy. From that perspective, the proposed revenue-sharing under channel coordination can be viewed as a management policy that drives locally optimal decisions towards globally optimal ones.

As shown, revenue sharing is an intriguing method for a manufacturer to achieve channel coordination. The two models as discussed in the earlier chapter, shows that revenue sharing without channel coordination the retailer gains more in profit than the manufacturer in this way as a result to a lost to the manufacturer. However, the second model which is the revenue sharing with channel coordination shows both the retailer and the manufacturer gaining which brings about a win-win situation. Unfortunately, if the manufacturer wishes to maintain the win-win outcome pricing structure for the good while allowing for revenue sharing, the retail price will be very low and for the protection of price in the market and to achieve an optimal revenue sharing ratio, there can be a reasonable negotiation between the retailer and the manufacturer with a possible side payment from the retailer because without that the manufacturer's expected profit would actually decrease.

Appendix

Proof of Equations (3.3.22): From equation (3.3.17) we have for a uniform distribution that:

$$EV\left(Q_1^*,Q_2^*\right)=\left.\frac{\left(p_1-s\right)x^2}{2\left(B-A\right)}\right|_A^{Q_1^*}+\left.\frac{p_2x^2}{2\left(B-A\right)}\right|_{Q_1^*}^{Q_1^*+Q_2^*}-\left.\frac{gx^2}{\left(B-A\right)}\right|_{Q_1^*+Q_2^*}^{B} \qquad (3.3.A.1)$$

From equation (3.13) we have that

$$Q_1^*=\left(B-A\right)\frac{p_1-p_2+c_2-c_1}{p_1-p_2-s}+A \qquad (3.3.A.2)$$

From equation (3.3.15) we have that

$$Q_1^*+Q_2^*=\left(B-A\right)\frac{p_1-g-c_2}{p_2+g}+A \qquad (3.3.A.3)$$

Substituting (3.3.A.2) and (3.3.A.3) into (3.3.A.1) and simplifying gives

$$EV\left(Q_1^*,Q_2^*\right)=\frac{\left(p_1-p_2-c_1+c_2\right)^2}{p_1-p_2-s}+\frac{\left(p_2+g-c_2\right)^2}{p_2+g}-g\frac{\left(B-A\right)}{2}+A\left(p_1-c\right) \qquad (3.3.A.4)$$

Proof of Equation (3.3.23): From Equation (3.3.18) we have for a uniform distribution that

$$EM\left(Q_1^*,Q_2^*\right)=\left.\frac{\left(p_1-p_2-s\right)x^2}{2\left(B-A\right)}\right|_{Q_1^*}^{Q_1^*+Q_2^*} \qquad (3.3.A.5)$$

or

$$EM\left(Q_1^*,Q_2^*\right)=\frac{\left(p_1-p_2-s\right)\left(2Q_1^*+Q_2^*\right)Q_2^*}{2\left(B-A\right)} \qquad (3.3.A.6)$$

From equation (3.3.14) we have

$$Q_1^*+Q_2^*=\left(B-A\right)\frac{p_1-g-m}{p_1+g-s}+A \qquad (3.3.A.7)$$

Define $Q_1^*=\alpha\left(B-A\right)+A$, where $\alpha=\frac{p_1-p_2+c_2-c_1}{p_1-p_2-s}$ and $Q_1^*+Q_2^*=\beta\left(B-A\right)+A$, where $\beta=\frac{p_2-g-c_2}{p_2+g}$. Then from (3.3.A.6) we have:

$$EM\left(Q_1^*, Q_2^*\right) = \left(p_1 - p_2 - s\right)\left(\beta - \alpha\right)A + \frac{(\alpha+\beta)(B-A)}{2} \qquad (3.3.A.8)$$

But, from the definition of α and β we have:

$$\begin{aligned}
\left(p_1 - p_2 - s\right)\left(\beta - \alpha\right) &= \left(p_1 - p_2 - s\right)\frac{\left(p_1 + g - m\right)}{\left(p_1 + g - s\right)} - \frac{\left(p_1 - p_2 + c_2 - c_1\right)}{\left(p_1 - p_2 - s\right)} \\
&= \frac{\left(p_1 + g - s + s - m\right)\left(p_1 - p_2 - s\right)}{\left(p_1 + g - s\right)} - p_1 + p_2 - c_2 + c_1 \\
&= \frac{(s-m)\left(p_1 + g - s - p_2 - g\right)}{\left(p_1 + g - s\right)} + c_1 - c_2 - s \\
&= \frac{(m-s)\left(p_2 + g\right)}{p_1 + g - s} + c_1 - c_2 - m \\
&= c_1 - m \qquad (3.3.A.9)
\end{aligned}$$

The last substitution in (3.3.A.9) follows from equation (3.3.16). From (3.3.A.9) we have that

$$\begin{aligned}
\frac{p_1 - p_2 - s}{2}\left[(\beta - \alpha)(\beta + \alpha)\right] &= \frac{(c_1 - m)(\beta + \alpha)}{2} \\
&= \frac{(c_1 - m)(\alpha - \beta + 2\beta)}{2} \qquad (3.3.A.10)
\end{aligned}$$

But from (3.3.A.9) we have that $(\alpha - \beta) = -\frac{(c_1 - m)}{p_1 + g - s}$. Hence, from (3.3.A.9) and (3.3.A.10) we have

$$EM\left(Q_1^*, Q_2^*\right) = -\frac{(c_1 - m)^2}{p_1 - p_2 - s} + \frac{2(c_1 - m)\left(p_1 + g - m\right)}{p_1 + g - s}\frac{B-A}{2} + A\left(c_1 - m\right) \qquad (3.3.A.11)$$

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