The logistics of milk collection: an exploratory case study between New Zealand and Brazil

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Abstract

Logistics has became one of the most important activities for all companies where has been treated as strategic function to gain competitive advantage over a companies` competitors.

Agribusiness as any other business is also using logistics tools in their supply chain to reduce their chain cost and more important to improve their business efficiency as a whole. Transportation is one of the logistics activities that most influences price of product which in some cases can represent 25% of the final price.

Milk collection for a dairy business plays an important part in the overall performance of the company. A poor milk collection system jeopardise the entire chain as it is the first stage of the manufacturing process.

The main purpose of this work is to identify and describe the possible differences and similarities between a Brazilian and New Zealand Dairy Company regarding their logistics of milk collection.

Even though the two companies are in the same business segment they are inserted in different environments/markets therefore need to deal with different issues regarding milk collection such as companies` structure, milk production's cycle, and routing and scheduling applications. However, both understand the importance of the logistics activities and apply tools in their chain to improve their efficiency.

Due to its size and market share the New Zealand Company has a better collection system in place than the Brazilian Company. Both have implemented some changes in the last few years that brought some improvements for their milk collection.

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Chapter 1 Introduction

1.1 Introduction

The first part of this chapter covers the background of the study such as the importance of logistics and the history of milk in Brazil and New Zealand. Furthermore, it is presents the objectives and hypothesis.

1.2 Background

1.2.1 Increasing Importance of Logistics and its Influence in Dairy

Globalization and the competitiveness of markets have brought a lot of changes due mainly to the development of the new commercial and financial technologies implemented by the companies.

The logistics activities of movement and storage have been used by companies for many years. The current innovation is on the coordination management of the inter-related activities which have developed from the traditional management format to the integrated management or inter-functional coordination (Ballou, 2004), responsible for processing the incoming products to the plants and distributing the final products to the consumers (encompassing all activities that support production such as purchasing, warehousing, transportation, insurance, banking, packing and packaging, exporting and customer service) and place where they have been requested at the least possible cost (Stock and Lambert, 2001; Ballou, 2004), adding value to the companies' products when the stock is correctly placed to facilitate the sales (Bowersox and Closs, 1996).

Managing and enhancing the logistics activities is one of the most important tasks for the companies, as customers as well as shareholders are putting pressure into the companies to seek ways to decrease their costs while at the same time increasing performance through improving the efficiency and effectiveness of their operations (Stock and Lambert, 2001; Kujawa, 2003).

The dairy company's supply chain is as complex as any other chains. The distribution and collection of milk is one of the problems that bring concerns for dairy

companies, especially when considering transportation. Its supply chain includes carrier companies which allows the transportation of raw materials and final products, other companies which supply products to support the production such as packaging, other raw materials required to produce dairy products as well as machines, and the final member of the chain is the final consumers or another company that is going to use the dairy material to produce another product.

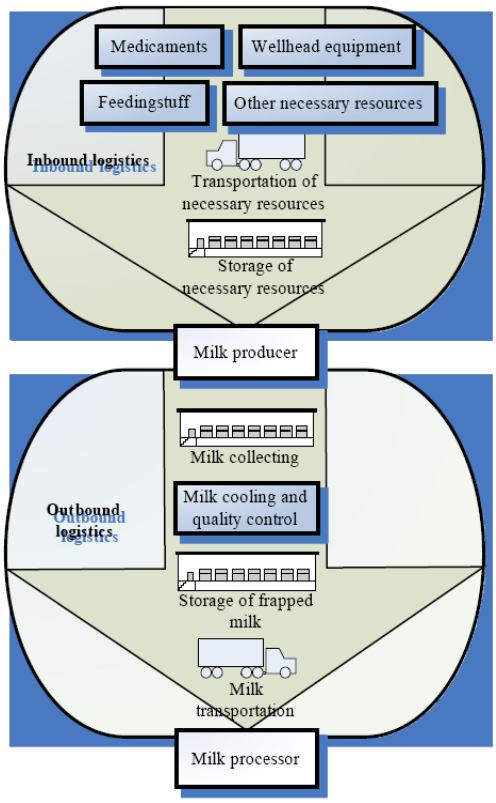

Figure 1.1 - Flow of material resources in the dairy production sector (Radzele and Krieviņa)

And so its success and competitiveness in the market deeply depends on transportation cost which is strongly linked to the companies` logistics infrastructure. Many of the problems can be seen during the transport of milk from farms to the factories and from there to the final consumer where road conditions and trucks used to transport the milk are an important part of this issue.

Logistics costs, especially the ones related to transport, can represent an excessive fraction of the business` total cost and this can be from 5% to 35% of the product's final value depending on the sector to which the company belongs, the geographic location and the trade-off between the product weight and product value.

For some companies, the logistics cost can represent the second highest cost of the product among the others, surpassed only by the cost of the products sold. (Bowersox and Closs, 1996; Ballou, 2004).

Companies are spending an important part of their capital to reach high standards of logistics operational performance and more economic configurations for its production chains without compromising its customer service level (Ballou, 2004; Chopra and Meindl, 2007).

As with many other categories, the dairy market has many companies competing for its market, including multinational and national companies and cooperatives. They all share a policy of high investments in technology, marketing and production. Even small dairies know that they need to keep up with technologies and improve their chain in order to compete in the national and international market. These investments are to improve the whole production chain which includes the milk collection and the distribution of their final products to consumers/customers.

The International Monetary Fund- IMF has completed studies to determine the logistics costs in relation to the economy of the nation and the companies, which concluded that the cost of the logistics represents around 12% of GDP in the world (Stock and Lambert, 2001; Ballou, 2004). In the USA in 2004, the annual cost to perform the logistics activities was around 8.6% of its GDP or US$ 1,015 Billion where transportation cost represents 63.3% of the total logistics cost (Bowersox *et al*, 2007).

Due to the differences between countries, the logistics cost can be different. In Brazil, the logistics cost represents, in 2004, 12.6% of the GDP which is a considerable drop from the 17% in 1996 (Lima, 2006).

Improvements in logistics have positive affects on prices paid for goods and services, the balance of national payments, currency evaluation, the ability to compete effectively in global markets, industry profits, the ability to raise investment capital, economic growth – leading to a higher level of employment, interest rates, productivity, energy cost and availability of goods (Bowersox and Closs, 1996; Stock and Lambert, 2001).

Although the logistics costs are significant, the main focus of interest is not on how to contain the costs, but on logistics ability that some companies had developed to create competitive advantage (Bowersox and Closs, 1996, Bowersox et al, 2007).

Traditional logistics systems were not worried about the issues that its activity could bring to the environment. They only aim to minimize costs and maximize profits (Wu and Dunn, 1995). However environmental issues will become another important concern as consumers have modified their behaviour from price to quality and now they are changing it again towards conscience, especially consumers from developed countries. They are demanding environmentally friendly products produced under sustainable systems with minimum pollution (Stafford, 1993). Packaging and transportation will be greatly affected where packaging will move towards more recyclable type products, while transportation will need to undergo vast changes as fossil fuels become scarce and cycle time becomes more important as a competitive tool (Fleischmann *et al*, 2000).

All companies, including dairies, must evaluate environmental impact from the total system perspective in addition to the traditional trade-offs, such as transport versus inventory, inbound versus outbound logistics, transport costs versus transit time and customer service versus logistics cost (Logozar *et al*, 2006).

Logistics in Brazil is significantly complicated due basically to the country's dimensions and its industrial area that is concentrated in the developed regions such as the south east region that includes the three main states in Brazil - Sao Paulo, Minas Gerais and Rio de Janeiro. Lack of modal options, and road conditions are factors that increases the logistics cost of road transport in Brazil.

Milk production has traditionally been one of the most important agricultural sectors in New Zealand, representing a large contribution of labour and productivity of the country. Its overall efficiency of the utilization of production resources, modern technologies and economy of scale are interconnected making its milk production structure one of the best in the world.

Due to its distinctive geography, being constituted of two islands, and its location in the world far away from the biggest markets and customers, logistics activity must be well developed and managed in order to add value to the final product. The internal transport system is mainly done on road and rail and almost everything that is exported must be done by ship.

1.2.2 History of Milk Industry

Many years ago, humans started to domesticate animals that could provide milk for the family/community. At the beginning, the nomadic communities used to farm them and take them to where they were going to.

As the years have gone by and civilizations began to be formed, people started to own dairy animals and milk them in order to supply milk for their own family and local villages. At that time, the dairy farmers did not have large numbers of animals and used to milk them using their own hands.

As the industrial era began and cities started being formed around the industrial areas, it was necessary to develop the milk supply system. Farmers changed their amateur process to become more professional. They increased their numbers of cows and started farming herds which were more suitable for dairy process, that is, different from those used for beef or draught animals. In addition to the increase in milk production and size of herds, farmers had to employ more people to milk their cows.

Soon after, some mechanization was applied to the farms as milking machines were designed to make the work easier and more efficient. At the beginning of the commercial era, the farmers milked and processed the milk on their farms to make dairy products such as butter and cheese. Later on, they further developed the process and began to use machines to separate the cream from the milk. After separation, the cream was transported to a factory where it was processed to make butter. The transportation cost at that time was really high as roads weren't well built and the trucks used were not refrigerated. Consequently farmers, who were not close to the factories, could not afford the cost of sending their skim milk to factories and used to throw it away or feed other farm animals with it. In fact, only farms that were close to factories could afford to take whole milk to them as it is indispensable for making cheese in industrial quantities. This situation began to change in the late 1950`s when refrigeration systems were developed and better roads were built. In was refrigeration system that allowed the farms to store their milk for a period of time until the trucks collect and take it to the factories (Wikipedia website, 2007).

The dairy industry involves processing raw milk into products such as consumer milk, butter, cheese, yoghurt, condensed milk, dried milk (milk powder), and ice cream, using processes such as chilling, pasteurization, and homogenization.

History of Milk Industry in New Zealand

Dairy farming is part of a long and proud agricultural tradition in New Zealand.

The first record is dated early in the 19th century, when in 1815, Reverend Samuel Marsden imported cattle to Russell from Sydney, Australia. The dairy cattle were imported to provide milk, butter and cheese for the missionaries (Holmes *et al*, 1987).

As early as 1846, only six years after the signing of the Treaty of Waitangi, the first exports began. In 1871, the first dairy company was established, the Otago cooperative Cheese factory. By 1882 New Zealand was exporting refrigerated shipments – a worldwide first – of meat and butter from Port Chalmers, Dunedin to London on the ship "Dunedin" (Dairy Companies association of New Zealand web site).

The advent of refrigerated shipping enabled New Zealand to develop a substantial dairy export trade to the United Kingdom, which remained the largest export market until as late as the 1970s, when Britain joined the European Union (Dairy Companies association of New Zealand web site). Also, the use of refrigerated shipping has provided favourable transport conditions to the New Zealand product to reach distant consumers and so more dairy companies were opened as results of increase product demand. In 1885 there were 23 factories and the number was increased to 218 in 1895. Furthermore, new milk products were developed such as condensed milk, and casein and lactose (Holmes *et al*, 1987).

The New Zealand dairy industry had grown to 372,000 cows by 1900 producing about 102 kilograms of milksolids per cow per year. As the production increased so did the exports and revenue. Mainly to Britain and Australia, the export generated revenue of NZ$2.16m which represented 8.5% of New Zealand's export earnings and consisted of 10,000 tons of butter and 5,200 tons of cheese. In 1905, there were 15,600 factory suppliers with an average herd size of 25.5 cows (Marshall, 1996).

The companies' numbers kept increasing and by the 1930s, more than 400 separate dairy co-operatives were operating throughout the country. However the search for more efficient manufacturing processes made the companies consolidate

operations, therefore by 1998 there were only 11 companies around the country which ended up only one in 2001, when Fonterra Cooperative Group was formed.

The New Zealand Companies have always been export driven however its main export market has changed from the 1970s. Now the United States is its largest single market and the United Kingdom has been surpassed by Japan and several other Asian markets that barely existed 30 years ago (Dairy Companies association of New Zealand web site).

History of Milk Industry in Brazil

The history of the dairy industry in Brazil is totally related to the evolution of the national economy and occurred in three phases (Furtado, 1998):

1st - The colonial phase (century XV to XVIII)
2nd - The republican phase (centuries XVIII and XIX)
3rd - The contemporary phase (century XIX and XX).

During the colonial phase, cattle were brought to Brazil by the Portuguese in order to supply towns and villages which had just been established. These cattle were used to do some farm work and also to provide meat as well as milk.

During the republican phase, the selection of appropriate breeds was taken in order to produce more milk and supply the country. The first breed was the Dutch Taurino.

Furthermore at the contemporary phase, the introduction of improved milking European breeds occurred such as Guernsey and Jersey. The first cattle herds of Jersey breed were formed in the countryside of Minas Gerais state, from where they spread to the whole country.

Between 1910 and 1920, the first milk business farms were founded to produce and distribute milk in order to make a profit. In 1918, the Oliva da Fonseca Co, pioneering on the production of milk powder in Brazil, was funded. In 1920, it changed its name to Fábrica de Produtos Alimentícios Vigor and inaugurated the condensed milk plant in Itanhandu, Minas Gerais (Alves, 2000).

The 1920`s were characterized by the discovery of the Brazilian market by multinational dairy companies. They brought new technologies and a new mix of products to the national dairy sector (Alves, 2000).

In July of 1939, the Sao Paulo government set a new regulation policy which prohibited the commercialization of milk that has not been pasteurised (Alves, 2000).

In the 1940`s the dairy industry underwent important changes such as standardization of the distribution packaging, transportation of the milk which was previously done by pushed vehicles with these being replaced by motorized vehicles and also, in this period, the Federal Government instituted the price control of milk sold in the country. This policy lasted until middle 1990.

The 1950`s and 1960`s were considered the golden periods for the dairy industry due to the increase in roading which guaranteed the milk transportation in bulk for long distances. Another essential factor was the consolidation of the machinery industry (machines and equipment) that helped to modernise the growing dairy industry.

Until the end of the 1980`s, the Brazil government controlled the price paid to the producer and the final consumers. The milk cooperatives and national companies dominated the pasteurized milk markets and the multinationals were competing in other parts of the dairy market such as yoghurt, dairy desserts, etc.

In the 1990`s the dairy market underwent more changes which affected the whole chain. The abolition of the milk price control brought new companies interested in investing on the market. Consumers started getting products with more quality and better price due to market competition. Nowadays, Brazil is one of the biggest milk producers in the world (Alves, 2000).

1.3 Objectives

1.3.1 Problem Statement

Milk distribution in agribusiness has become one of the major problems that the dairy companies are now facing, especially when it comes to transporting the milk. The milk collection, its transportation to the dairy plants and its cost depends on the logistics infrastructure of the dairy company. Therefore, it is necessary to

implement a good logistics management system in order to obtain an efficient system that avoids building up cost.

Many problems can occur during the transport of milk from the farms to the cooperatives or reception stations and from the plants to the final consumer. These problems are not only related to the road infrastructure, which is a government responsibility, but also by the trucks used for the transport of raw milk and the storage system used to keep the milk in acceptable condition.

It is expected to find that the companies studied in this work have different logistics structure. In addition to problems with the technology used in milk collection until its transformation into products, the companies belong to different environments with diverse economies and infra-structure. Due to these differences, several problems can occur within the milk collection process.

Among the problems that can cause loss of the raw material and, consequently deficit for the studied companies are:

- Lack of technology on the farms
- The transport of the milk from the dairy farms to the dairy plant or reception station
- The absence of trucks with cooling systems for the transport of raw milk
- The absence of an efficient system to unload the trucks and tankers

In fact, the problem is more complex as it not only involves technical aspects but also the need to change the culture of the farms regarding the modernization of its production. However, nowadays farmers have realized their survival depends on the modernization of their processes in order to maintain their competitiveness.

1.3.2 Objectives

The general objective of this work is to identify the problems related to logistics of milk collection and also to compare the two companies and their milk collection/system and process.

The specific objectives are:

- To define agribusiness

- To study the use of logistics and its application in agribusiness
- To determine which are the problems faced by the logistics of milk collection
- To identify the differences between milk collection processes

1.3.3 Hypothesis

Hypotheses have the function to direct a work and therefore a subject/topic can be introduced and concluded. In this thesis, the hypotheses are tested through the observed comment and bibliographical revision of the subject/topic. The hypotheses are:

H_1 - The milk collection system used by the New Zealand company is much more developed than the one used by the Brazil company.

H_2 - The use of Decision Support System (DSS) is essential for the management of milk collection.

H_3 - The better the planned collection, and the less contact with the milk, the less chance of contamination.

In this thesis, the above hypotheses are tested through literature review and two case studies that provide necessary information to carry out the study.

Chapter 2 Literature Review

2. 1 Introduction

This chapter provides an overview of the literature which is believed to be relevant for this thesis. This review covers the concepts of agribusiness and cooperatives, the definition of logistics and its role in supply chain management, the definitions of logistics transport and its divisions, routing and scheduling, and outsourcing.

2.2 Agribusiness

After the Second World War, agriculture went through a modernization of its process of doing business. Farmers decided to implement new technologies on their farms and also implement new management techniques to better run their farms. At the time, all the farming activities suffered a huge expansion and increasing specialization due to the influence of economical development and growing urbanization.

This new agricultural business environment forced the farmers to specialise in core activities, that is, cultivation and animal breeding operations and reassign the other activities such as storing, processing and distribution of animal products as well as the supply of input and production factors to organizations other than the farm (Silva, 1996).

In order to obtain a definition which fits all the members of the chain, from the farmers to the final consumers, and also representing this new environment, Goldberg and Davis created the term agribusiness in 1957 to describe the high degree of interdependence that then existed between the worlds of agriculture and business. According to them the agribusiness concept is the sum total of all operations involved in the manufacture and distribution of farm supplies; production operations on the farm; and the storage, processing, and distribution of farm commodities and items made from them (Coclanis, 2005).

They took an important initial step in attempting to treat agribusiness like a differentiated activity, with its own concepts and characteristics. All studies by Davis

and Goldberg are focused on the notion of systemic vision that goes from the agricultural producer to arrive at the distribution of final products (Binotto *et al*, 2004; Coclanis, 2005).

Nowadays, agribusiness organizations are preoccupied with improving their competitiveness, flexibility and agility. These organizations are aiming to reduce costs and improve the quality of their products and services. In order to leverage their competitive advantage, these agribusiness organizations must have people who are aware of the importance of the service delivery by them (Binotto *et al*, 2004).

Davis and Goldberg (1957) also said that the modern farmer has become a specialist who has had his operations reduced to growing plants and bringing up animals. Other activities have been transferred, for the most part, to outside the farm gate (Silva, 1996).

From 1970s onwards, due to globalization, farmers have been depending on incomes from selling their products in international markets. Therefore, in order to meet the global market standards and lower the cost, industrialization of production has been implemented by the agribusiness companies that begin to have large-scale production units and use standardized technology and new management techniques (Boehlje, 2003).

All the segments of the agribusiness are now moving toward industrialized production. Cattle feeding moved to the industrialized model in the 1960s and 1970s. However, the dairy and pork industries are still transforming to the industrial model, with the current transition largely to be completed by 2010 (Boehlje, 2003).

In Brazil, agribusiness also follows the concept of Davis and Golberg (1957) and is responsible for about 40% of total value exported. Therefore, it is considered one of the most important activities for the Brazil economy (Furlanetto and Cândido, 2006).

Brazilian agribusiness has built up its agricultural strengths and found itself a place in the global market as a leader in exporting agricultural products. Examples of its achievements are its recent world leadership in beef exportation, second place in soybean production and becoming one of the major producers and exporters of sugar (Binotto *et al*, 2004).

New Zealand agribusiness has also a huge influence on New Zealand's economy and is heavily dependent on overseas trade. In fact, agribusiness has been and continues to be the main export industry in New Zealand. In the year to June

2007, dairy products accounted for 21% ($7.5 billion) of total merchandise exports and its largest company is one of the biggest in the world. It is responsible for almost one-third of the international dairy trade. Other agricultural products are meat, 13.2%, wood, 6.3%, fruit, 3.5% and fish, 3.3%. Furthermore New Zealand's wine industry is building up strength, expanding and gaining importance in the world market. New Zealand's major markets for meat are the USA, United Kingdom, Canada, Germany, France, Japan and the Middle East where dairy products are exported mostly to the Asia/Pacific region. New Zealand produces 60% of the world trade in strong wool, and 13% of the total world wool production (New Zealand External Trade Statistics, 2007).

2.3 Logistics

One of the first indications of Logistics activities was in Old Greece. Due to the long distances it was necessary to study how to supply the troops with the weapons, foods, medicines, information and strategies about where the troops should be established in order to conquer victories (DHL web site, 2008).

During World War II, logistics was used to supply the United States` allies. After the war, the American population was anxious to consume new released products; however the companies were not prepared to meet the demand with agility. Neither its production nor its distribution was capable to supply the huge demand. At this time, the managers realized they were losing sales, not meeting their customer's needs and logistics was used to deliver the products faster and with quality.

In Europe the consumption was at a slower pace compared to the US because it took longer for them to recover from the outcomes left after the war. The European concern was about how to carry its production to the whole continent.

Logistics started being used more frequently by companies around the world when Intelligence Technology (IT) was developed and implemented in the companies (Dias, 1993; Stock and Lambert, 2001). However, most of the Brazilian companies, in middle 1990`s, did not fully use logistics tools but the food industries had to study and apply it due to the difficulties to distribute all its products around the country (Dias, 1993).

According to Dias (1993) and Stock and Lambert (2001) logistics is responsible for the movement of materials and products, through the use of

equipment, labour, and installations, in such a way that the consumer has access to the product at the right time, and at the least cost that they agree to pay for it.

It is also necessary, in the study of logistics, to distinguish supplier, customer and final consumer. The supplier is the company that produces, transforms the product to sell and to distribute in the retail. The customer is everybody who is between the final suppliers and users, the supermarkets, for example. The final member of this chain is the final consumers/customers who go to the supermarket to purchase products (Dias, 1993).

However there is another member of this logistics chain which is the primary producers of the material necessary to supply the supplier in order to produce a consumable product which will be the farms, in the case of a dairy chain.

Some years ago, the concept of logistics covered only the transport, supplies and storage however it has been changed since and nowadays is seen as an integrated chain. This chain is formed by the relationship between suppliers, production, distribution and customer through flow of materials and information (Stock and Lambert, 2001).

Logistics is thus playing more and more of an important role in company performance, in particular for companies seeking to increase their competitive advantage and corporate profitability. This competitive advantage gained through the use of logistics can place the company in a better position in terms of customers' preference and it is obtained when a company has the ability to differentiate itself, in the eyes of the customer, from its competition, and to operate at a lower cost, and therefore a greater profit than its competitors. Competitive advantage is obtained when the activities that companies perform such as designing, producing, marketing, delivering, and supporting its products are integrated (Kujawa, 2003).

The Council of Logistics Management (CLM) define "logistics management as that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of raw materials, in-process inventory, finished goods, services and related information from the point-of-origin to the point-of-consumption (including inbound, outbound, internal and external flows) in such a way as to meet customers' requirements cost-effectively and ensure that current and future profitability are maximised" (Kujawa, 2003, Chapter 2, page 9).

Logistics is a combination of five basic activities that work together and depend on each other (Stock and Lambert, 2001):

1. Purchase
2. Flow of material (goods)
3. Storage of material
4. Delivery of material
5. Information Flow

According to Stock and Lambert (2001) Logistics is fundamental to: Purchasing and Supply, Materials Handing, Materials Management, Production Planning, Production Control, Transport, Storage, Distribution, Project Management, Installation and Servicing, Re-use and Recycling and Strategic Management. The management of these activities helps companies to increase the value of their goods which strengthens the customers` satisfaction (Stock and Lambert, 2001; Ballou, 2004; Chopra and Mendill, 2007).

The logistic activity must be measured in terms of availability, operational performance and flexibility. The availability means that the company must have enough products to supply the customer at the right place and time. The operational performance refers to the time between the act of receiving the order and delivering the order. Flexibility shows the capacity of the company to respond to unexpected situations (Bowersox and Closs, 1996; Ballou, 2004).

The global market has allowed companies to look around and search for better and cheaper suppliers that provide high quality materials at low costs. A good integrated logistics system can positively impact the profit of companies. Each $1.00 saved makes much more impact at a profit level than $1.00 increase sale. This happens because of the cost of goods sold has other cost associated with them (Stock and Lambert, 2001).

These outputs and the inputs of the logistics management process also can be summarised as follows (Stock and Lambert, 2001):

Outputs of the logistics management process are:

- Competitive advantage for the organisation resulting from a marketing orientation and operational efficiencies and effectiveness
- Time and place utility

- Efficient movement to customer
- Proprietary asset of the organisation

Inputs to the process, with respect to services or products (raw materials, in-process inventory, and finished goods), obtained from various suppliers, include:

- Natural resources (land, facilities and equipment)
- Human resources
- Financial resources
- Information resources
- Technical resources

Stock and Lambert (2001) and Kajuwa (2003) say that the overall logistics objective is to minimise the total costs given to the customer, where the logistics total costs is a sum of:

- Inventory carrying costs: these are costs that vary with the level of inventory stored and include capital, inventory service, storage space, and inventory risk costs.
- Lot quantity costs: is a combination of production or purchasing costs.
- Warehousing costs: are all the expenses that can decrease or increase as a result of a change in the number of warehousing facilities. The number of warehouses used in the logistics system will also have an impact on the levels of inventory.
- The cost of customer service: management must minimise the total of the other cost components for a desired level of customer service.
- Order processing and information costs: are costs for order transmittal, order entry, order processing, related handling costs, and associated internal and external communication costs.
- Transportation costs: are the costs associated with the transportation function and can be identified in total and by segments, that is, inbound/outbound, and by vendor/customer/mode/carrier/product/channel.

The uses of the theory, the technique and the methods of logistics implemented have significantly helped to increase its manufacturing efficiency through optimization of its process such as delivery, production, storage, and information systems.

2.4 The Role of Logistics in the Supply Chain

In the last few years, with the globalization of the economy, competition has increased to a world-wide level. Consequently, the capacity to produce at the least cost possible has become a factor of survival for companies.

The relationship between suppliers and customers, and how they fit into the supply chain environment, has been the subject of much discussion. Traditionally, such relationships were seen as adversaries. Nowadays it is really important to consider not only the suppliers but all parts involved in the supply chain, from the suppliers of the supplier until the final customers (Stock and Lambert, 2001; Kajuwa, 2003).

Supply chain management (SCM) is the integration of key business processes from the end user through to original suppliers that provide products, services, and information that add value for customers and stakeholders (Stock and Lambert, 2001; Chopra and Meindl, 2007).

A well implemented supply chain allows companies to have a better market understanding and a quicker response to the customer's needs.

According to Kujawa (2003, chapter 2 page 12) "logistics is concerned with how to create a single plan for the flow of products and related information through a business chain. On the other hand, supply chain management is concerned with how to build upon this plan and framework, seeking to achieve linkage and co-ordination between processes of other entities in the chain or network (suppliers and customers) and the company itself".

In addition supply chain management should be focused on the management of relationships between buyers and sellers in order to achieve a more profitable outcome for all parties in the chain (Kajuwa, 2003).

Due to the increasing demand, managers are finding themselves in a complicated dilemma of how to attend to this demand and also keep the company

competitive and profitable. Therefore supply chain management is treated as a strategic tool to achieve the best trade off between customers' service and profits.

Nevertheless, Supply Chain aims to (Chopra and Meindl, 2007):

- Engage all customers involved in the chain until the final customers through integration and coordination of various parts of the companies.
- Involve various independent organizations.
- Involve flows of products (material and services) and information in both directions.
- Have objectives of delivering good products to the customers through the right use of its tools and to build a competitive chain as a whole.

Chopra and Meindl (2007, page 5) say that "the primary purpose for the existence of any supply chain is to satisfy customer's needs, in the process of generating profits for itself. Supply chain management activities begin with a customer's order and ends when a satisfied customer has paid for his or her purchase".

The supply chain for a particular product or service is thus the collection of all components or activities associated with the creation and final delivery of that product or service. A strong link between each part of the process aims to obtain the optimization of the whole process and thus maximize the customer's services at the same time as minimize the cost and lead time (Christopher, 1998).

Supply chain management assumes a strategic position in the company as it will process the necessary information about suppliers and customers and use this to enable the whole chain to reach the best performance. All the information, strategic and operational, needs to be circulated between suppliers and the company and be used to take the necessary action at the right moment to increase the company's ability to compete and increase the profit through customer's satisfaction.

Management should use the total cost analysis tool to control the cost of integrated supply chain system. In order to achieve a high level of customer service, management should minimise total supply chain costs rather than attempting to minimise the cost of individual activities to obtain the best performance (Stock and Lambert, 2001; Kajuwa, 2003; Chopra and Meindl, 2007). Thus improvement of the

profitability of the chain is obtained through minimising the total cost of transportation, warehousing, inventory, order processing and information systems, and lot quantity cost, while achieving a desired customer service level.

In addition to seeing the chain as a whole, considering all involved links during the management of products, service and information, it is also necessary to set achievable results with focus on increasing profits, utilization of the process and cost reduction through (Kajuwa, 2003):

- Understanding customer needs: companies must separate their customers in groups, understand their needs and aspirations in order to create and manage a supply chain that meets their needs.
- Logistics operations: normally companies tend to standardize the logistics system for the whole process (stocks, storage and transport). However, companies should design and personalise a logistics system for each of their customers in order to provide a better and personalized service to obtain improved profitability.
- Market signs: management must keep an eye on the market in order to respond quickly to market needs. It is also necessary to line up the production or service according to the new demand and communicate the changes to the whole chain to avoid losses.
- Product characteristics: a well integrated and coordinated supply chain will respond quicker to any changes in the product characteristics.
- Strategic administration of the supplier: a good relationship and communication with suppliers is needed in order to avoid carrying extra stock which will increase the cost of the product supplied.
- Development of technology strategy: the development of a technology strategy which incorporates the whole supply chain and supports the decision making process creates opportunities to change the supply chain through electronic transactions and stock reduction.
- Key performance indicators: a method of measuring the performance of supply chain members is necessary to check if the chain is performing in the way they expect.

Also, supply chain management needs to identify the chain members, the constraints in the chain, recognize which part of the chain needs to link with each other and how to link them, that is, the structure of the chain. Therefore, it is important for SCM to decide the chain configuration that will be implemented to support the chain and/or a new product development and/or marketing strategies.

The chain configuration is the principal phases of the SCM which involves (Chopra and Meindl, 2007):

- Supply chain strategy or design: in this phase the strategy and/or design of the chain for the next years and all resources necessary to support it is decided.
- Supply chain planning: in this phase the strategy is decided for the next year or semester. Based on more accurate forecast it will be determined how to better reach the market using the company facilities defined by supply chain strategy.
- Supply chain operations: responsible for the performance of the chain activities on daily/weekly basis. The operations are responsible to take the customer order and dispatch it using the facilities set up by the supply chain strategy and supply chain planning.

Sinclair (2002) says that a successful supply chain should definitely increase shareholder value as it will maximise the return on funds employed through reducing operating costs. Furthermore, the larger the company, the larger will be the savings from an efficient supply chain.

As the success of a good supply chain strategy is shared by all members of the chain so it is its failure. The ineffective management of a supply chain such as those that cause production and shipping delays jeopardise the profitability and destroy shareholder value and consequently decrease the value of company shares.

Furthermore, even if the losses occur in one link of the supply chain, that is, on the supplier manufacturer, or customer, it will affect the overall performance and companies can lose their market value and share (Sinclair, 2002; Kujuwa, 2003).

2.5 Logistics of Transport

Transport is the way used by companies to move goods/products from A to B through the many stages of the supply chain. The transport activity has an enormous influence on the level of the services and on the efficiency of the supply chain. The choice of the transportation model will have a great impact on the customer perception of the service provided. The preference for a faster transportation mode will reduce the delivery time, on the other hand, it will increase the transportation cost. Transportation activity plays an important role as an indicator of the stock levels and localization of the installations in the supply chain (Chopra and Meindl, 2007).

According to Rushton *et al* (2006), the selection of transportation mode must look at some key stages as shown on Figure 2.1.

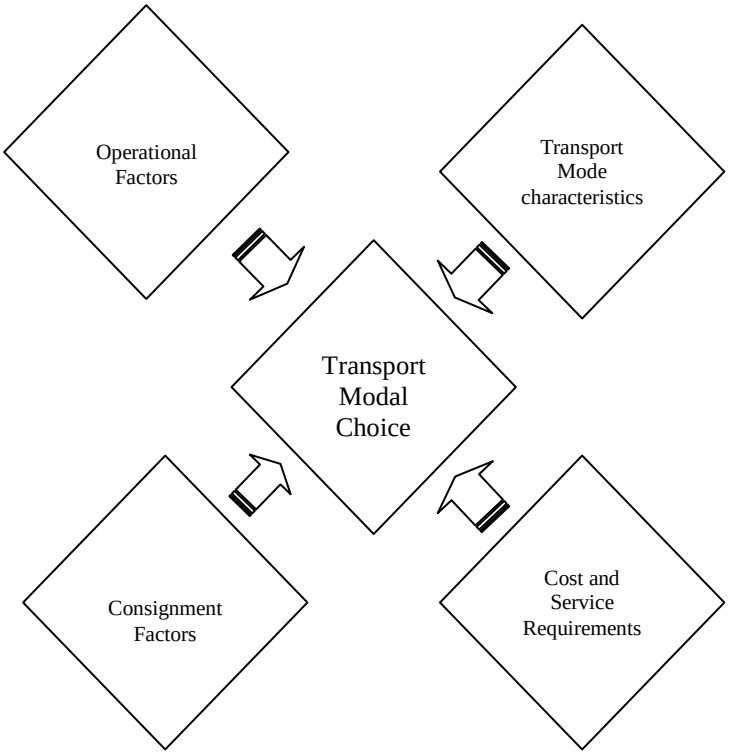

Figure 2.1 – Mode Choice: Selection Process (Rushton et al, 2006, page 362).

Companies use transportation activity as a competitive tool, to provide a better service for the customers who demand a high level of service, as well as for companies whose transportation cost is critical for their results and consequently must be optimized. Considering the stock level as one of the crucial factors for the performance of the supply chain, the companies must find the balance between the

stock level and transport cost in order to reach efficiency in cost and offer high level of service in order to meet the customers' expectation.

"Transportation usually represents the most important single element in logistics cost for most of the firms. Freight movements have been observed to absorb between one-third and two-thirds of the total logistics cost" (Ballou, 1999, page 135).

According to Chopra and Meindl (2007) all the decisions taken by the companies related to the project and operations throughout the supply chain must consider the following ways of transport: air, road, rail, water and pipe.

Each of these transportation modes has its specific characteristics regarding capacity, speed, dimensions, trustworthiness and flexibility. Before choosing the mode or intermodal that will be used to best meet the customer's needs in terms of service levels and efficiency is necessary to further study (Rushton *et al*, 2006):

- External factors: country/ region infrastructure, trade barriers, export controls and licence, law and taxation, financial institutions and services, and economic conditions of the region/country, communications systems used in the region/country, culture, and climate. These factors need to be considered especially in case of international transportation mode choice.
- Customer Characteristics: service level requirements, delivery points constraints, credit rating, terms of sale preference, order size preference, customer's importance, and product knowledge. These customers' characteristics need to be addressed for national and international transportation mode choice.
- Physical nature of the product: volume to weight ratio, value to weight ratio, substitutability (product alternatives), special characteristics (hazard, fragility, perish-ability, time constraints, security).
- Other logistics components: supply point locations, production plant locations, warehouse and storage facility locations, depot locations, marketing plans and polices, and existing delivering system.

Companies can choose from several types of transportation to move their raw materials and products. This availability allows the companies to contract the carrier

companies whenever it suits them, that is, they can contract the carrier company only when they need or have a contract with them, or even have their own fleet. The carrier companies have taken the responsibility for all activities related to the transport, assuming the responsibility for the planning, programming, collection, invoicing, delivery and control of information. It is also responsible for making investment decisions regarding its equipment, such as trains, airplanes, trucks, ships and in some cases railway infrastructure. They also make operational decisions in order to maximize profit from the use of their assets. On the other hand, the shipper uses the carrier service to minimize its cost related to inventory, transportation, IT and others while providing a good service for its customers (Bowersox and Closs, 1996; Chopra and Meindl, 2007).

Below are some of concepts to get a better understanding of the transportation activity.

a) Movement of Products

The transport is an activity that permits the movement of raw material and final products throughout the supply chain, from the primary suppliers until the final customers (Chopra and Meindl, 2007).

As its primary function, transportation is responsible for product movement up and down the value chain such as materials, components, assemblies, work-in-progress, or finished goods to the next stage of the manufacturing process or physically closer to the final customer. It is important that products be moved only when it truly improves product value (Bowersox and Closs, 1996; Bowersox *et al*, 2007).

According to Bowersox and Closs (1996) and Chopra and Meindl (2007), time is the most important factor when any transportation decision is taken. Thus, it is also necessary to look at the time spent during the transportation from A to B, as during that time the product is not available and therefore cannot be used. Furthermore, the longer the transportation time the greater is the cost. It also increases the uncertainty about the delivery of the products and may affect the final quality of product.

Bowersox and Closs (1996) also say that transportation has a huge impact on the environment as the vehicles used to move the products is one of the biggest

consumers of fuels and oil. In the United States, for example, transportation consumes 67% of all the oil used in the country.

Even with the application of new technologies and operational practices that permit the reduction of fuel consumption during transportation, consumption levels tend to be steady due to the distance of global commerce. Another problem created by the transportation is the pollution that is generated by the vehicles. It also aggravates problems in urban areas and increases noise pollution, with serious consequences for the quality of life, especially in the big cities (Chopra and Meindl, 2007; Bowersox *et al*, 2007).

Summarizing, the main objective of transportation is to move products between the members/phases of the supply chain as fast as possible, with lower cost and minimal effects on the environment.

b) In-transit Inventory

Although the vehicles are an expensive form of storage system, in some situations, they can be used as viable storage area, that is, when the products need to be stored for a short period of time (few days) before getting moved again to other locations, it can be more economical to leave the products in transportation, as the cost of loading, unloading and reloading and capacity constraints can be more expensive than to store the products in a vehicle or even when the warehouse has space limitations. This alternative is really useful as the in-transit inventory will not need to be unloaded and reloaded again later on. Therefore, it can be justified from a total-cost or performance perspective and be considered as a viable storage option (Bowersox and Closs, 1996; Bowersox *et al*, 2007).

The in-transit inventory has become a crucial factor for the performance of the logistics due its huge impact on the logistics total cost and its influence on the availability of products to the customers. The amount of financial resources involved on the movement of products is generally significant. The investments and the costs of maintenance of the fleets combined with the operational and administrative costs represent for many companies the biggest part of total logistics costs.

Managers try to reduce in-transit inventory to a minimum when designing a new logistics system which is much easier nowadays due to the improvements of information technology (Bowersox *et al*, 2007).

c) Economy in Scale and Distance

"There are two fundamental economic principles that impact transportation efficiency: economy of scale and economy of distance" (Bowersox *et al*, 2007, page 168)".

The economy of scale in production is obtained by increasing the ratio between the load and capacity of the transport and reducing the unit cost of the product transported. Obviously, when all the capacity of the vehicle is used it will be less costly than if it used only part of the vehicle (Bowersox and Closs, 1996; Bowersox *et al*, 2007).

The transport operations have variable costs, such as fuels and oil as well as some fixed costs, such as labour, IT services used to process the transportation and invoicing orders, time to position the vehicles for loading and unloading and fleet insurance, and tax. These costs are considered fixed because they do not vary with the volume of the load (Chopra and Meindl, 2007).

Furthermore, the economy of distance is possible because the transport fixed cost is reduced when the distance increases. In this case, along with fixed costs listed above, it is necessary to include the load and unload costs which are distributed over the distance, that is, the unit fixed cost per distance for a 2,000km trip is, in theory, half of the cost of 1,000km (Bowersox et al, 2007).

d) Parties Involved in Transportation

Chopra and Meindl (2007) suggest that there are also some parties that play an important role in the performance and effectiveness of logistics of transport into the supply chain which are:

- The shipper: the party that requires the movement of the product from A to B.
- The carriers: The party that transport the products from A to B, and therefore it owns the transportation's vehicles.
- The owners and operators: the party that owns the infrastructure for the transportation such as ports, canals, roads, rail, airports, etc.
- The government: The party that sets the transportation policies locally and worldwide.

For Bowersox *et al* (2007), there are another two parties that can be added in this system due to their importance nowadays in the logistics of transport: the internet and the public. Figure 2.2 illustrate the relationship between the parties.

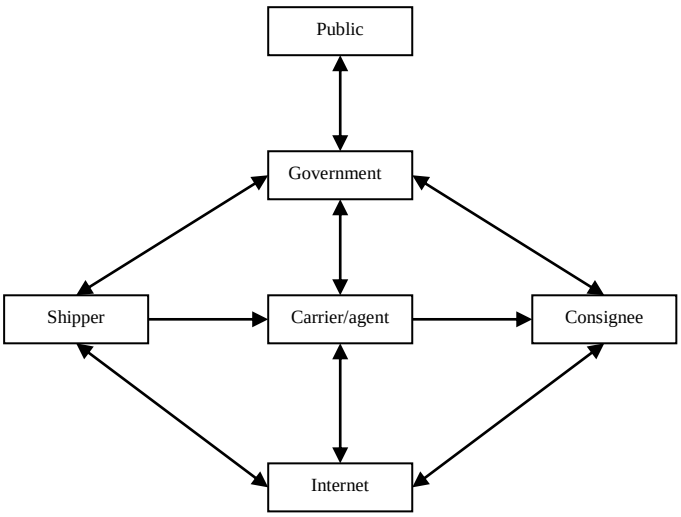

Figure 2.2 – Relationship among transportation parties (Bowersox et al, 2007, page 169)

Generally, these agents operate independently and have different interests.

The shipper and consignee have the same objective which is to move the products from A to B within a particular time for the least possible cost. The carrier's intention is to charge the freight as high as the supplier agrees to pay, and try to minimize the labour, fuel and vehicle usage costs. In order to achieve this, the carrier needs to negotiate flexible delivery time in order to consolidate less than truckloads (LTD) to full truckloads (TL) which will reduce the transportation cost.

The government has the biggest interest in the transports` transactions as they are considered critical factors for the sustainable growth of the economy. In many countries the government has taken either full responsibility or played a significant role building and managing these infrastructure elements such as roads, seaports, airports, rail, and canals that are some of the major infrastructure elements that exist along nodes and links of the transportation network (Chopra and Meindl, 2007)

Beyond the strategic importance, it also allows the government to look at the movements of the products which can prevent tax evasion. In many countries, the government adopts tax incentive policies to support research and technological

development. In the United Kingdom and Germany, the government owns its own transport to secure the absolute control over the transactions, services and freight taxes (Bowersox and Closs, 1996).

The public wants to have access to the services, the cost and the effectiveness of the transport, as well as security and protection of the environment. Although the improvements over the last decades in relation to the pollution and security of the transport, some of the problems relative to the environmental contamination and the bad conditions of the vehicles used to transport is still putting the public at risk.

The internet has a huge importance on exchanging information between the parties. It can provide information on fuel purchase, equipment and parts usage, and suppliers, that is, all operational information that can be used to identify opportunities for improvements of the system (Bowersox et al, 2007).

2.6 Transportation Modes

"The transportation infrastructure consists of rights-of-way, vehicles and carrier organizations that offer transportation services on a for-hire or internal basis" (Bowersox and Closs, 1996, page 316).

The basic modes of transports are: rail, highway, water, air and pipelines. The importance of each mode can be measured by the volume each one carries, the distance covered, the generated profit and the nature of the traffic compositions. Table 2.1 shows the commercial activity in the US in 2002.

Mode	Freight Value ($Billion)	Percent Change Since 1993	Freight Tons (Billions)	Percent Change sense 1993	Freight ton - Miles (Millions)	Percent Change since 1993
Air(includes Truck and air)	777	96.7	10	45.9	15	63.2
Truck	6,660	42.2	9,197	26.4	1,449	55.5
Rail	388	39.2	1,895	19.9	1,254	29.9
Water	867	39.9	2,345	10.2	733	-16.9
Pipeline	285	-8.7	1,165	3.8	753	27
Multimode	1,111	67	213	-7.5	226	36.7

Table 2.1- Commercial Freight Activity in US, 2002 (Chopra and Meindl, 2007, page 387)

In Europe, the most used transportation mode is the road freight, it will tend to continue like this for many years ahead, followed by the sea and inland waterways which are more used for bulk movements of products around the European coast. The rail mode is more used in large countries or where environment issues or restrictions are involved (Rushton *et al*, 2006).

"The effectiveness of any mode is affected by the equipment, investment and operating decisions by the carriers as well as the available infrastructure and transportation policy" (Chopra and Meindl, 2007, page 388).

In the next two decades, freight transportation will face some critical issues such as (Roop, 2008):

- Increase demand on highways
- Increase in maintenance expenditures
- Decrease in funds available for capacity expansion
- Diminishing returns on highway expenditures
- Projected growth in freight
- Increased truck traffic
- Environmental issues & restrictions
- Homeland security constraints
- Insufficient public funds available to address transportation needs

2.6.1 Rail

According to Bowersox and Closs (1996) rail freight was once the most used transport mode in the U.S.A due to the extensive rail network which provides connection to the majority of the cities and states.

After World War II, rail freight started having the competition of road transport that was introduced by the construction of roads and express highways in order to support the growth of vehicles and trucks.

Considering the impact on the gross revenue generated, it dropped from 40% in 1950 to 20.9% in 1982. In 1990, the rail freight companies had carried 37.4% of the total volume transported. This figure did not change until 2000.

The main advantage of rail freight over the other modes is, transportation efficiency of great volumes over long distances (Rushton *et al*, 2006). The fixed costs related with this mode are high due to the investment in equipment used to provide maintenance of the railway lines or concession payments to the state.

On the other hand, the variable costs of tons per kilometres is relatively low and keeps decreasing due to the substitution of steam energy to oil and electric motors, and technological improvements of the equipment. Therefore the use of variable costs is still more advantageous for long distances (Bowersox and Closs, 1996).

Bowersox and Closs (1996) and Rushton *et al* (2006) have noticed a clear intention to renovate the rail freight mode in order to meet the new competitive strategies adopted by the companies such as:

a) The alliances with road transporters to offer an efficient form of intermodal transport;

b) The technological innovations to reduce the weight of the wagons and containers in order to facilitate the loading and unloading, and increase the capacity and the speed of the transport;

c) The implementation of quality programs that will focus on the customers` satisfaction and efficiency.

d) The integration of all regional offices into only one national office leading to the consolidation of the operations in only one distribution centre which will receive all the investments in information systems and communication.

Railroads provide a range of special services to the shipper, including the movement of bulk commodities such as coal and grain to special cars for refrigerated products and new cars which require special equipment (Ballou, 2004).

It can also provide other offerings such as (Ballou, 2004):

- Expedited service to guarantee arrival within a certain number of hours.
- Various stop-off privileges: permit partial loading and unloading between origin and destination points.
- Pickup and delivery.

- Diversion and re-consignment: allow circuitous routing and changes in final destination of a shipment while in route.

However, even with all the improvements it still has some disadvantages (Rushton et al, 2006):

- It can provoke some damage to the product due to the lack of shocks in old wagons.
- There is a need of double handling in many cases.
- Its high maintenance cost.
- It's almost impossible to ship from origin to destination.
- Can be slow.
- Incompatibility of structure in international movements (different track gauge sizes, bridge weights and lack of electrification.

2.6.2 Road

The road use grew quickly in U.S.A., after the 2nd World War. This growth in the road transport sector was stimulated by the flexibility of vehicles to operate on all types of road, allowing door to door service and the flexibility of transportation between cities and states (Bowersox and Closs, 1996; Ballou, 2004; Chopra and Meindl, 2007). In Europe, the road transportation is also used for international transportation even to countries with geographic constraints like the UK (Rushton *et al*, 2006).

Due to its versatility, the road mode practically dominated the sector of transporting products between wholesalers and retailers. According to Bowersox and Closs (1996), in 1990 in the U.S.A., almost all intercity transportations less than 7,000 kg, were transported by road carriers. In 2002, it was responsible for 64% of all commercial value transported and 58% of the weight transported (Chopra and Meindl, 2007).

Despite the advantages above, this mode faces high costs of replacing equipment, maintenance, driver's wages, platform and dock wages and others such as cost of licenses and the tolls which are directly related to the type of vehicles used and

the distance covered in miles. In fact, the labour wages have a huge impact on the cost of the road carriers also (Bowersox *et al*, 2007).

Over the years, many initiatives have been implemented to minimize the transportation costs, such as: the implementation of information systems to better manage transportation planning; the mechanization of the load and unload terminals; the use of a single power unit to pull two or three trailers; the integrated coordination of intermodal systems to optimize the resources in order to reduce the labour costs (Chopra and Meindl, 2007).

The road mode consists of three segments: the truckload (TL), less than truckload (LTL) and the specialized carriers. The truckload segment has covered the necessities of transport above 7,000 kg that generally do not need load consolidation, and only moves the loads between the supplier and the final customer. The TL segment is the better one when compared with the other two due to the fact there are large numbers of small carriers that can offer competitive prices for this service (Bowersox and Closs, 1996). The TL has also a relatively low fixed cost especially for large shipments as the products price per unit gets lower (Chopra and Meindl, 2007).

The LTL takes care of the load below of 7,000 kg that generally need intermediate terminals to consolidate loads in order to become an economically viable transport unit. The elevated costs with the terminals and labour have led companies to merge their businesses, resulting in fewer companies.

In order to reduce their costs, the LTL carriers need to have a consolidation centre where the small loads are unloaded and consolidated to improve the vehicle usage (Chopra and Meindl, 2007).

Specialized carriers cover the necessities of movement of small packages, dangerous goods and oversize loads.

2.6.3 Water

Bowersox and Closs (1996) say the ocean and rivers are the oldest way used to move products from A to B. The old sail-boats were replaced by steam-boats at the beginning of XIX century and later by the oil engine.

"In global trade, water transport is dominant mode for shipping all kinds of products. Cars, grain, apparel, and others products are transported by sea" (Chopra

and Meindl, 2007, page 391). In 2001, U$718 billion in merchandize value was transported from the USA to overseas ports and 78% of weight was transported inside the USA.

According to Bowersox and Closs (1996), Chopra and Meindl (2007) and Rushton *et al* (2006), the main advantage of water transportation is the capacity to carry large volumes, and its cost compared to the other modes.

This system operates with two types of boats. The ones projected to sail in oceans and waterways and to access the appropriate ports, and the other ones designed to sail in rivers and canals, with less loading capacities, however with more flexibility to access to inland ports.

The water mode has many limitations such as speed and accessibility to ports and ships. If the origin or the destination of the products is not near to the port, complementary transport through the rail or road is necessary. Thus, this mode is more viable to large volumes of loads, or when one requires a low freight cost with less concern for the delivery time.

According to Ballou (2004), the weather has a great impact on the viability of the use of the water mode. Due the development of barge-carrying ships, the capability and handling of products have increased as well as further improvements on satellite navigation with radar, refined depth finders, and auto piloting.

Besides speed and accessibility, the equipment used to unload/load and the labour also affects the efficiency of the water mode. Many delays can occur due to port congestion, customs security and the size of the containers used (Rushton et al, 2006).

In addition, the needs of double handling and rough sea movements make this mode more likely to provoke damage on both products and packaging. It also needs to be integrated with the other modal systems of the supply chain (Rushton et al, 2006).

According to Bowersox and Closs (1996), the internal transport for sailing rivers and waterways will continue to be a viable option in the logistic systems. Low speed of the water mode can be used as a form of in-transit storage.

2.6.4 Pipelines

Both, Europe and the USA, use pipelines to transport some specialized products such as crude petroleum, refined petroleum and natural gas (Rushton *et al*, 2006; Chopra and Meindl, 2007). "In the U.S.A. pipelines accounted for 17% of total ton- kilometres in 2002" (Chopra and Meindl, 2007, page 391).

In the U.S.A., the pipelines, both oil and natural gas, are private and are operated by private companies. Besides oil and gas, there has been some further study in using pipes to transport some solid products suspended in a liquid. These innovations, once it is proved to be viable economically, will expand the use of the pipelines. Furthermore, the pipes are already being used to transport water waste and clean water for cities (Bowersox and Closs, 1996; Ballou, 2004).

According to Bowersox and Closs (1996) and Chopra and Meindl, (2007), the great advantage of the pipes is that they can be operated continuously, except for the maintenance and change of products. Cost wise, the pipeline has the highest fixed cost and the lowest variable cost compared to the other transport modes. The high fixed cost is the result of land access rights where the pipes were installed, the investments in the construction of the underground installations, the control and maintenance of the pumping stations and the other installations that integrate the system.

2.6.5 Air

The air mode is the most recent transportation mode and the least used however its usage has grown fast in the past years. Its great advantage over the others is fast delivery time where intercontinental distances are covered in a few hours, while the other modes can take days/weeks to reach the product's destination. On the other hand, the high cost makes the air transportation less used, except in situations where the high cost can be compensated by the fast delivery time, less inventory, less packaging and less insurance cost (Bowersox and Closs, 1996; Ballou, 2004; Rushton et al, 2006; Chopra and Meindl, 2007).

Besides its high costs, the size, the weight of the load and the availability of aircraft limit the capacity of air transportation. Due to its irregularity and low demand, most of the loads are transported in passengers' flights which are practical

and even economic; however it limits the capacity and the flexibility of air transportation. Nevertheless, there are several companies such as Federal Express, the United Parcel Service overnight and DHL that have their own cargo aircraft due to their performance on a global level.

In order to overcome these limitations some improvements such as new technologies, deregulation, large aircraft, aircraft availability, productivity-improvements programs such as integrated units loads, and handling systems are being implemented in air transport to leverage its capability and drop its cost down to one-half of the current levels (Ballou, 2004; Rushton *et al*, 2006).

The use of this mode started with the transport of documents, extending its market to larger orders. Currently, it offers express delivery and overnight services from the distribution centres to the final destinations. This type of service is recommended for high aggregated value and special deliveries (Bowersox and Closs, 1996; Chopra and Meindl, 2007).

2.6.6 Intermodal

The use of more than one mode to move products from A to B is called Intermodal. The most common intermodal is rail/road however the increased use of containers has leveraged the combination of road/water/rail intermodals.

According to Ballou (2004), there are ten possible intermodal service combinations:

1 Rail - truck
2 Rail - water
3 Rail - pipeline
4 Rail - air
5 Truck - air
6 Truck - water
7 Truck - pipeline
8 Water - pipeline
9 Water - air
10 Air - pipeline

The combination of rail - truck has lower cost comparing to the TL and short delivery times. In the past years, some developments have been done to facilitate the use of this intermodal such as the development of the road-wagon trailer that can be used on the road or on rail (Rushton *et al*, 2006).

On the other hand, intermodals are more complicated to deal with and need a better information system as the quantity of information exchanges increases (Chopra and Meindl, 2007).

2.6.7 Comparison Between Modes

Before making any decision regarding which mode will be used to transport the company's products, managers must look at the costs of installations, fuel, labour, equipments, price (Table 2.2), in order to make the final decision on which mode or modes are going to used.

Mode	Price(ton/mile)
Rail	2.28 (b)
Truck	26.19 (c)
Water	0.74 (d)
Pipe	1.46 (e)
Air	61.20 (f)

a based on average cost
b Class 1
c less then truck load
d barge
e oil pipeline
f domestic

Table 2.2 - Average freight ton-mile transportation price by mode (a) (Ballou, 2004, page 168)

Companies can choose between two types of transportation to move their products which will have relevant influence on the final cost and the final supply chain structure. Companies can contract a shipper company or can have their own fleet. At the first situation the cost or the price that will be charged for the service is a standard price plus some other additional services provided such as pickup at origin, delivery at destination, insurance, and preparing goods for shipment. The second

option, the company will have to allocate other costs such as fuel, insurance, labour, maintenance, depreciation of equipment, and administrative cost (Ballou, 2004).

Bowersox and Closs (1996) developed a table 2.3 which shows the cost structure of each mode.

The type of transportation mode used to provide the service to the customers has a huge influence on the overall performance of a company's supply chain. In order to facilitate the problem of choosing the transportation service it is indispensable to look at the transportation service in terms of characteristics that are basic and most important factors to all services: average transit time, transit time variability, and loss and damage (Ballou, 2004).

Modal:	Characteristics
Rail	High fixed cost in equipment, terminals, tracks, etc. Low variable cost
Road	Low fixed cost (highways in place and provided by public support). Medium variable cost (fuel, maintenance, etc.)
Water	Medium fixed cost (ships and equipments). Low variable cost (capability to transport large amount of tonnage)
Pipeline	Highest fixed cost (rights-of-way, construction, requirements for control stations, and capacity). Lowest variable cost (no labour cost of any significance)
Air	Low fixed cost (aircraft and handling and cargo systems). High variable cost (fuel, labour, maintenance, etc.)

Table 2.3 - Cost structure for each mode (Bowersox *et al*, 2007, page 183)

It is also relevant to the decision process to look at the performance of each mode with respect to cost, delivery time, loss and damage (table 2.4).

Mode of transportation	Cost (b) 1 = highest	Average delivery time (c) 1 = fastest	Delivery time variability		Loss and damage 1= least
			absolute 1= least	Percent (d) 1= least	
Rail	3	3	4	3	5
Truck	2	2	3	2	4
Water	5	5	5	4	2
Pipe	4	4	2	1	1
Air	1	1	1	5	3

a service is assumed to be available
b cost per ton-mile
c door-to-door speed
d ratio of absolute variation in delivery time to average delivery time

Table 2.4 – Relative rankings of transportation mode by cost and operating performance characteristics (a) (Ballou, 2004, page 176)

Summarizing, the final decision on mode/modes to be used depends on logistics trade-off between cost and service. The volume (size) of the freight and distance state the choice of the mode based on relative costs (Table 2.5).

	Size of Order/Load			
100T	road	road/rail	rail/sea	Sea
20T	road	Road	road/rail	rail/sea
Pallet	road	Road	road/rail	air/sea
Parcel	post/road	post/road/air	Post/road/air	post/air
	short	**medium**	**long**	**very long**
	Delivery Distance			

Table 2.5 - Size of Order/Load (Rushton et al, 2006, page 373).

2.7 Designs for Transportation Network

The design of the transport in the supply chain has a huge impact on companies' responsiveness to its customers. The success and performance of companies supply chain starts with recognizing customers' requirements and then on choosing the most appropriate transportation network to reach it.

"All transportation decisions made by shippers in a supply chain network must take into account their impact on inventory costs, facility and processing cost, the cost of coordinating operations, as well as the level of responsiveness provided to customers" (Chopra and Meindl, 2007, page 399).

The network decision must be done after detailed study on the trade off between:

- Transportation and inventory cost
- Transportation cost and customers responsiveness.
- Transportation and handling cost.
- Service level requirements

2.7.1 Direct Shipment Network

In this transport network structure, the carriers pick up and transport the products from each supplier's location straight to each buyer location. In this option, the route of each delivery does not change and the manager only need to decide on quantity transported and the type of transport to be used. The inventory and transportation costs are the ones that need to be looked at in order to make any decision (Sunil and Chopra, 2007).

As the products are directly transported from point A to B there is no need of intermediate storage facilities between the origin and delivery point which is a great advantage of this network. It is also easer to make a decision as the shipments work independently and the transportation time is shorter as the shipment goes directly from A to B.

When the demand from the buyer is high enough to fill or close to fill a TL from each supplier to each location, the use of direct shipment is highly recommended. However the direct shipment tends to have a high cost with small buyer locations (Sunil and Chopra, 2007).

2.7.2 Direct Shipment with Milk Runs

"A milk run is a route on which a truck either delivers product from a single supplier to multiples buyers or goes from a multiple supplier to a single buyer location" (Sunil and Chopra, 2007, page 395).

Different from the direct shipment network the manager needs to decide the route of each milk run beforehand and try to reduce the transportation cost by consolidating the shipments from multiple locations into a single truck load.

This network can significantly reduce the transportation cost, especially when the suppliers are close to the destination point.

2.7.3 All Shipments via Central Distribution Centre (DC)

This type of infrastructure is used when the distance between the suppliers and destination points are great. In this case, the use of a DC can be used to store inventory or transfer locations.

The transfer locations will help to reduce the cost of the chain by receiving large load from some different suppliers. After the products have been received, the orders are separated and consolidated into another truck to be sent to the final destination. In this case there is no hold of products (Sunil and Chopra, 2007).

The DC will work as a storage place if the shipment is very large and final destination cannot hold much inventory. Thus, the DC will send the products using the Cross-docking technique to the final destination only when it has storage space available.

2.7.4 Shipping via DC using Milk Runs

"Milk runs can be used from a DC if the lot size to be delivered to each buyer location is small" (Sunil and Chopra, 2007, page 398).

This network structure will reduce the transportation cost by using the milk runs combining with cross-docking which consolidates the small order into shipments.

This network required a high level of coordination between cross-docking and milk runs activities in order to obtain a suitable scheduling route for deliveries or pick ups of products.

2.7.5 Tailored Network

This network is a combination of different transportation networks such as cross docking, milk runs, TL, LTL and packages carrier. It uses a combination of them to obtain the lowest transportation cost for each situation which will depend on customers and products characteristics as some companies sells different products and quantities, different delivery destination and different costumers. Therefore it needs a high investment in information technology (IT) in order to facilitate the coordination of products and to reduce transportation as well as inventory cost.

2.7.6 Differences between Transportation Networks

The network infrastructure chosen by companies defines the future of company. The performance of its transportation network will provide a trustful service at low cost to its customers. Table 2.6 shows the pros and cons of each transportation network design.

Network Structure	**Pros**	**Cons**
Direct shipping	No intermediate warehouse Simple to coordinate	High inventory (due to large lots size) Significant receiving expenses
Direct shipping with milk run	Lower transportation cost for small lots Lower inventory	Increased coordination complexity
All shipments via Central DC with inventory storage	lower inbound transportation cost through consolidation	Increased inventory cost Increased handling at DC
All shipments via central DC with cross - docking	Very low inventory requirement Lower transportation cost through consolidation	Increased coordination complexity
Shipping via DC using milk runs	Lower outbound transportation cost for small lots	Further Increase in coordination complexity
Tailored network	Transportation cost best matches needs of individual product and store	Highest coordination complexity

Table 2.6 - Pros and cons of different transportation network (Sunil and Chopra, 2007, page 399).

2.8 Utilization of Information Technology

The information technology applied to logistics aims to take the company to a competitive advantage.

The relationship between the members of the chain and also areas inside the company is very complex. Therefore it is necessary to have an understanding of the company's product or service and the relationships between members of the chain to improve the competitiveness and reduce the cost for each one of the chain's members (Barut *et al*, 2002).

The development of computer technology has allowed executives to manage and implement logistics management much more effectively and efficiently than ever before. The speed and accuracy that computers provide can improve the companies` cost efficiency. Managers can use sophisticated techniques to manage and control activities such as production scheduling, inventory control, and order processing (Stock & Lambert, 2001).

Information technology (IT) gathers together all the information necessary for the managers to make the right decisions and consequently to better manage the chain as it makes it easier to process and understand the large quantity of information by using sophisticated analysis, modelling, and decision support capabilities which improves the performance of the companies by reducing errors and increasing efficiency of the work processes. Although it is difficult to obtain information from other members of the supply chain, it can also reduce the negative effects of uncertainty Supply chain IT is critical to logistic operations and strategic planning (Chopra and Meindl, 2007).

However, the exchange of information between companies is not as easy as it seems for reasons such as (Boyson *et al*, 2003, page 176):

- Different systems and standards are used
- The number of relations with other companies in the network is usually too large to manage
- Most systems are not open for easy exchange of information with other systems

- Most companies are very reluctant to share information with other companies in the first place.

There are several types of IT systems that can be applied by companies however it is necessary to analyse the company organizational structure and variables in the chain before the final decision on which IT system will be used (Buttermann *et al*, 2008). EDI, teleconferencing, and voice mail systems reduce the cycle time in communication. Bar-coding and material handling technologies are being used for more efficient distribution centres and inventory management (Boyson *et al*, 2003). Operational methodologies such as Just in Time (JIT), coupled with Enterprise Resource Planning (ERP) which plans how to manage the business resources (materials, employees, customers, etc) are being implemented.

In order to get a better understanding of the implications and improvements that a IT service can bring into the company it is necessary to follow all the physical flows between the members of the supply chain and understand what information needs to be shared with members of the chain such as uncertain demand, information about delivery of products, production capacity, paper work. For this reason, the company must invest in an IT program that can support all this information and also is suitable for the whole company and its members (Boyson et al, 2003).

Managers have realised the importance of IT for their companies after seeing the possibilities that technology improvements have generated. However, the cost of communication and coordination among the many independent suppliers in each supply chain has been a barrier to full usage of IT systems (Boyson et al, 2003).

As an essential tool, the use of Information Technology offers the following key attributes and contribution to creating competitive advantage (Gattorna and Walters, 1996):

- Accurate and reliable information input for decision-making
- The ability to respond rapidly
- Greater knowledge and therefore understanding of the marketplace
- A means of differentiating the business to reinforce its competitive advantage

2.9 Transportation Routing and Scheduling

One-third to two-thirds of the total logistics cost for some companies is generated by the transport activity (Ballou 2004; Coyle *at all*, 2003). However this issue can be addressed by maximizing the use of its fleet, labour and equipment. The better route planning of the trips will substantially increase the overall transport efficiency, reducing its cost.

There are a number of problems such as products that cannot be in-transit for a long time or vehicles/equipment/people that need to have a break after some time working or even products that need to be collected at certain times. All these problems can be resolved with a well implemented vehicle routing and scheduling system.

However, these problems are relatively complicated and need to be addressed differently according to the problem. There are many types of methods and algorithms that can be used to sort the problems out (Rushton *et al*, 2006).

A Company like Whirlpool Corp. had its distance for deliveries reduced by 10% by installing a computerized routing, scheduling and dispatch system, after years of managing its service fleet manually. The reduction in distance ranged from 6 to 30% on individual delivery schedule/routes (Stock and Lambert; 2001).

According to Ballou (2004) the use of one or more modes by the companies must be thoroughly thought out as there are many variations of routing problems such as finding a path through a network:

- Where the origin points are different from the destination
- Where there are many origins points and multiple destinations
- When the origin and destination points are the same.

Before starting to resolve any of the routing problems it is necessary to look at all the activities related to the transportation costs, such as time and distance or a combination of both. Some times the shortest route does not mean the fastest one therefore it is necessary to give weights to travel distance and time in order to obtain the more suitable route for that trip (Ballou, 2004).

There are also some other constraints that bring some complexity to the routing and scheduling plans that need to be addressed such as:

- Each stop may have a maximum volume to be picked up or delivered.
- Vehicle limitations: weight and volume.
- Vehicle and people may have a maximum driving time.
- Pick ups and deliveries can be only done at certain time.
- Drivers and other labour may have to take a rest at certain time of the day
- Different vehicle models can be used.
- Different speed zones.
- Products characteristics.
- Customers service requirements.

2.9.1 Use of Simulation within Supply Chain

The simulation is constituted by a process of modelling and a process of experimentation on this model, with the intention to evaluate the behaviour of a real system under different operational scenes. The simulation models are evaluative models, that is, they evaluate the performance of a scene. The application of the simulation to a supply chain system involves the modelling of each company and the representation of the relation of business between companies (Winston, 1994).

All the information that can be related to the company and their partners need to be analysed. The parts of this information are demand (the forecast and the orders), resources (people, machines, material) and company/partners capacity (storage space, delivering time, etc). After putting all this information together a linear program is designed to simulate the process and its variables.

The definition of linear programming is a mathematical procedure for minimizing or maximizing a linear function of several variables, subject to a finite number of linear restrictions on these variables which means they can be used in wide range of decision making situations, in different areas (Eyefortransport website, 2008).

However, there are restrictions on the total of activities that can be modelled and how many variables, a computer can support. Consequently, managers need to choose the ones which really bring some benefits for the system. Also, the relationship between the activities and their variables must be linear in order to use a linear programme to simulate the supply chain network.

The right use of the linear programme can help the manager to make the decision which best suits the company goal. Analysing transport activity will help managers to find out the best way to move goods from the origin of the material to the destination within supply a chain network (Barut *et al*, 2002).

The simulation of a transportation activity must always try to reach the equilibrated solution, that is, the best solution for the problem. However, this will not happen on many occasions since demand and forecast are not equilibrated. In this case, it is necessary to add some other variables to the equation (Barut *et al*, 2002).

The variable cost is not really easy to calculate due to it having a lot of restrictions that impact on it. Hence, on some occasions is better to use other variables such as total distance travelled in kilometres, total tons delivered or how much fuel consumed. Minimizing these variables will directly minimize the total cost.

There are also other situations where the system will be unbalanced, e.g, the capacity of the warehouse is lower than production capacity, the demand is variable, or the influence of seasonality. Therefore, it is necessary to use a linear programme that simulates the system where all the production reach the warehouses but respecting the capacities of each warehouse and minimum travelled distance (Winston, 2004).

Also, in this case it is possible for example that each warehouse only receives products from one plant or supplier which can also minimize the transportation cost. Furthermore, it is possible to better use of the warehouse's capacities to avoid idle space.

Other variables that can be simulated would be waste of product during the transportation activity or transportation time between plant/supplier to the warehouses or to simulate the situation of demand greater than production or vice-versa.

In addition to improving the supply chain network simulation it would be good to know ways to decide the batch sizes that are going to be produced to minimize the cost without jeopardizing demand (Winston, 2004).

In this case, it is necessary to obtain all information related to the product, the cost of each product and also the resource that will be used to manufacture that mix of product. It is necessary to know all the resources necessary to manufacture the mix of products in each part of the chain network. That is the reason it is important to share information. Without the information from the other part it is impossible to minimize

or maximize any function. After collecting the information and modelling the simulation system, the manager can use the linear programme to simulate real situation and try other combinations of resources to find out the best way to reach the goal.

Consequently, many situations can be simulated to obtain the more suitable strategy to reach the company supply chain requirements such as (Barut *et al*, 2002):

- Production and distribution schedules for an assembly supply chain network which has the intention to determinate which way the products should be assembled to obtain the minimum cost and satisfy the demand.
- The ideal batch sizes to be produced and distributed in the supply chain network with the objective of minimizing the average cost per period during a small or long period.
- The stock levels and the lead times to avoid stockout and dead inventory and also to determine the minimum cost in a supply chain network.
- The production and distribution which maximizes the profitability after tax.
- The best way to use the transportation in order to reduce cost through maximisation of fleet usage.
- The best way to produce and distribute the production in order to minimize the total cost of the chain and satisfy the demand.
- Better understand how the system constrains work and to better manager this. These constraints can be human resources and/or machines and also feasibility, availability, demand limits which will give the answers for amount of finished products to be shipped to each retailer.
- To minimize the variety of products held in inventory and concentrate on the ones that provide greater profitability. This can be done by using variables of lead time and demand required to design the model and stay with the option of the minimum cost.

2.10 Outsourcing in Transport

Globalization has created a competition where companies search for new ways to improve their service, surpassing the difficulties, to guarantee their very survival.

Companies that desire to develop products for global markets need to search for suppliers not only in its internal market but also around the world. This will make companies more competitive but also will increase the supply chain complexity. This picture requires more agile and flexible companies and this is achieved through the synchronizing of their supply chain operations (Kujawa, 2003).

In order to increase their competitiveness in this global market, companies must focus on their core activities and in particular the more lucrative ones, and then outsource the non-core activities. Therefore outsourcing logistics or third-party logistics (3PL) is one of the strategies used by these companies to gain competitive advantage by performing strategically important activities more efficiently than their competitors by reaching markets faster, reducing costs, obtaining leverage by economies of scale, and optimising the supply chains which will make then more flexible and will improve return on investment for the shareholders (Christopher, 1998; Enow, 2003; Kajuwa, 2003; Sangam 2004).

According to Horngren (2000, page 383), outsourcing is "the process of purchasing goods and services from outside vendors rather than producing the same goods or services within the organization, which is called insourcing. Decisions for a producer of goods or services to insource or outsource are also called make-or-buy decisions, sometimes qualitative factors dictate management make-or-buy decision".

However outsourcing can bring benefit to some companies but not for all of them. The choice of outsourcing or keep it in-house will depend on the type of business and its supply chain structure (Chopra and Meindl, 2007). Many companies have experienced problems managing the complex and growing supply chain, in regard to management of: quality, lead-time, delivery reliability and purchasing (Hill, 2000).

For dairy companies, the choice of keeping the milk collection in house or have it outsourced needs to be carefully studied and analysed in order to come up with a decision that best suits that company. It is also necessary to study the market environment where the companies have their business as the conditions and even the way to do business differ from market to market.

Chopra and Mendl (2007) and Ballou (2004) say that outsourcing brings the benefits cited below:

- Better economies of scale

- More efficient procurement transactions
- Better coordination of the chain
- Increasing in profitability for the members of the chain.
- Lower inventory
- Better match between demand and forecast.
- Reduce cost and lower capital activities
- Access to technology and management skills
- Improve customers service
- Competitive advantage such as through increased market penetration
- Increased access to information for planning
- Reduced risk and uncertainty
- Reduction in transportation/distribution cost
- Free up capital in non-core areas

The greatest impact of outsourcing 3PL is in containing logistics costs, with 84% surveyed of respondents reporting positive results in this area. The least positive impact was in the human resources area (Accenture Survey, 2001)

Each market has its own reasons to outsource. The main reason to use outsourcing in Australia is to improve customer satisfaction, whereas in China this is the third reason. New Zealand's first reason is to focus on core business.

Outsourcing has improved productivity and significantly reduced costs in many companies. All areas have faced around 15% reduction in logistics cost and fixed logistics assets which has a lower reduction in USA (16%) and the greatest in Latin America (41%). Furthermore, outsourcing is reducing the average order cycle, reducing inventory and improving the service level in all areas (Sangam, 2004).

2.10.1 The Third Party Logistic (3PL) Usage

"Third parties increase the supply chain surplus if they either increase value for the customers or decrease the supply chain cost relative to a firm performing the task in-house" (Sunill and Chopra, 2007,page 419).

The use of 3PL has been steady or even decreased in the last years in markets such as Western Europe (76%) and North America (79%). However the revenue generated by these services has grown in both areas. The reason is that companies in

the USA have been using 3PL only for transportation and warehousing and now companies are using 3PL as partners and utilizing all the services that 3PL can provide (Sangam, 2004).

A problem that USA and Western Europe 3PL's are facing is the decrease in spending on outsourcing logistics due to the globalization which has moved factories to other countries and brought importation of goods. On the other hand, globalization permits USA companies to use the 3PL services of other areas to reach their market and increase their sales.

Asia-Pacific and Latin America however are expecting to spend more in outsourcing logistics and the market as this service is growing in this region.

Even with all the advantages of the outsourcing, some companies are still avoiding contracting 3PL saying that it will not reduce their costs, there will be a loss of control, service level will decrease, and that logistics is an important activity which shouldn't be outsourced (Sangam, 2004).

2.10.2 3PL Selection Criteria

Globalization has increased the speed of the changes therefore the selection of a 3PL provider needs to be done carefully and with consideration of a long-term relationship. In order to meet their logistics targets, companies must select the outsourcing partners that will make the plan possible.

Cost and profitability are the main reasons to outsource and its decisions involve consideration of strategy issues, detailed financial evaluation, efficiency and risk dimensions relating to supplier quality, lead times and delivery reliability (Tayles and Drury, 2001).

The criteria should cover general information about product lines, price, shipping volumes, financial stability, areas which the company wants to reach, growth forecast, IT system used, quality standards, the value added services which the company expects from a 3PL, and the capacity and compliance that 3PL will put on the partnership for continuous performance improvement (Sangam, 2004).

Therefore, clear and realistic objectives and expectations of a 3PL arrangement will permit a company to establish its selection criteria and better evaluate which 3PL will meet and provide the best service (Sangam, 2004).

2.10.3 The Future of Logistics Outsourcing

With globalization, companies set up operations in many countries to facilitate their logistics and to integrate their local subsidiaries. Thus, the overall perspective is that the market will keep expanding based on acquisition and consolidation of 3PL services providers. The relationship will be focused more on tactical and strategic models and is expecting the 3PL companies to become 4PL (Sangam, 2004).

Logistics must not be seen as a lifting and shifting activity but as an important activity that makes a huge contribution to gain competitive advantage. Therefore, an important reason for the 3PL services growth is that most 3PL providers have specialised their services through differentiation where they offer a variety of service options, for example transportation, to broad activities which cover the supply chain. Providing an overview of logistics into the 21st century, it has been proposed that planning and forecasting will be very important (Sohail and Sohal, 2003).

Other services provided by 3PL will be in IT, of which the use and the complexity will increase in the next years in order to support the supply chain. Companies have been using more 3PL service in order to reduce costs in non-core areas, minimise their inventory, and invest the saving in research and development (Sangam, 2004).

In all markets, the 3PL will have to improve their technology to keep up with the company's needs, thus IT will be responsible for a great part of the growth. They focus on priorities, such as implementing information technologies, developing customized management processes, integrating services and technologies globally, and delivering comprehensive solutions that create value for 3PL users and their supply chains (Sangam, 2004).

Earlier according to Greaver (1998), outsourcing is a strategic tool when it is aligned with the organization long-term strategies. Therefore, after some years of partnership, the company and the provider must analyse the results, either positive or negative, and check the relevance to the company. Companies must ask themselves:

- Vision of its future.
- Current and future core competencies.
- Current and future structure.

- Current and future costs.
- Current and future performance.
- Current and future competitive advantage.

The search for better cost efficiency will drive markets in USA and Western Europe to suffer a period of no growth, especially in areas of value added service. However growth is expected in logistics outsourcing services in both areas, especially in warehouse space at Western Europe.

Asia Pacific area (China, India) and Eastern Europe will be facing the greatest growth in logistics outsourcing especially due to the shifting of factories from USA and will be receiving more investment from outsourcing.

2.11 Summary

This chapter covered all the background that was considered relevant for the study. It first provided an overview about agribusiness and how it fitted into the supply chain environment.

It also explained the concept of logistics and its role in the supply chain, the types of transportation that can be used including its pros and cons, the types of transportation design logistics network, the importance of IT in the logistics and its application on scheduling and routing, and finally the outsourcing of logistics activities.

Chapter 3 Logistics of Perishable Products

3.1 Introduction

This chapter covers the background of the logistics used to transport perishable products. Firstly is an introduction to the transport of perishable products followed by transportation of flowers, fruits and vegetables, ready mix concrete and finalising with milk transportation.

3.2 Introduction to Transportation of Perishable Products

Due to the fact that part of food production is not immediately consumed, it is necessary to preserve the food from its production until its consumption. The quality of the final product depends on how the transportation and storage of the products are done. There are numbers of issues that need to be addressed in order to keep the product's quality (Chonchol, 1989):

- The product must be transported as fast as possible from its harvest/production to its storage place or plant to prevent losses due to climatic conditions. Highly perishable products such as milk must arrive quickly at the consumer or plant, vegetables and fruit must also arrive early at the distribution centres.
- The quantity and quality of storage places, as in many developing countries, the losses are very high due to poor or non-existent conservation.

There are several proposals to avoid this loss; however it would be much more efficient to increase the food availability and its quality through better storage and transportation systems than increasing production (Chonchol, 1989).

The transportation of perishable products is more complicated due to products deteriorating over the time. Perishable products are affected by temperature variations (heat or cold), humidity, other environmental conditions and transportation time. Therefore, it is extremely important that transportation time, handling, storage

and others requirements are well planned in order to maintain the products characteristics when they reach the customers.

Transportation costs (labour cost of the drivers, fuel cost, cost of the trucks, etc) are always a significant component of logistics total cost, especially for companies where the movement of raw material or product is required. These costs are even more important when the transportation of perishable product is involved and special handling is required (Butler *et al*, 2005).

In the past, most perishables had to be consumed around the area where they were manufactured or collected due to the lack of transportation equipment. It was almost impossible to reach long distance and keep perishable product with acceptable quality (Huttner, 2005; Heap *et al*, 1998). However, improvements of transportation facilities have made it possible to reach other areas, regions and markets around the globe (Heap *et al*, 1998).

"The market for fresh and perishable products is increasingly guided by demands regarding freshness, inherent quality and minimum food safety requirements" (Ruben, 2006, page 6). Therefore there are some regulations for production, handling, processing and transportation that need to be followed in order to guarantee and ensure safety and quality of products, and meet the customers` standards (Heap *et al*, 1998).

The ATP – the agreement on the international carriage of perishable foodstuffs on special equipment to be used for such carriage (ATP, 1970) has been signed and used by about 41 countries since 1976. Its application has helped companies to reduce the risk of rejections of damage or poor quality products which can increase the production costs. Investments in quality systems are essential to improve shelf live and control loss of products (Panazzo and Cortlella, 2008). Table 3.1 shows the recommended temperature for transport of some products.

The ATP (1970) regulates the transportation of some foodstuffs and applies rules on certification of refrigerated vehicles used for land and rail transport of them. However, this agreement does not encompass all foodstuffs, as well as other goods such as medical, flowers, cosmetics and high value goods (Panazzo and Cortlella, 2008).

The availability of fresh flowers, exotic fruit and special kinds of meat, fish or seafood and even highly seasonal products has become regular on the markets due mainly to the logistics activity (Huttner, 2005). This is only possible due the

continuous delivery of these products over the year which comes from different countries, unless the producers are able to maintain a harvest planning that permits them to keep producing during the whole year. The logistics of delivering fresh food to markets around world are extremely complex and depend on close coordination between production and logistic activities that consumers are not aware of (Huttner, 2005; Ruben, 2006).

Foodstuff	Maximum temperature
Ice cream	−20 °C*
Frozen or quick (deep)-frozen fish, fish products, molluscs and crustaceans and all other quick (deep)-frozen foodstuffs	−18 °C*
All frozen foodstuffs (except butter)	−12 °C*
Butter	−10 °C*
Red offal	+3 °C
Butter	+6 °C
Game	+4 °C
Milk (raw or pasteurized) in tanks, for immediate consumption	+4 °C
Industrial milk	+6 °C
Dairy products (yoghurt, kefir, cream, and fresh cheese)	+4 °C
Fish, molluscs and crustaceans	Melting ice
Meat products	+6 °C
Meat (other than red offal)	+7 °C
Poultry and rabbits	+4 °C
(*) During certain operations, a brief rise of the temperature of the surface of the foodstuffs of not more than 3 °C in a part of the load above the appropriate temperature may be permitted.	

Table 3.1 - Maximum temperature during transport following Annexes 2 and 3 of the ATP agreement (ATP, 1970) (Panazzo and Cortlella, 2008).

The use of air freight for the transportation of perishable foods is particularly important as many seasonal products such as fruits, vegetables, flowers and fish grow during the year but in different countries. Approximately 15% of the total air cargo is perishables and among this 80% are common perishables such as seafood, fruit or meat. Figure 3.1 shows the movement of perishable products around the globe (Huttner, 2005).

Fortunately improvements have occurred in the transportation of perishable products which permit products to get to customers with the same quality as if they were fresh. The development and design of new types of car for railway

transportation and the high technology tools such as the use of satellites to monitor and control the temperatures in the cars have made possible the transportation of perishable products, especially food (Miller, 2002). Along with improvements on warehouse, hubs, the way of handling products, better integration of modes have increased the capability of intermodal networks.

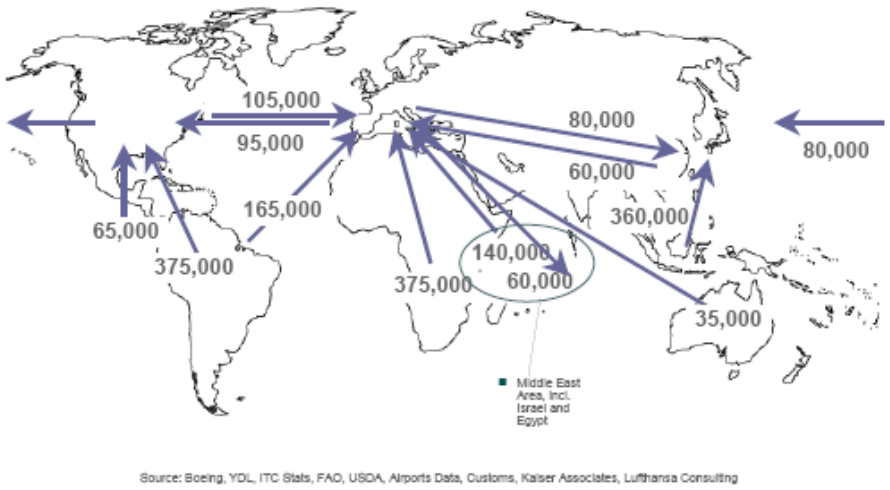

Figure 3.1- Estimate of worldwide perishable flows 2005 in tonnes (Huttner, 2005).

The use of satellite technology has also reduced the logistics cost. Now, the refrigeration system runs during the trajectory from A to B, only when it is necessary. Furthermore, it can reduce the time cars spend at inspection which improves car utilization (Miller, 2002).

However, even with all the improvements, the waste of perishable products from the point of origin until they reach the final consumer is around 40% (Huttner, 2005).

3.3 Fruit, Vegetables and Flowers Transportation

Quality is considered a huge issue when it comes to fruit, vegetables and flowers. Poor quality products are generally discarded by the consumers before they become unsafe (Panazzo and Cortlella, 2008).

Fruits, flowers and vegetables are still alive even after being harvested, continuing to perform life sustaining physiological and metabolic reactions. Thus,

biological changes are still occurring during the storage and transportation activities (Heap *et al*, 1998).

Some products with high value added are more sensitive to long storage conditions; therefore any losses during any stage of the chain have a significant effect on revenue.

The transport of these products must be monitored during their journey as their quality can be jeopardised by any increase or decrease of the recommended storage temperature (Panazzo and Cortlella, 2008). Thus, not only vehicles with refrigeration are of interest to customers, but also those with a heat system to transport the products during the cold season (Radulescu *et al*, 2005; Heap *et al*, 1998).

According to Panazzo and Cortlella (2008, page 434), vehicles for the transport of fruit, flowers and vegetables should have these main characteristics:

- A heating system for compensating for low external temperatures;
- The possibility of rapid air movement, to take advantage of the ‘‘evaporative cooling’’ of the goods, of the air exchange with the external ambient, and to avoid gas concentration build up.

The transportation of minimally processed ready to eat fruit and vegetables also needs special treatment for their storage and transportation. They do receive a treatment to reduce the bacteria growth however the diced and sliced vegetables are more suitable because the cut areas are bigger than in uncut vegetables or fruit which is much easer to be contaminated and also increases the speed of deterioration.

Transportation temperatures play a considerable role in keeping the quality of the final product by avoiding the growth of bacteria, mould and yeast which consequently extends the shelf life that is not very long in this type of product.

Therefore it is also important that the refrigerated vehicles, containers and shipping spaces have been pre-cooled before any product is loaded, especially when dealing with fresh products. In addition, the unloading process into the shipping spaces or cold stores must be done as quickly as possible to avoid any increase in the product temperature which can affect the quality of the final product (Heap *et al*, 1998).

Although the transport vehicles, which may also be called Mobile Cold Stores, have the capacity of maintaining the product temperature as required, they should not

be used to cool the products, that is, the products shall be loaded into the vehicles at its optimum storage temperature (Heap *et al*, 1998).

Generally, after being harvested they are transported straight away, by truck, to the distribution centre where they will be kept for a certain time, packed, pre-cooled and then transported to the final customers or to the airport in case of exportation. In the case of export, intermodal logistics will take place, where the truck will be used to transport the product to the airport or port where products will be transferred to the ship or plane.

The use of ships for the transportation of these types of perishable products is only recommended for those which are less perishable and more resistant to long trips. Bananas and onions are some of the perishable products that are often transported by sea however they do require some special transportation conditions in order to reach the final customers with quality (Heap *et al*, 1998). Flowers, on the other hand, when transported overseas, need to be transported by air due to their short life which is around 20 to 30 days after being harvested (Anafelos, 2004).

3.4 Ready Mix Concrete (RMC) Transportation

RMC has a lot in common with other production and distribution of perishable chains such as agro- foodstuff and hazardous materials (Gargouri and Hammadi, 2003).

Due to a strongly interrelated combination of problems on both operational and strategic levels, the transportation of RMC is very complex (Luh *et al*, 2003). The distribution of RMC is totally correlated with time constraints and resource sharing therefore any short delay in an activity can produce some effects on preceding activities on the chain.

Compared to other perishable products, the RMC has a considerable shorter life, generally about 2 hours after being produced. Furthermore, to increase the complexity of the chain, it must be delivered to the construction site within strict time windows which are given by the customers (Naso *et al*, 2007). Thus, it needs to be produced just-in -time, just before it is handed to the customers (Garcia *et al*, 2002).

Generally, the customers place their order on the day before specifying the time and the quantity needed although sometimes there are some late orders which come up on the day. Some of the RMC suppliers have their own fleet to deliver the

material to its customers, but others don't. It is also important to mention that due to the size of the orders, the load must sometimes be split in two. Even though being competitors, RMC suppliers try to share the fleet in order to gain the ability to satisfy the market requests, because due to the complexity it is almost impossible for one company to supply a whole region (Naso *et al*, 2007).

RMC suppliers use computational resources, that is, simulating computer programs to reproduce the chain in order to (Naso *et al*, 2007*)*:

- reduce the cost of production and distribution
- maximize the amount of supply product
- provide timeliness of the delivery

Although, the production of RMC is fully automated and known in advance, the time the product shall be delivered, customers order, vehicle travel time and even the distance, it is still difficult to reach the ideal solution as some perturbation on the chain can happen such as bad traffic, road closed, different travel speed, truck capacity, fleet availability etc. Therefore it is necessary to monitor the loading docks, trucks viability, etc in order to reschedule the plans without jeopardizing the customers' orders.

The computational program must be designed to show the managers a clear and interpretable view of the chain. "Therefore it is essentially a transparent algorithm in which decisions and priorities can be changed without modifying the mathematical model used by the optimization engine" (Naso *et al*, 2007, page 409).

Even with all technologies, companies still rely on their skilled operators to work out scheduling decisions based on their own experiences or to plan production operations on short time horizons. However, this decision sacrifices the long term optimization of the chain (Feng *et al*, 2004; Matsatsinis, 2004).

The delivery stage of the RMC chain can be represented as more complex routing problem called multidepot multivehicle routing problem with time windows (Naso *et al*, 2007).

3.5 Milk Transportation

Milk is a highly perishable product. It must be processed within a couple of hours after production, unless kept at low temperatures at which it can be stored for 2 or 3 days before processing. The key process of milk logistics is during its collection and cool storage (Ruben, 2006).

The capacity of dairy companies to keep themselves competitive in a market is based on their ability to manage the production cost at an acceptable level. The transportation cost is one of the components which has the most significant impact on the total logistic costs, where the main barrier to improve the efficiency of the productive process is the transportation cost between the producers and the plant (Batalha, 1997; Butler *et al*, 2005). According to Dooley *et al* (2005) New Zealand dairy companies deduct about $0.04 per litre from farms payout to cover cost associated with transportation and storage of bulk milk.

"Significant transportation problems arise both in collection of the milk from farms and the distribution of the final products to shops. Therefore, bulk milk collection is a distinctive logistics application and one where the major transport costs are incurred" (Butler *et al*, 2005, page 341).

The requirements of quality and productivity in the process of milk production have stimulated improvements in the logistics of the milk collection into dairy agribusiness which make possible the reduction of collection routes and the increase in the amount of milk carried by truck, resulting in significant economy in the transportation cost (Martins *et al*., 2004) and increase in profits (Sobrinho *et al*., 1995).

Nowadays, there is a growing demand for high quality dairy products, which puts some pressure on the dairy companies to search for ways to improve their product's quality. In some countries, there is some differentiation on the payment for the milk provided by the farms which varies depending on the fat and protein levels. In Brazil, this type of payment according to the protein and fat levels has been happening since the Instrução Normativa 51 policy (Reis *et al*, 2007).

In the old days, dairy companies were small and milk production was not great, the milk was supplied by nearby farms and collected daily therefore did not spend too much time on its way to the plant. It was also easier to keep the bacteria

growth in the milk under control using a minimum of refrigeration conditions (Dairy Process hand book, 2003).

Nowadays, the situation is significantly different. Milk production is now much bigger, the concern about the quality has increased and the distance travelled is also greater.

The logistics of milk transportation encompasses 3 parts:

1st Part: From the farms to the milk collection stations
2nd Part: From the stations to the plants
3rd Part: From the plant to the customers.

There are some situations where the milk is transported straight from the farms to the plants. According to Sobrinho *et at* (1995), the 2nd Part, that is, from the stations to the plants, represents 4 to 25% of the final milk price and can reach up to 40% in some regions.

Dairy companies must avoid the increase in transportation cost as it will effect the price paid for the milk collected from their farmers. The cost of the milk has two components (Butler *et al*, 2005):

1st – The cost of transport
2nd – The cost of paying the farmer for the milk.

Therefore, dairy companies are always trying to find ways of reducing the milk collection cost by applying an efficient transportation system which allows a higher milk price for the farms.

3.5.1 Ways of Transporting Milk

The milk collection has gone through some changes in order to focus on the quality of the raw material. Until the first half of the 1990`s, in Brazil, the milk was milked on the farms and carried directly to the plants in common trucks using churns (milk cans). From the second half of the 1990`s, bulk milk collection was introduced and quickly spread. This means the milk is transported in trucks equipped with isothermal tanks. The implementation of this bulk milk collection system in Brazil

occurred at a fast pace. It is expected that by 2011, the whole of Brazil will be using this type of milk collection (Martins *et al*, 2004).

The most common methods of milk transportation are using churns and road tankers. In both ways, the milk must be kept at 4°C, free from air and treated as gently as possible.

a) Transportation in Churn

The churns generally have capacity of 20 to 50 litres, have a cylindrical form and are made of tin, steel or aluminium. In this case, the milk is cooled using cold water or ice and then placed into the storage place and moved to the collection point just before the truck comes, collects and takes them to the milk station (Sobrinho, 1995; Dairy Processing handbook, 2003). Milk collection from the collection point has to be well planned so that trucks collect the milk at the same time every day.

After being collected, the churns must be taken straight to the milk collection centres or to the plants. However this type of transportation has considerable affect on the quality of milk, due to bacterial proliferation. This happens because the churns are placed on the side of the road waiting for the truck, which allows an increase in temperature (Sobrinho, 1995). Therefore, it is necessary to build a shed or shelter that protects them from the sun and even better if it has an insulating cover around the churns (Dairy Processing handbook, 2003).

Collection centres must be built in regions where there are not good roads that lead to the dairy farms or when the production is too small to justify the investment in cooling tanks.

b) Bulk Collection

The second option of milk collection is using road tankers. In this case, the milk is collected in bulk from farms which have a special room to keep the milk cooled or have a cooling tank. The last one is becoming more common nowadays.

The bulk tankers have capacity that vary between 300 to 30,000 litres, with an agitator to keep the milk in the tank at a homogeneous temperature and a cooling system to meet the milk storage requirements, that is, 4°C two hours after milking. In

some big farms, there are separate plate coolers for chilling the milk before it enters the bulk tankers (Dairy Processing handbook, 2003).

In this case, the milk tanker drives all the way through the bulk tank and connects its hose to the cooling tank outlet. The milk is then transferred to the road tank which is equipped with a pump and a meter to record the volume of milk collected (Sobrinho, 1995; Dairy Processing handbook, 2003).

The road tank is divided into compartments to avoid the milk being splashed during its route to the plant, which compromises its quality.

The milk collection in bulk has produced innumerable advantages in milk agribusiness and its chain members (producers, companies and consumers). This collection system reduces the collection costs of the raw material, eliminates the necessity of collection point, increases the productivity in the farm by having flexibility on milk scheduling and the possibility of having a second milking on the same day, significantly increases the quality of the milk that arrives for processing in the plants and finally the consumers gain with the improvement of the raw material. This process makes possible that the milk collected at the farm conserves its properties by immediate cooling (Sobrinho *et al*., 1995; Martins *et al*, 2004).

In spite of all the advantages obtained by bulk collection, there are some barriers that make the implementation of this system in Brazil difficult such as (Sobrinho, 1995):

- The difficult access to the country properties
- The lack of electricity or oscillations on its supply
- The cost of acquisition and maintenance of the cooling tanks
- Small production of some farms.
- The routing that involves the bulk collection.
- Risk of contamination of the whole tank by one farm batch.

Furthermore, the transportation costs must consider the regional aspects and the specific characteristics of each activity such as conditions of the roads, volumes carried at different times of the year, costs of petrol, lubricant, vehicle washing, etc.

3.5.2 Milk Reception

The dairy companies have a system in place to receive the milk from the farms. The trucks bringing the milk park on any free reception station and unload the milk. Before starting unloading the milk it is necessary to measure its quantity, record and enter into the dairy weighing system in order to calculate the input against the output at the end of production. The quality is also checked.

Churn Reception

Every churn has it own identification number that matches with its farm provider. The churns are received in the dairy company, unloaded from the truck and placed on the conveyor. The conveyor takes the churns to the weighing station automatically removing its lid, where the milk quantity is recorded and entered by the operator against its identification number.

From the weighing station the milk is pumped to storage tanks where it waits until processing starts.

The empty churns are conveyed to a cleaning station, washed and taken to the storage dock to be returned to farms. In some cases, the churns are also used to store some final product such as butter milk or skim milk while waiting to be packed and after that washed again and sent to the storage dock.

Tanker Reception

The dairy companies have bays where the tankers park and unload. There are two ways to measure the quantity of milk in each tank:

1st - By Volume: in this case the volume is measured through a flowmeter that is hooked up on the pump and records the volume of the milk pumped to the silos. It is important to have an air eliminator before the meter as the air can jeopardize the real readings.

2nd – By Weight: this method also provide two ways of measuring the quantity of the milk.

- Weighing the tanker before and after unloading: the tanker is driven onto a weighbridge where its weight is recorded before and after being unloaded. Before going to the weighbridge, the tank must be washed. The milk then is pumped to a storage tank and waits until processing starts.
- Weighing using a load cell in the fleet: in this case, the milk is pumped into a special tank built with load cells capable of recording the weight of the milk unloaded by sending electric signals. The strength of the signal increases as the tank gets full, telling the weight of the milk. After being totally unloaded and measured, the milk is then pumped to a storage tank.

3.5.3 Milk Collection

The problems of routing milk collection differ in many ways from routing problems of other product due to the characteristics of its routes which are static in nature and vary slightly on a day to day basis (Fisher, 1995; Butler *et al*, 2005).

Therefore dairy companies have a specialised employee called a scheduler to look after the routing of milk collection and allocation of the resources needed to perform the task.

Schedulers, along with routing software, have to manage the interests of all the involved resources and design a cost efficient route which best allocates farms, trucks, drivers and plant capacity in order to minimize the cost of milk collection (Butler *et al*, 2005).

The first attempt at using computer software to manage the milk collection and replace the schedulers was not successful. The aim of software was to minimize the cost without checking the interest and constraints of the other parts such as difficult access to the farms, drivers work hours, truck size, and farms routines. Consequently a Decision Support System (DSS) which is software that is intended to support the schedulers and not replace them was developed (Butler *et al*, 2005). In the 1990s a number of routing systems were developed such as The Milk Collection Fleetmanager system in New Zealand (Basnet *et al*, 1996; Butler *et al*, 2005).

There are many restrictions that need to be considered during the route decision by the scheduler in order to minimize the travel distance and maximise the truck utilization such as (Martins, 2004):

- Frequency of collection: it depends on the daily production and capacity of the storage tank.
- Capacity of tank trucks: there are differences in capacity and size of the trucks.
- Accessibility of farms: some farms do have restriction on accessibility while others cannot have big vehicles due to its road access and space for truck turning.

The first generation of DSS had only information about route and volume of the milk. Later on a data base called geographic information system (GIS) was developed which was incorporated to DSS and allowed it to have more information about milk collection, such as (Butler *et al*, 2005):

- Supplier name
- Telephone number
- Supplier code
- Volume collected at most recent collection
- Butterfat for most recent test
- Protein for the most recent test
- Lactose for most recent test
- Total bacteria count (TBC) for most recent test
- Somatic cell count (SCC) for most recent test
- Total supplies to date
- Quota
- Reference butterfat
- Butterfat adjusted quota position (% of quota used)

Furthermore, other technical developments such Geographic Position System (GPS) was included into the DSS. This tool has helped to calculate the travel distance and time more accurately which is really important in this case as the rural road network is quite spread out and the road distance between two points can be much further than the coordinate distance (Butler *et al*, 2005). All this information helps the scheduler to have a better view of the changes made on the routing collection and its implications.

Although DSS provides great information about the milk collection it is also necessary to have a system that works in parallel with DSS. This system is used by the dairies manager to plan and control all aspects of the milk collection system such as (Figure 3.2):

- Allocation of the tank truck to weighbridge
- Milk quota for each farm
- Payment to each farm

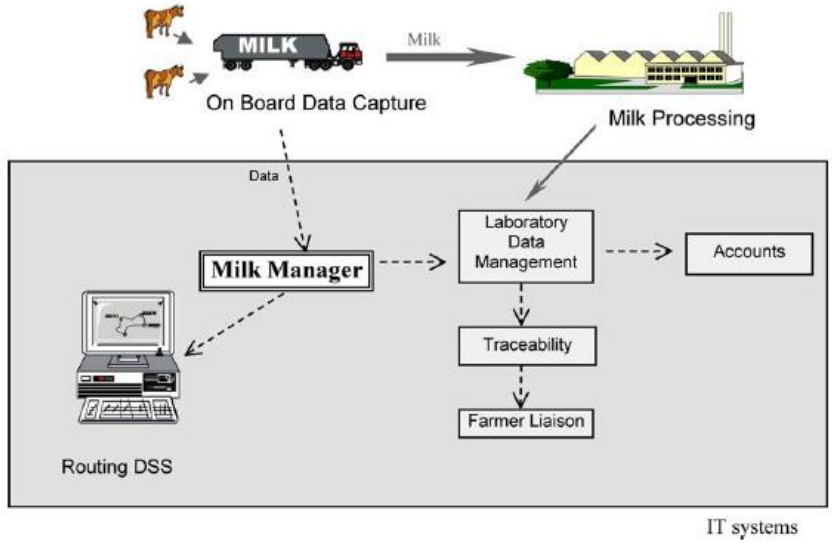

Figure 3.2 - Data flow in milk management system (Butler *et al*, 2005).

Chapter 4 Milk Industry

4.1 Introduction

In order to give evidence of the importance of the milk production in the world, this chapter will show an overview of the milk market and its figures especially in Brazil and New Zealand.

4.2 World

Rising incomes, population growth and pressures on the limited availability of agricultural land and products are sustaining higher world food prices which include Dairy products (Dairy Australia report, 2008).

The global market sales for dairy products have grown by 39% from 2002 to 2006, which is US$302 billion at the present time. In order to support this international market, millions of litres of milk are commercialized around the world. Markets like China have a huge potential in volume growth and other markets such as Western Europe tend to grow in value added products (Euromonitor, 2007).

However, for the next few years it is expected that world milk production will increase at a slow pace, around 2.2% in 2008 and by another 2.5% in 2009, reaching almost 710 million tonnes. The reasons for this drop compared to the previous years are the changes in demand and supply which are now getting close, high international price levels in the last two years and food safety concerns (FAO, 2008).

Milk production can face many differences between countries where some conditions such as production costs can be much more favourable in some countries rather than others. However, some countries do not have the capacity to produce enough milk to supply their local market where others do have excess production.

The prospects for the world's six major milk product exporters, which are responsible for 77% of global trade, have improved in recent months. Their milk production is now expected to amount to 280 million tonnes (or 40% of global production) and to grow 1.5% in 2009 (FAO, 2008).

The weather has a great impact on the production and price of milk. The 2008/2009 season in Oceania is expected to grow as the weather forecasted for this

region 2008-09 is promising good conditions for the dairy farms. Australia is expecting to have its first production increase in four years where New Zealand is expected to grow by 8%. However, there are still some issues to be addressed which can jeopardize the production such as high feed prices.

In Asia, milk production is now expected to rise by only 3.5%. This drop is mainly caused by the drop in the China's production (fourth largest dairy producer) which used to be 20% average in past decade and is expected to be only 5 to 6% in 2008/2009.

In South America, milk production is expected to have the highest growth rate compared to the other regions where Brazil (8%) and Argentina (5%) are the biggest producers, with 8% and 5% respectively production increase in 2008. On the other hand, African milk production is expected to increase by only 1% in 2008 (FAO, 2008).

World's Milk Production

Year	Milk Productions	Variation
1990	478,966,269	-
1991	469,795,134	-2%
1992	460,427,599	-2%
1993	459,915,094	0%
1994	461,076,699	0%
1995	464,158,162	1%
1996	467,529,751	1%
1997	468,941,618	0%
1998	475,039,799	1%
1999	483,525,531	2%
2000	490,530,475	1%
2001	497,568,203	1%
2002	507,763,964	2%
2003	517,067,367	2%
2004	525,543,842	2%
2005	541,342,679	3%
2006	555,704,177	3%
2007	560,787,275	1%

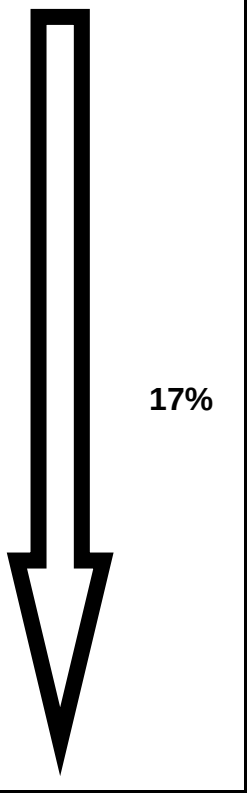

Table 4.1 - World's Milk Production (Embrapa, 2009)

In the USA, the growth of milk production is expected to be 2.2%, lower than it was predicted due to the higher US dollar which reduces the competitiveness of its products and the decline in profitability.

The European Union will also grow at a slow pace; their production will be around 1% higher them 2007. Countries such as Ukraine, one of the biggest milk producers, will have its production decline by 7% from its peak production in 2002.

Although the milk production in the world is not growing as much as the past years, the sales of dairy products has been continuing to increase in volume and value with steady price growth across all the major dairy categories (Euromonitor, 2007). The global exports of key milk products may reach 40.4 million tonnes in 2008 which represents almost 3% increase compared to previous year and another 2% in 2009 due basically to increases in exports from countries such as USA, which may export 50% and South American countries (Brazil and Argentina) with 9% rise. On the other hand, big export players such New Zealand, Australia and European Union are expected to fall (FAO, 2008).

Furthermore, the milk world trade is expecting some changes in the near future. EU is losing its position as the major supplier of milk in the world and so is Oceania to USA where as South America and Asia which are growing. USA is expected to increase its share to 12% and EU is likely to fall to 21%.

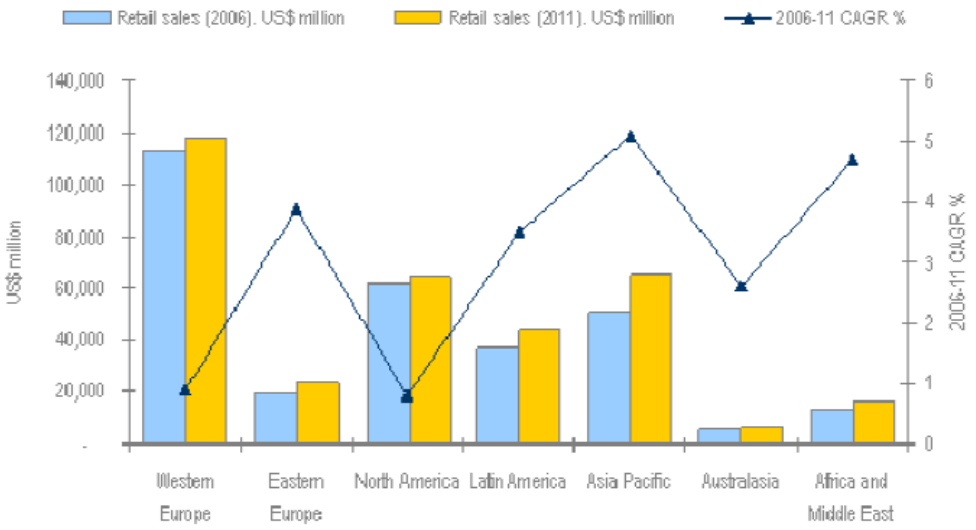

Figure 4.1 – Graph of Global Sales of Dairy Products per Region (forecast) in US$ (Euromonitor, 2007, page 103).

Milk production has also improved in productivity. The numbers of milking cows in the world has decreased by 1.8 % from 2000 to 2004 where the milk production at the same period grew 5.8%, implying a milk increase of 7% per cow (Neves *et al*, 2005). The members of the European Union have the highest productivity share and are responsible for 44% of the Milk production in the world, although they have only 18% of total numbers of cows (Neves *et al*, 2005).

The biggest dairy countries in the world market are shown on the table 4.1 below.

Top 20 dairy countries 2007						
No	Production	Milk Delivered	Exports	Net Trade Surplus	Imports	Net Trade deficit
1	India	USA	New Zealand	New Zealand	Germany	Italy
2	USA	Germany	Germany	Germany	Italy	Mexico
3	Pakistan	China	Netherlands	Netherlands	Netherlands	Russia
4	China	France	France	France	Belgium	UK
5	Germany	India	Belgium	Australia	France	Algeria
6	Russia	Brazil	Australia	Ireland	IUK	China
7	Brazil	New Zealand	USA	Denmark	Spain	Japan
8	France	UK	Ireland	Poland	Russia	Spain
9	New Zealand	Russia	Denmark	Belarus	Mexico	Indonesia
10	UK	Netherlands	UK	Argentina	China	Saudi Arabia
11	Ukraine	Italy	Poland	USA	Algeria	Malaysia
12	Poland	Australia	Belarus	Lithuania	USA	Greece
13	Netherlands	Poland	Italy	Austria	Saudi Arabia	Philippines
14	Italy	Japan	Argentina	Finland	Japan	Belgium
15	Turkey	Argentina	Austria	Ukraine	Indonesia	Singapore
16	Mexico	Canada	Spain	Uruguay	Malaysia	Thailand
17	Australia	Mexico	Czech Republic	Czech Republic	Singapore	Egypt
18	Egypt	Pakistan	Finland	Switzerland	Greece	Vietnam
19	Argentina	Turkey	Lithuania	India	Philippines	Taiwan
20	Canada	Ukraine	Sweden	Slovakia	Denmark	Republic of Korea

Table 4.2 – Top 20 Dairy Countries in the World (Dairy Report, 2008, page 59)

4.3 Brazil

The Brazilian market has gone through profound changes over the last 15 years which stabilised its economy for external investments and stimulated agricultural growth. Macroeconomic stability was achieved in the mid-1990s through the implementation of a new economic plan (Real Plan) and structural reforms

included the privatisation of state companies, deregulation of domestic markets, and the establishment of the Mercosur (Martins *et al*, 2002).

The agribusiness in Brazil has improved in both productivity and in cultivated area which according to official numbers is around 152 million acres. Altogether, agribusiness is responsible for more than a quarter of total GDP. Examples of agribusiness production are sugar (40% of the sugar traded on world markets), orange juice and coffee (world top producer), soy bean and meat (second in the world) and fruits and corn (third world producer) (Euromonitor, 2007). The table 4.3 shows the most important products of the agribusiness in Brazil. Furthermore, Brazil's industrial base which includes automobiles, consumer electronics, computers and software, heavy industries, and tourism is one of the largest and most diversified of any emerging economy.

Although Brazil`s economy has a lot to improve, its infrastructure is inadequate and obsolete, Brazil's GPD grew, in 2007, 5.4% (Euromonitor, 2008, Rodobank, 2007).

Commodity	Production	Exports	Export value (USD mln)
Coffee	1st	1st	2,533
Sugar	1st	1st	2,382
Orange Juice	1st	1st	796
Ethanol	2nd	1st	766
Beef	2nd	1st	2,419
Poultry	3rd	1st	3,324
Soybeans	2nd	2nd	5,345
Soy oil	4th	2nd	1,022
Soy meal	4th	2nd	2,865
Swine meat	4th	4th	1,160
Dairy	6th	11th*	130

Table 4.3 – Agribusiness products in Brazil (Radobank, 2007)

4.3.1 Dairy Industry in Brazil

The Brazilian dairy industry is transforming rapidly and becoming a net exporter of dairy products (Farina, 2002). In the last 8 years, the export of dairy products has increased 234% due to the increase in the national production and also to

the fact that the Brazilian companies started to foresee the opportunities on international market (Brazilian Agriculture department web site).

In order to support this new market, new supply chain structures were developed, with quality guarantee systems and preferred supplier schemes. The Brazilian dairy sector is characterized by its large quality variation with inefficiencies in collection and storage of dairy products which leads to losses of product and product value. Although improvements in productivity have been occurring, Brazil is still behind countries such New Zealand where its productivity is 3 times more.

Company		Milk reception	
		2006	2007
1	DPA	1,702,000	1,800,000
2	ELEGE	897,965	1,324,007
3	ITAMBE	1,039,000	1,090,000
4	PARMALAT	612,070	725,021
5	BOM GOSTO	231,673	632,735
6	LATICIONIOS MORRINHOS	338,098	387,140
7	EMBARE	3,009,453	336,573
8	CONFEPAR	288,782	333,490
9	CENTROLEITE	263,128	300,095
10	LIDER ALIMENTOS	226,535	248,725
11	CCL	316,045	247,950
12	BATAVIA	241,601	246,759
13	SUDCOOP/FRIMESA	225,995	225,804
14	DANONE	221,905	222,091
15	NILZA	196,500	219,449
16	GRUPO VIGOR	201,498	201,300

Table 4.4 – Milk Processors list intake 1000 tons (Embrapa, 2009)

In order to overcome these problems, several investments in collection and cooling facilities are being implemented by private companies, and cooperatives and its members to minimize quality problems and increase production in order to meet international standards. Other improvements which will leverage Brazil milk production and quality will be investment in cattle genetics and nutrition, and to leverage the whole chain.

Cooperatives account for approximately 40% of all Brazilian milk. They perform many different functions, ranging from colleting milk and bargaining with processor, to processing into generic products to processing into branded consumer products (Ruben, 2006).

Milk production in Brazil may increase to 31.2 million tonnes, or by 8%, and this will help to improve its position as a big exporter of milk products. Brazil may soon be the second largest exporter in the region, or even the largest if current trends continue over the next several years (FAO, 2008).

Some facts about the Brazilian market in 2007 (Dairy report, 2008):

- It produced 26.2 million tons of milk where 67% where delivered*.
- The price of Brazilian milk is 26% below the world price.
- The internal consumption is 137 Kg ME per person/year.
- Export about 1% of its production.
- Import about 1% of the local consumption.
- Milk production had gown 4.1% per year (2002-2007).
- Milk Consumption is also increase 1.7% a year (2002 -2007).

* Milk delivered: milk delivered to the plants to be processed.

However competitiveness of the produced milk in Brazil has been ensured due to the Brazilian environment where some resource prices comparing to some developed countries are much lower in cost such as labour.

4.4 New Zealand

New Zealand agribusiness is responsible for about 7% of GDP and the manufacturing sector contributes about 15% of GDP. Half of its area consists of pasture land for sheep and cattle and most of the rest is constituted of woodlands and forests which are used for the extraction of hard woods. New Zealand industries encompass a range of heavy smelting to light industry. Its total GPD grew 3.2% in 2007 (Euromonitor, 2007).

4.4.1 New Zealand Dairy Industry

In the past 20 years, there has been a huge reduction in the number of relatively independent dairy cooperatives – from 36 in 1983 to three key cooperatives today (New Zealand Trade and Enterprise, 2007). The New Zealand dairy industry

was deregulated in 2001 and now is considered one of the best examples of a vertically integrated, co-ordinated global supplier industry. The dominant players are now Fonterra, Tatua, Westland and Open Country.

Due to its small market and high production, New Zealand exports around 95% of its dairy production therefore it is considered the biggest export earner at NZ$8 billion, which accounts for more than 20% by value of the country's merchandise exports (Euromonitor, 2007).

Fonterra	13882
Westland	452
Open Country	200
Tatua	97

Table 4.5 - Milk Processor List in 1000 tons (Dairy report, 2008, page 122)

The 2008/09 season is looking promising as improved weather conditions will help to increase the milk production by 8 % which would restore the country stocks of dairy products and increase its exportable supplies from a poor 2007/08 when the poor weather conditions resulted in a milk production fall of 4.5% compared with the previous season (FAO, 2008)

The New Zealand dairy industry is considered one of the best in world. Its products are known by their high quality and innovation. Due to the country's efficient all grass farming system combined with large-scale processing and high research and development, the dairy productivity has increased from 259 kilograms (average) of milk solids (kg ms) a season per cow in 1992/1993 to 322 kg ms (average) in 2003/2004. This increase of 24% over a decade was the result of genetic gains, improved farm management, and stock nutrition followed by the increase in cow numbers from 2.7 million in 1993/94 to 3.9 million (mainly Friesian) in 2003/04 (New Zealand Trade and Enterprise, 2007).

The industry, which employs 37,000 people, has been successful at diversifying both its product range (milk powders, butter, cheese, ice-cream, spray dried milk proteins, protein hydrolysates) and the numbers of markets which its products are exported, despite most of the western world markets being subject to quota restrictions or effectively closed to New Zealand dairy products, the country

still accounts for 35 percent of the world trade in dairy products. New Zealand has built an international reputation as a leading edge supplier of dairy products (New Zealand Trade and Enterprise, 2007).

Some facts of New Zealand Dairy Industry in 2007 (Dairy report, 2008):

- Milk production: 17.3 millions tons (average growth from 2002-2007 of 2.8% per year)
- Milk delivered: 98% of the total production
- Milk price: - 29% below world market
- Milk consumption: >350 Kg ME per capita/year
- Imports approximately 2.6% of local consumption

Chapter 5 Methodology

5.1 Introduction

This chapter covers the methodology used in order to obtain the best outcome from the study. It will first give the introduction on methodology followed by the difference between qualitative and quantitative methods. Furthermore, it gives some reasons why the qualitative method and the case study approach were chosen.

5.2 Introduction of the Methodology

The main purpose of any scientific activity is to search for the reality, through the evidence of facts that are the links between the reality and scientific theory.

Science is a systematization of knowledge, a set of proposals logically correlated to the behaviour of certain phenomena which want to be studied. In the evidence of the facts, the method is the set of systematic and rational activities that allows reaching the valid and true objective through recognition of errors which assist the scientists' decisions (Lakatos and Marconi, 1991).

Given that, there are some scientific methodologies that need to be followed in order to successfully obtain the true outcome of the study. According to Holbert and Speece (1993) researchers must use a research method and a design that provide the information they aim for.

The approach methodology, its procedures, its research instruments and the form of analysis of its data used in this research are related to the characteristics of the study and must provide facts that prove its objectives and test the hypotheses formulated. Therefore, due to its characteristics, this thesis will use the qualitative research based on the case study approach.

The research method adopted in this thesis was carried out through Literature review and observed research. The methodology proposed by Vergara (2003) says the research is characterized by the description and clear delineation of the critical factors that contribute for the performance of the study which is in our case: the logistics activity applied on milk collection by two different dairy companies that face

different environmental conditions such the geographic localization of farms and plants.

5.3 Research Methods

According to Lakatos and Marconi (1991), the research approach is behaviour that guides the examination process, it shows forms of approaching and focusing on the problem or phenomenon that intends to study. Creswell (1994) affirms that the research approach can be: quantitative, qualitative or a combination of both. According to Bryman (2004, page 62), "the quantitative approach is described as entailing the collection of numerical data and exhibiting a view of the relationship between theory and research as deductive, a predilection for natural science approach and as having an objectivist conception of the society reality".

On the other hand, the qualitative research according to Bryman (2004, page 266) "tends to be concerned with the words rather than numbers". That is, it tends to be interpretive of the individuals in its environments, its own behaviours and compares to the others. The presentation of results tends to demonstrate what the people say about the context in which its actions happen. The choice between the quantitative and qualitative or both approaches must fit into the goals of the research study. The main characteristics of these approaches are (Bryman, 2004):

- Qualitative approach:

    - The researcher inserts himself into the organization as member of it.
    - Strong sense of context of the study which facilitates the research.
    - Emphasis in the process of the events, that is, sequence of the facts throughout the time.
    - Absence of structure, with more flexibility.
    - Use of more than one source of data conceives the organizational reality as something in which the people participate actively in planning.

- Proximity of the researcher with the phenomenon studied.

- Quantitative Approach

  - Lesser emphasis in the interpretation and focus in parameters that the researcher judges important.
  - Little attention to the context.
  - Little emphasis in the aspects of organization, frequently demanding analysis statistics in which relationships between variables are explored.
  - Rigorous preparation of procedures for the data collection
  - Tends to use only one source of data.
  - The social reality is seen as something external to the activity, in which it has little participation.
  - Distance between researcher and subject involved in research.

Based on the approaches described above and the characteristics of this research, the approach used in this work is the qualitative approach. This option appeared more suitable for the conduct of this research due to:

- It allows the obtaining of the perceptions of interviewees and the details on the effect of the Decision Support System and information technology in the logistics of collection which cannot be obtained through the application of inflexible questionnaires.
- Necessity to better understand the relationship between logistics systems and the dairy business.
- It allows interviewing the people who daily deal with the milk collection in the companies which are more suitable to evaluate and give the opinion on logistics of milk collection.
- More suitable to obtain the opinion of different people in different areas of the companies.

- Due to the fact this work does not intend to collect quantitative data in order to evaluate the logistics of milk collection.

5.4 Research Approach Method

There are several strategies/methods that can be used to carry out research. According to Yin (2003), each strategy presents advantages and disadvantages therefore in order to obtain the maximum of each strategy it is necessary to know the difference between them. The choice between them depends on:

- The type of research
- The control that the researcher has on the events

According to Bryman (2004) there are different strategies/methods of research approach, among then are: experiment, survey, study of case and research action. Beyond these, Bertrand and Fransoo (2002) and Berendes and Romme (1999) also included the modelling and simulation in the strategies/methods list.

The research survey involves the collection of information from individuals (through questionnaires sent in the personal post, phone calls, interviews, email) about themselves or the social environments to which they belong. The researchers do not interfere in the organization but observe the effect of the interventions. The sampling process survey determines information on ample population (Bryman, 2004).

The research action is a strategy that has the objective of understanding an action and creating knowledge and theory on the topic studied. This method of research creates participative environment where it promotes ample interaction between researchers and members of the investigated situation. Thus, the researcher becomes part of the member of the study environment. The type of strategy demands more work than conventional research (Coughlan and Coughlan, 2002).

The simulation is defined as the construction of a model that physically or symbolically represents all or some aspects of an individual or group. The components and the interactions are taken from a real situation. The simulation can be physical, that is, it implies experimentation with real objects that act as models of some real subgroup. It can also be mathematical, where the relations of a system are expressed in mathematical formulas (Berends and Romme, 1999).

Finally, the case study method allows the detailed examination of one or a few cases. The objective of analysis is frequently the organization, but it can also be any departments and sections in the organization and inter–organizations (Bryman, 2004).

Due to the characteristics of the methods described above and the characteristics of this research the case study approach was used as this best fits the research objectives.

Thus, the case study is more appropriate to the necessities of the research. Segundo Yin (2003, page 13-14) "a case study is an empirical inquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between object of study and context are not clearly evident". The focus of this research is strictly on the present situation, that is, the way the companies use logistics system to manage its milk collection and the impacts of the logistics management on a company's supply chain. The case study allows the perceptions of the individuals to be collected on the effect of the use of IT technologies and its performance on the companies. These details cannot be obtained through the application of well structured and rigid questionnaire or other methods.

According to Yin (2003), case studies can be exploratory and explanatory. The exploratory study occurs in the initial period of the research where the exploration is necessary to develop ideas and questions of the research. The objectives of this type of study are to search background and gain knowledge about the fact; to develop theory, and to raise possible problems of the research in order to best describe the study environment.

The explanatory study applies questions that deal with operational links that need to be traced throughout the time. It aims to identify the factors that determine or contribute to the occurrence of certain phenomena. It extends the knowledge of the reality as it explains the reason for facts to happen (Yin, 2003).

This study used exploratory methods in its first stage where the search of publications (books, articles and scientific magazine) related to logistics, supply chain and milk collection was done. The explanatory study was used to search to identify the parameters and critical points that make it possible to explain the effect of the Logistics systems and IT on the logistics of milk collection of these dairy companies.

The case study approach can be applied on a single event/case or on multiple events/cases (Yin, 2003). A single case/event research is justified when the event is rare or exclusive. On the other hand, multiple cases/events increase the external

validity where the results are considered more convincing and make possible the comparison between cases.

This research used multiple cases. Thus, two dairy cooperative companies (one in Brazil and another in New Zealand) that use IT and logistics system to manage their logistics of milk collection was studied. The companies were chosen due to their importance for the agribusiness in their countries and also because they can supply sufficient and critical information to this study.

5.5 Summary

Below it is the summary of the procedures and methods that this research used in order to answer the hypothesis stated and describe the format of logistics of milk collection used in these companies:

a) **Method/Approach**

It applied the qualitative method using the case study approach to obtain the information related to the logistics systems, its role in the company supply chain and the importance of the IT to coordinate the milk collection. According to Yin (2003), the best source data to carry out a qualitative approach is through a well elaborated interview, especially for a case study method. Thus, due to the characteristics of qualitative method and case study approach, the data collection was obtained through the application of elaborated questionnaire which was applied to the person/persons responsible for the milk collection.

b) Research Place

The research was carried out in two dairy Cooperatives Companies, one Brazilian and one New Zealand. It is believed that there are differences in the way these companies perform their milk collection. Therefore, the aim of the study is to confirm whether this statement is true or not.

c) Questionnaire Design

In order to obtain a trustful view of the companies studied, it is necessary to design a questionnaire that extracts the information from the interviewed person. According to Yin (2003) the main source of information for a case study is the interview. Furthermore Bryman (2004) says that interviews can be structured, semi-structured or not structured. The structured interviews demand more standardized questions, frequently closed questions, more suitable for formal survey. Generally, in the qualitative studies, the interviews need to be either semi-structured or not structured. The semi-structured allows the interviewed to be more spontaneous and assumes the character of an informal exchange. However the researcher must follow a certain set of questions or a script which allows him to get the vision of the research without running away from the important factors. The not structured permits spontaneous answers where the interview is conducted in very informal way which allows the interviewed to better express his opinion (Bryman, 2004; Yin, 2003).

Due to the characteristics of this research, a semi-structured questionnaire was applied as it permitted the collecting of a wider range of details which helped to interpret the information collected from the companies, and thus to evaluate the benefits and disadvantages of the use of the logistics operations into supply chain. The questionnaire was developed from the initial proposals of this work, its objectives and through the information collected from the literature review.

5.6 Schematic Representation

The figure 5.1 shows the schematic representation of the research process.

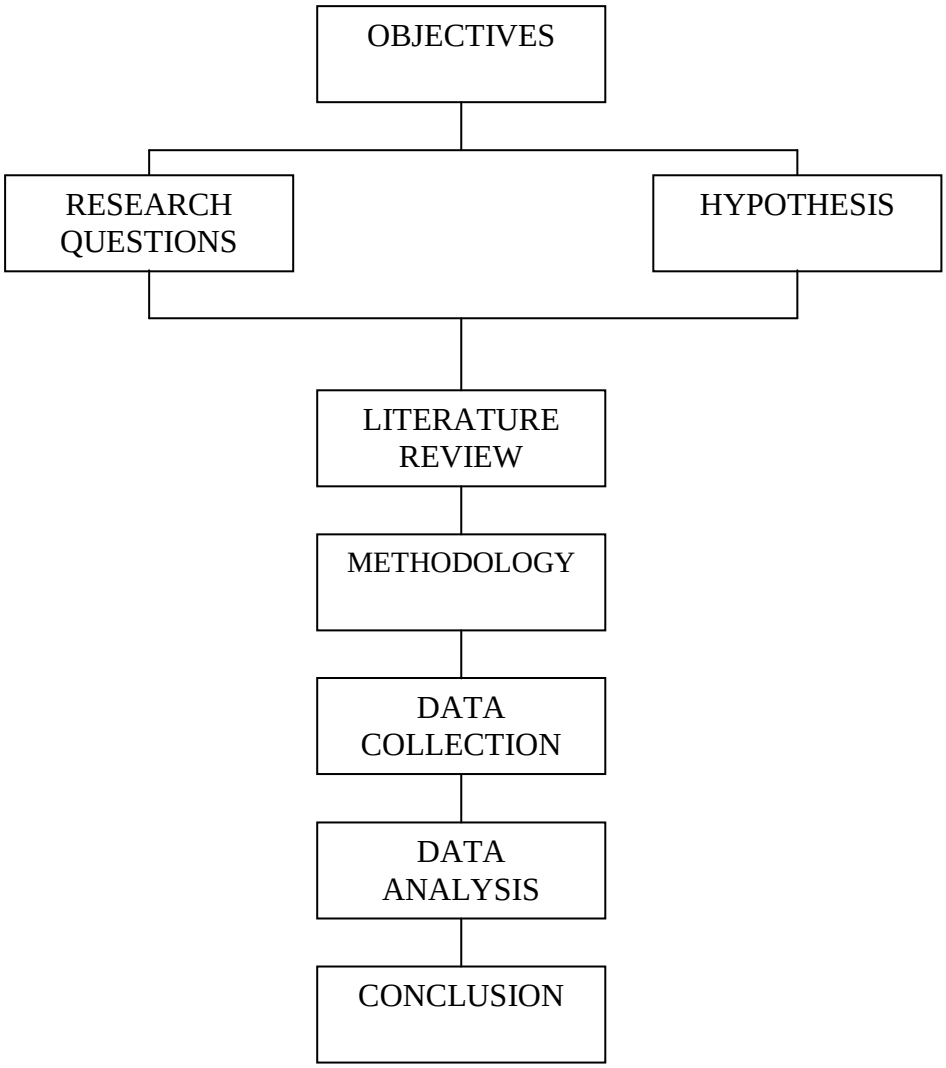

Figure 5.1 – Schematic Representation of the Research

Chapter 6 Analysis and Discussion

6.1 Introduction

This chapter contains the information and analysis of the data obtained through the application of the questionnaire. It contains and explains the logistics of the milk collection used by the companies and a comparison between the two companies.

6.2 Objectives

The general objective of this work is to identify the problems related to the logistics of milk collection and also to compare the two companies and their milk collection.

The specific objectives are:

- To define agribusiness and cooperatives.
- To study the use of logistics and its application in the agribusiness.
- To determine what are the problems are faced by the logistics of Milk collection.
- To identify the differences between the companies' milk collection systems.

6.3 New Zealand Company

6.3.1 Company Background

The New Zealand Company has a huge influence in the New Zealand economy and is considered one of the big players in the world market. It employs about 15,900 people around the world and has 10,724 shareholders responsible for supplying and maintaining the reputation of producing high quality milk. Since its foundation, it has become the largest dairy exporter responsible for more than a third of international dairy trade.

Each year in New Zealand, its 430 tankers collect about 14 billion litres of milk. It sells about 350 tonnes of product each hour - 24 hours a day, seven days a week and 365 days a year. In fact, every five minutes they close the door of a container and send it to one of the 140 markets they reach. It is responsible for 95% of export of New Zealand made dairy products to our customers and consumers in more than 140 countries.

The company has assets of NZ$ 14.4 billion and an annual turnover of around NZ$ 19.5 billion coming from its core business which consists of exporting dairy ingredients such as milk protein concentrate (MPC), whey protein concentrate (WPC), and anhydrous milkfat (AMF), among others. Most of their products are exported in bags of 20kg/25kg depending on the product type. It also has branches responsible for reaching the final consumers with dairy products such as cheese, yoghurt, butter and dairy dessert. In this case, they are marketed under brands which belong to the company.

Although New Zealand has huge milk production scale, this is not enough to keep up with the world market demand, therefore in order to keep its position in the global market, the company has a number of subsidiaries and joint-venture companies operating around the world. This strategy aims also to avoid local market regulations which, in some countries, forbid a non-local to sell dairy products in its market.

6.3.2 Company Structure

Nowadays, the company has 10,724 farms/suppliers that supply milk to their factories. The farms must buy shares of the company in order to be able to supply the milk.

As a cooperative, the company does not have shares in the stock market and the New Zealand farms/shareholders are considered its owner.

The number of shares define how much milk the farms/shareholders can supply to the company during the year, thus, if a farmer is producing more milk than his quota he will need to buy more shares for next year season or reduce his production.

The Cooperative also allows its farms/shareholders to supply 15% of their milk on contract. In this case, they do not need to have shares to supply that amount of milk. However under 5% of its milk is supplied this way.

The Cooperative is operated and managed by a Board of Directors, the Shareholders' Council (constituted of 35 shareholders who are elected by other shareholders, representing 35 regions all over New Zealand) and the Milk Commissioner who is appointed by the Shareholders' Council to mediate any supply disputes between shareholders and the cooperative board. They work together ensuring the interests and needs of shareholders are being looked after.

However, there have been some talks and consultation with its farms/shareholders around another capital structure for the company where the Dairy Co-operative will position part of the company in the New Zealand stock market but still retain most of the shares with farms/shareholders.

The amount of money paid by the Cooperative to its shareholders/farms is called payout (based on solids/kg). The payout value is decided by the Board and it is the revenue (from selling products) minus all cost (mostly collection, manufacturing and operating expenses) and the amount retained by the Board.

The company has around 60 manufacturing sites and 47 offices around the world, in addition to 25 other sites and 11 offices in New Zealand.

6.3.3 Milk Production

As mentioned before, the farms/shareholders supply the milk to the company's factories according to the number of shares they have. However, according to the Business Solution manager, none of the milk is left without being collected even if the farm/shareholder has already reached his quota. This issue will be sorted out at the end of the season when the final payment for the milk is done and most likely will be filled under the 15% contracted milk that every farmer is entitled to. Last year production was about 13.86 billion litres of milk just in New Zealand.

Each supplying farm has an average area of 112 hectares and an average herd size of 318 dairy cows. In 2005/06 their suppliers produced an average of 99,000 kg milk solids per farm (1,165,000L).

The outline of the milk production/collection follows very closely the grass growth cycle, where the milk production is really low during the winter season (May, June and July) and starts to pick up when the weather gets warmer. During the off peak season some plants close and the milk collection can occur every two days or so,

whereas during the peak season some farms might need more than one collection per day, depending on the farms` silo size and its milk production.

The cattle are predominantly fed by grass which implies that milk production is strictly related to the availability of grass and the local climatic conditions. It is also strongly influenced by the cow's gestation cycle. These factors cause huge oscillations in milk production which makes it more difficult to synchronise the milk collection, storage and processing of milk. Furthermore, the people responsible for the logistics of the milk collection need to deal with a number of milk producers who are well spread around the country.

On a day by day basis, the logistics of the company needs to:

- Collect milk from farms
- Deliver milk to the factories
- Transport liquid by-product between factories
- Transport dairy products and ingredients around New Zealand
- Ship dairy products and ingredients around the world

This scenario delivers great challenges, and the company must deal with these obstacles in an efficient way in order to guarantee the delivery of about 14 billion litres of milk a year to its factories.

6.3.4 Collection

In order to collect this amount of milk, the company employs 1200 truck drivers, 12 schedulers and a number of others who are responsible for placing the right quantity of milk in factory silos when it is required. Most of the employees are permanent and the rest are contracted for certain periods.

The collection is done by 430 milk tankers with approximately 26000 Litres capacity per tanker. This restriction is due to road regulation which allows a maximum of approximately 44 tons (the trucks and trailers weigh around 8 to 12 tons) to be carried on New Zealand's roads.

The company also uses rail to transport the raw milk. In this case, the milk tanker unloads the milk into a big silo that has a facility to pump the milk into the train later. The train tanker is also insulated.

It is also uses the rail to transport final products from its stores to the port. Approximately one million tonnes of product is transported this way every year. By choosing rail over road, they have significantly reduced truck journeys and the associated emissions by an estimated of 9,100 tons per year.

Due to the climate conditions in New Zealand, none of the milk tankers have a refrigeration unit installed on them, but they are all equipped with insulated tanks which avoid any significant rise in temperature. The milk tankers transport approximately 120,000 litres of milk per day during the season.

The average milk collected per day is about 67 million litres during the peak season and about half a million during the off season.

Due to the large area that needs to be covered by the milk tankers, the schedulers must plan and schedule the collection to avoid any problems. In the past, the collection scheduling was done using the traditional pen and paper approach which was inefficient and generated many problems.

Routing and Scheduling

The use of decision support systems (DSS) was implemented to help the schedulers in this task of assigning the collection of milk to the tankers. Nevertheless, the DSS was there to help the schedulers not to replace them.

The company operates the milk collection over two shifts per day to collect milk from their supplier farms and have it delivered to their processing plant for processing. The first one starts at 6:30am and finishes at 5pm and the second one which starts 5pm and finishes at 1am.

Due to the variation of the quantity of milk collected per day from each farm, the scheduling must be done on a daily basis to improve the efficiency, avoiding the cost that occurs when trucks travel with not enough milk or are not able to go to a farm that was assigned because it is already full.

The schedulers receive orders from the plants twice a day, thus the first shift plans the collection for the afternoon pick-ups and deliveries and the night shift plans the collection for the next day.

The schedulers need to allocate the runs (sequence of suppliers which are visited by a tanker in a specific order) to each tanker which will pick up the milk from the farms and deliver it to the plants. When a tanker finishes its run and returns to the

plant after the collection, it drives to the bay, which has the facility for pumping the milk from the tanker to the milk silos.

Before the installation of the new DSS software some waiting occurred at the bays due to the fact there were not enough bays or because the scheduling was not planned well which resulted in many tankers returning from their run at the same time. This could be made even worse when a mechanical failure happened in a bay. Therefore, the DSS helps the schedulers to plan the sequence of the runs so that this waiting is minimised.

To further complicate the process, the plants produce different products such as butter, fresh milk, casein, milk powders, cheese, cream, among others. Hence, the schedulers are also responsible to plan the movements of products between plants and also need to consider the time spent for each of these products to be unloaded/pumped when planning the run to obtain the optimal solutions.

Depending on the type of product and the market that it is going to some specifications must be followed. There are some farms that supply milk only for factories that can process the milk for that particular customer.

Once the schedulers receive the orders from the plants, they enter the specifications of the product, quantity needed, and plant delivered to, into the DSS software program and let it run until it finds the optimal solution. Depending on the region and the number of farms, it can take about 30 min for the DSS to find the optimal solution. Sometimes the solution provided by the DSS is not the best one and the schedulers can change it.

The weather conditions on the day have a major influence on the milk collection and therefore needs to be considered when a run is planned. Bad weather such as rain, snow, cloud or combinations of them make the driving conditions more dangerous. Sometimes it is much more difficult to access farm roads due to heavy rain and tanker speed is also reduced.

There are also some other requirements in addition to the ones cited above such as driver preferences and work hours and breaks that need to be taken into account during the scheduling process. Therefore in addition to all the other reasons mentioned above the optimal solution sometimes is not the perfect one for that particular collection scenario.

Summarizing, the milk collection operation faces some challenges such as:

- Geographical issues
- Weather
- Shelf life
- Specialty milk collections
- Access restrictions
- Inter-site transfers
- Available time windows to pick up and deliver raw milk and milk by-products

In order to address the issues related to the milk collection and distribution between factories an efficient system had to be implemented to maintain an outstanding service to their suppliers, factories and external clients.

Collection at different times of day

Due to the fact that in some regions there are multiple factories and the milk from any given farm can be delivered to any of the factories thus depending on the location of the farm and the target factory on a given day, the collection time can change.

Another variable that affects collection time is the quantity of milk that a factory has at the start of a given shift. In that case, if the factory has very little milk stored at the start of a shift it is important to get a lot of milk to that factory quickly in order to not delay its production. In this case, milk is collected from farms which are close to the factory. On the other hand, if the factory has enough milk stored and not much storage space left, then milk is collected from far away farms to avoid unloading delays at the factory which have a negative impact to both cost and service.

The milk can be collected very efficiently by carefully allocating farm volumes to tanker runs making sure the legal load capacity of tankers is reached over least distance. However, farm volumes can change on a daily basis and therefore so does the best allocation to tanker runs. A different tanker run will usually mean a different time of collection.

6.3.5 Implementation of New Technologies

The implementation of new technologies aims at improving efficiency on milk collection and distribution while retaining its focus on service for its shareholders. The introduction of new scheduling, despatch and GPS systems were gradually introduced into the company milk collection chain.

As an international company which always aims to be one of the best in its market, it always tries to improve its system through replacing outdated technologies for new ones which makes the logistics systems more efficient while improving the service level to its farmers. Consequently in 2006, the company decided to adopt a new integrated scheduling and despatch solution called Genesis. Along with the new DSS system other features were needed to be implemented such as a GPS system into its milk tanker fleet.

Apart from the GPS system, other improvements were necessary to standardize the whole milk collection process in order to fully use the new DSS system. Thus, the milk tankers were equipped with:

- Radio frequency identification (RFID) technology
- The latest development in mobile metering and sampling technologies
- Every company vat:
    - has the same75mm (three - inch) piping
    - bayonet connection
    - has a RFID tag

Different to the old scheduling system where a large amount of manual effort was required to create a schedule, Genesis is much more automated allowing schedulers to focus on the quality of data entered in the DSS and adjusting the schedules which results in a better coordination of pick ups from farms and deliveries to factories.

The implementation of the Genesis DSS system was carefully done by regions, starting in the north and heading south and was only fully used when all scheduling and despatching operations were running well, delivering good results.

The use of a GPS system by the tanker fleet allowed more information to be transferred to and from the tanker, permitting them to visualize activities in real time,

identifying and considering the options and reacting more efficiently to any unexpected events that may happen. It is possible to see how much milk the tanker is carrying, its position, its speed, and the driver's name on the computer screen. The implementation of GPS took a long time as it involved fitting equipment to more than 430 tankers and training more than 1,200 drivers to use it.

Nowadays the Genesis system is being fully used and has reduced by 7% the cost of the milk collection since its implementation. Also, due to the better utilization of the fleet, the numbers of milk tankers were reduced from 460 to 430.

The company is also using a new technology that enables the milk to be pre-concentrated before it is transported, which allows the transport of more milk per tanker trip. The use of this new technology resulted in 3,000 less tanker trips per year and saves 1,350 tonnes of carbon dioxide emissions annually.

Furthermore, the cooperative is aiming to replace its old milk tanker fleet for eco-friendly milk tankers in order reduces the N_2O emissions by 30% and particulates emissions by 80%.

6.3.6 Milk Quality

The quality of the raw milk supplied by the farms/shareholders has a great influence on the quality of the final product, especially for plants that produce fresh products such as pasteurized milk, cheese, yoghurt and others.

The quality checks start at the farms which need to comply with some standard quality targets in order to keep supplying the milk. Farmers who do not provide milk within the company limits are penalized.

Before the milk is pumped from the farm silo to the milk tanker, the tanker driver does a quick quality check on the milk such as temperature, acidity, colour and odour.

In case something does not comply with the company quality standards, the driver has the authorization to not collect the milk. In this case, the driver communicates with the dispatcher centre which will notify the farmer about the issue and he is responsible for disposing of the contaminated milk.

The company has also implemented a new quality check that test the milk for inhibitory substances in each milk tanker before it unloads in any company site. The test involves taking a sample of the milk on the last collection of the run and

incubating it on the way to the factory. When it gets to the factory the test strip is read by an electronic device. This ensures that all products meet the strict standards for antibiotic-free milk. If antibiotics or others contaminations are detected, the milk is then discarded unless it can be used by another plant where these contaminations do not affect the final quality of the product.

This also affects the scheduling as the tanker has to be rerouted to another factory and then another tanker has to have its route changed to unload at another factory.

Drivers' Responsibilities

Apart of driving the milk tanker, the company's drivers nowadays play an important role in the logistics of milk collection. They are well trained in order to perform others tasks such as collecting milk samples to be analysed by the company labs afterwards.

The drivers must collect two samples from every farm they visit. Before starting their shifts and leaving the site they must go to the office and get an ice block and at least enough sample bottles for that run. The ice block is to keep the samples cold, ensuring the samples maintain their characteristics during the journey from the farm back to the site. As was mentioned before, during the implementation of the Genesis system many other improvements were made and the sample collection system was one of them. The sample bottles had a magnetic disk installed to it that avoids future confusion with the results. When the driver reaches a farm and before loading the milk into the tank, he places two sample bottles on the collection place and puts a bar code on the bottles (each farm has its own bar code). When the loading process begins, the driver starts collecting samples as the milk is pumping into the tank. Once their runs finish and they go back to the site to unload the truck, the driver drops the samples off at the office where a technician from the quality control laboratory collects then.

Road Conditions

Most of the times the roads are in good condition although they are country roads and therefore often narrow and twisty. The driver must drive with extra care due to the blind corners and lower their speed.

However the farms roads, that is after the farm gate, can be really bad which makes it harder to reach the silos. The drivers can report any bad conditions to the office which then contacts the farm and asks them to fix it.

Another issue that jeopardizes the collection is that the farms sometimes park their car or tractor right in the way of the tanker. In some case it is impossible to drive through and the driver has to stop and ask the farmer to move his vehicle, delaying the trip and its delivery to the factory.

All the farmers have a number and this number is supposed to be displayed on a place by the road to make it easier for the driver to locate the farm. However sometimes these signs are hidden by trees, or are not in good condition which makes it difficult, especially during the night, to see it. On some occasions drivers have to stop the tanker in some places with no side roads and walk over and check the number to ensure they are at right place.

6.4 Brazilian Company

6.4.1 Company Background

Founded in 1955 to mainly produce butter the company has grown in size and market share. Nowadays it is one of the biggest dairy industries at the central west of Brazil.

It employees approximately 500 people direct and generates about 2,500 indirect jobs. In 2007 the company invested approximately R$9.2 million to increase its industrial area from 20,000 to 28,000 square metres and also to buy new equipment. Hence the company expects to boost its processing line up to 1.6 million litres of milk daily.

Its product range includes UHT milk, milk powder, cream, chocolate UHT milk beverage, condensed milk, cheese and butter which are distributed to the market under three major brands and another six not-owned brands.

Due to the quality of its products its brands are some of the most well known by the consumers according to the "Pop List" survey carried out every year in Goiana, the capital of Brazil`s Goias State and it is on the top of the list of companies that generated tax back to the state.

Not long ago it started exporting its products (UHT milk, cream and milk powder) to some other markets such as USA, Africa and Chile.

6.4.2 Company Structure

The company is private with no open capital, that is, does not have shares in the market and all the decisions are made in order to improve the company profitability. Although they do consider the implications to its suppliers as they want to maintain a good relationship with them. Thus the companies and suppliers work together to ensure their interests and needs are reached.

Nowadays, the company has around 2,300 farmers/suppliers that supply the milk to their factories and 3 manufacturing sites spread through the states of Minas Gerais and Goias.

6.4.3 Milk Production

Before the season/financial year starts the company searches for farmers/ suppliers and negotiates the price for the milk supplied according to the market price at that moment. This price is not fixed, that is, it is not set for the whole season/ financial year. Depending on the market conditions the price can vary and the farmers can decide if they still want to supply milk for the company or find another company to sell their milk to.

The quantity of milk needed can vary according to the market demand therefore the company needs to enquire from each of its suppliers how much milk they can supply on a daily/weekly basis. The amount of milk supplied by each farm is taken into account to define the production plan, the resources needed for milk collection, and scheduling of the milk collections.

The value for the milk is based on market demand and can fluctuate over the year. The payment for the milk supplied is paid to the farm monthly and refers to the month just gone. The price is based on litres supplied.

There is no contract between the supplier and the company that states they have to supply milk for only that company therefore either farmers or the company can decide to supply/buy milk as they please. It is all dependant on the market conditions.

From the company side they can decide to not take the milk because they cannot process it for some reason or demand has dropped or access to the farms is not easy and so on. In this case, the farmers must find another alternative for their milk, such as sell it to another company or to local market or even find a way to take the milk to another local farm where it can be collected. In most of the case, some of the competitors can take the milk but might pay a lower price or use this situation to pursue the supplier to supply the milk to them. In this case, farmers/suppliers can decide not to supply the company anymore if they have found another company that pays a better price for its milk.

Therefore, there is more than the price paid for the milk involved in this relationship between farmers and the company. The maintenance of a good relationship is a key factor for the sustainability of the business.

If nothing wrong happens with the milk and the demand, none of the milk is left uncollected.

As the milk supply price varies according to the market demand, farmers can also reduce the amount of food fed to the cattle in order to reduce or increase the quantity of milk produced.

The size of the farms/supplier can vary substantially from really small producers with a few cows to big farms.

The cattle are predominantly fed by ration therefore the milk production is much more stable over the year and the local climatic conditions do not interfere as much. Although the milk production is a bit lower low during the winter season (May, June and July) and starts pick it up when the weather gets warmer. There are some regions that suffer more with the weather variations where its production can decrease by 40% comparing to the peak season. However, none of the plants shut down during this time, just the production plan is adjusted to better match market demand and the production. Another point to consider is the cow's gestation cycle which does influence the milk production.

Even though oscillations in milk production are not significant it still causes some complexity in the milk collection, storage and processing of milk.

The schedulers are the first point of contact for the drivers. As part of being responsible for the logistics of the milk collection, they also need to make sure all suppliers who are spread around the region maintain the farm roads in good condition and silos are easily accessible.

On a daily basis, the company deals with:

- Collection of milk from farms/ milk collection centres.
- Deliver milk to its factories.
- Transport milk from different suppliers to its factories.
- Transport dairy products and ingredients around Brazil.

Demand

The demand planning is done by the marketing department which has direct contact with the market.

Generally the overall milk demand planning is done based on the demand for the following year. Thus, the company can plan and allocate resources according market demand and milk availability.

After having the quantity of milk needed for the following year, the company can start planning how many suppliers they need and the number of milk tankers that will be necessary to collect the milk. It is also possible to have a rough idea of the scheduling process and problems that may happen. All this work is done to ensure the collection and quality of the milk is up to the company standards.

6.4.4 Collection

In order to collect the milk, the company has decided to outsource its milk collection. The company only has 4 trucks which in most cases are used to transport milk when some problems with the outsourced milk trucks occur and they are not able to collect the milk that day or week.

The decision of outsourcing their milk collection was based on the capital the company would have to spend in order to buy the equipment (milk tankers, trucks) and the cost that comes with it such as drivers wages, taxes, maintenance of the trucks, parking facilities, etc.

However the scheduling process is still performed by the company's logistics department and the people working there are permanent employees. They are responsible for placing the right quantity of milk in factory silos when it is required.

The collection is done by 60 outsourced milk tankers with capacities varying from 8, 12, 15 and 24 thousand litres of milk per tanker. This restriction is due to road regulations which allow a maximum of 25.5 tons to be carried on Brazil's roads.

They can be used in combination according to the farm they are going to, roads and the amount of milk they are collecting. In some cases due to the Brazilian landscape, road conditions and farm size, sometimes it is impossible to collect the milk or economically impractical to make the truck with or without a trailer to go to a farm. In some cases, the truck driver can disconnect the trailer and leave it parked at a strategic position, go the farm silo, load the milk, go back to the trailer and pump milk out into the trailer and go to the next farm to collect the milk and so on until the trailer is full.

Also when the farm, due to its size, does not produce enough milk that justifies a milk tanker trip the farmer has to transport the milk to a milk collection centre, where the quality and quantity of milk is checked before it is tipped into the silo. The milk collection centers are a connection between the farms and Dairy industry.

The transportation in this case is still done by churns but complies with all the company's quality standards. They are transported chilled under 5°C to avoid bacteria growth and are well sealed to avoid contamination.

Even though the company provides training and support for all farms there are still some problems relating to supply inadequacies and inferior quality of raw milk, especially on small dairy farms where the lack of capital limits the use and implementation of new technologies. Also, social factors appear in hygienic practices of the farmers during milking.

None of the milk tankers have a refrigeration unit installed on them, but they are all equipped with insulated tanks which prevent the temperature to rise. The milk tankers transport approximately 27,000 litres of milk per day during the season. The average milk collected per day is about 1.6 million litres.

In the past, the collection scheduling used to be done manually therefore it was imprecise which ended up generating many problems such as not having milk

delivery on time to factories, trucks travelling without full capacity (not cost effective).

Nowadays, the scheduling is done using a computer system of which the company did not want do disclose the name, stating that this information is a strategic tool and therefore confidential. However they did say they have been using it for about 4 years. They also mentioned that due to the large area that needs to be covered by the milk tankers and the Brazilian environment, the use of this computer system has helped schedulers to plan and schedule the collection much better than before, when the scheduling was done manually.

The cost of the milk collection varies from R$ 0.02 to R$ 0.06 cents of the price of milk collected.

Routing and Scheduling

Due to some studies and research about the milk collection the company wanted to ensure that the implementation of the decision support system (DSS) was there to help the schedulers in their task of assigning the collection of milk to the tankers not to replace them. According to the employee responsible to deal with suppliers, some research has shown that not letting the schedulers interfere with the system and change the routes was causing some problems such as tankers being sent to places where the collection couldn't be done.

Before the installations of the new DSS software some confusion happened with the milk truck assignments where they would be sent to collect the milk but did not have enough milk to fill the tanker or was not supposed to go to that farm that day. Another issue frequently arose during the unloading process where tankers had to wait long periods to unload the milk because there was a queue of trucks waiting to be unloaded. The schedulers must also consider the unloading time when planning the runs to maximise the trucks usage.

As with the other company, the schedulers are responsible to assign the runs, that is, the sequence of suppliers which the milk tanker visits in a specific order and collects the milk from the farms and deliver it to the plants. When a tanker finishes its run and returns to the plant after the collection, it drives to the bay, which has the facility for pumping the milk from the tanker to the plant's milk silos.

Depending on the market demand and production plan the company may have to obtain more milk from other sources such as a competitor plant or farmer. In this case, the schedulers also need to take this into consideration.

Even though the company has a rough collection plan for the whole year the milk collection plan is carried out every week to promptly respond to the market demand therefore the collection plan is done one week in advance.

Once the schedulers receive the production plan at the end the week from the company master plan, they start to plan the schedule for the next week, taking into consideration all the constraints such as roads conditions, specifications of the product, quantity needed, and plant delivered to, and enter this data into the DSS software program which will give the optimal scheduling plan. This can take a long time depending on the complexity of the run, region and its constraints.

After having the scheduling generated the schedulers can decide whether to accept or not the proposed solution.

One of the biggest constraints on the milk collection is the weather conditions which play an important role and have a major influence on the milk collection, especially during the wet season. The farm roads in Brazil are in most cases in a really bad condition and can get worse during the rainy season which sometimes makes it impossible to reach the farmer's silos. In this case, the farmers are responsible to transport their milk at their own cost to a collection point or to another farm which the tankers can reach. It is the farmer's responsibility to let the scheduler know as soon as possible of any problems that may interfere in the milk collection.

Furthermore, the climate conditions in Brazil and especially in that region is really warm and therefore the travelling time between collections and deliveries to the plants should be the least possible to avoid raising the milk temperature which can bring some microbiological problems.

The efficient communication system between the schedulers and the outsourced companies responsible for milk collection is in place to avoid any delay on the collection which can bring problems to the quality of the milk.

Also, the schedules must avoid some periods to collect the milk. Farms do not like to have milk tankers collect the milk during its milking time. The reason is that time is needed to allow the milk to cool down to between 3°C to 5°C.

The tankers are not allowed to collect milk which is over 5°C. In this case they need to contact the scheduling department to let them know and the scheduler may assign another farm for them to go to or tell then to stick on their schedule.

The Brazilian regulations also states that drivers need to take breaks which must be taken into account during the scheduling process.

Summarizing, the milk collection operation in Brazil faces some challenges such as:

- Geographical issues
- Weather
- Shelf life
- Access restrictions
- Supplier can be dropped off the chain or new ones can be add in.
- Transfers from third supplier to the company factories
- Available time windows to pick up and deliver raw milk and milk by-products

Collection at Different Times of Day

The milk collection for this company is programmed to be done every two days unless the supplier requests differently and it can be done daily.

Thus, most of the collection points and farmer silos must have enough capacity to hold two days of production. This was done to reduce the overall cost of the milk collection.

Due to the climate conditions all the silos have a refrigeration system able to keep the milk between 3°C to 5°C and it is monitored for future reference and traceability.

The collection points and farms silos must work according to the Brazilian law and are checked from time to time by the Brazilian government to ensure they are following it.

6.4.5 Implementation of New Technologies

As a national company aiming at having more participation at national market share as well as expanding its international market, it must invest in new technologies in order to keep up with the competitors and reduce its logistics costs related to milk collection. Therefore the company has decided to implement a DSS technology to improve its efficiency on milk collection and distribution.

In order to use all the resources of the DSS the company had to map all its suppliers and install a GPS system into its milk tanker fleet to standardize the whole milk collection process.

Nowadays is much easier to assign a run and plan the weeks scheduling than the old days due to the better coordination of pick ups from farms and deliveries to factories.

6.4.6 Milk Quality

Due to the fact that most of the products manufactured by the company need good fresh milk the quality of the raw milk supplied by the farms/supplier has to meet the company's high quality standard as it has a huge impact on the quality of the final product such as cheese, yoghurt, butter and others.

Farms are given some training in how to milk cows, how to keep the hygiene in the shed to avoid bacterial contamination. The Brazilian law states that fresh milk must comply with regulations and also that the company must have implemented policies to maintain the milk characteristics. The company provides training to its farms/suppliers and in their website there is information on how to reach and maintain the required standards.

As many contaminations can occur during the milking process the quality checks start at the farm at their milking shed which needs to comply with quality standard targets in order to keep supplying milk to the company. Farmers who do not meet the necessary minimum standards are penalized and can be dropped as a supplier.

The company provides training to the tanker drivers as they are responsible for the first quality check. Pumping up contaminated milk can cause huge issues for the whole chain. Therefore before starting to pump up the milk from farm silo to the milk

tanker, the drivers do a quick quality check on the temperature, acidity, colour and odour of the milk. Apart from that, they also need to collect samples and take them to the lab for further tests.

In case something does not comply with the company quality standards, the driver has the authorization to not collect the milk. In this case, the driver communicates with the scheduling department which will notify the farmer about the issue and the farmer decides what to do with it. The cleaning of the shed and silo are the farmer's responsibility.

Drivers' Responsibilities

As mentioned before the drivers are now responsible for the first quality check on the milk and therefore they play an important role in the chain. Their first impression of the milk to be collected can avoid many problems for the next stages of the chain. Therefore, they must be trained in order to perform the quality checks and to properly collect samples to be analysed by the company.

The drivers collect samples from every farm they visit.

Road Conditions

As mentioned before, the 95% of the farm roads that lead to the farms are gravel and not in good condition. In theory, the government is responsible for fixing up the roads and keeping them tidy, but the farmer is responsible to maintain the road from the gate to the silo driveable.

During the wet season, some farms are impossible to reach. Also, drivers must drive slower than normal. All these conditions must be taken into consideration during the scheduling process.

The company has a good relationship with the local government and both try to keep the roads in good condition.

Furthermore, farmers seem to have the some behaviour as those in NZ, as they park their car or tractor right in the way of the tanker. In some cases it is impossible to drive through and the driver has to stop and ask the farmer to move his car delaying the trip and its delivery to the factory.

6.5 Comparison

After studying the Brazilian and New Zealand companies and according to what was observed in their logistics operations of milk collection and their supply chains, some similarities as well as some differences were found, as their organization and structures are different.

Firstly the Brazilian company is a private business where the decisions are made to maximise the profits of its owners where the New Zealand one is a cooperative where the interest of its shareholder come first.

Due its size and market the New Zealand company has a wider range of products and produces much more than the Brazilian company. The Brazilian company is a small one compared to the NZ company and only started few years ago, aiming at other markets and increasing its product ranges.

There is a huge difference in the number of suppliers and the amount of milk each produce. The milk production in NZ is much more developed than in Brazil as well as the milk production per cow is greater.

Also the milk supply and the relationship between the company and the supplier are different. The fact that the NZ Company is a cooperative and so their suppliers own it makes a difference in their relationship. Furthermore, due to the NZ production environment where the cattle are fed with grass and therefore follow the seasons, where the winter production is low and summer is the peak, the production plan and milk collection need to be done accordingly. As milk is a perishable product they have to turn it into some final product therefore the production plan is decided before the season begins but can incur some changes during the season. Many of its plants close during the winter and this provides the opportunity to resolve issues, make improvements and carry out maintenance of factories.

In Brazil there is not much fluctuation in production as the farms feed their cattle with a mixture of ration and grass. Therefore it can respond quicker to the market demand as it produces milk as required. However, the planning needs to fit the factories maintenance over the season and correlate with production and collection to in order to avoid waste.

The collection in Brazil can still be done in churns as many farms do not produce much milk to justify a tanker run to collect it. In this case the farms need to take its milk to a milk collection centre from where a milk tanker collects the milk.

In NZ there is also a common silo where a milk tanker unloads the milk. However, this system was implemented to improve and reduce the cost of milk transportation. The railroad passes through some sites which makes it easier to unload the wagons. When this silo is full a train is used to transport the milk from the silo to the factory.

However, in both cases, all milk tanker fleets are insulated to avoid temperature rise and most of the transportation is done on roads. However due to climate conditions the temperature limits for milk to be collected in Brazil varies from 3°C to 5°C and up to 18°C in NZ.

Another strategic difference between the milk collection relates to the milk tankers and transportation. The NZ Company keeps it in house, that is, it owns all the milk tankers, the drivers are its employees, and the maintenance cost is its responsibility, saying that this department is one of the most important for the suitability of the business and therefore won't be outsourced. On the other hand, the Brazilian company decided to outsource the whole transportation department as it did not want to tie capital on milk tankers and all the cost related to it. However as with the NZ one, the scheduling is still being done in house.

As the quality of the milk collected is considered a factor of extreme importance. Both companies offer support and training to their suppliers to produce milk according to their standards. Farmers who do not meet the quality standards are penalised and can be dropped from the supplier chain. Both have trained milk tanker drivers in how to check the milk quality before loading it to the tanker, collect samples, use their truck computer system and read maps and empowered them to not take milk that they find defective.

Both companies use a DSS to perform their scheduling and assign runs to the milk tankers. They all agree that the system has improved the logistics of milk collection, reducing cost with fuel, maximising tanker usage which avoids idle time, reducing travel time and improving quality.

However it looks like the NZ company is one step ahead maybe because it is a bigger company and has more capital to invest in logistics.

The collection frequency is also done differently. Due to the size of the farms the collection in NZ is done daily and sometimes twice a day, wherein Brazil it is done every two days. In both cases, the company needs to respect the milking time and avoid sending milk tankers to collect the milk during this period. This is also important because it lets the farm's refrigeration system cool the milk to an acceptable temperature established by the company.

Chapter 7 Conclusion

7.1 Introduction

The objective of this chapter is to discuss the objectives and hypotheses providing the final conclusion and limitations of the study.

7.2 Objectives

The general objective of this work is to identify the problems related to logistics of milk collection and also to compare the two companies and their milk collection.

The specific objectives are:

- To define agribusiness and cooperatives.
- To study the use of logistics and its application in agribusiness.
- To determine the problems faced by the logistics of milk collection.
- To identify the differences between the milk collection processes.

7.2.1 Objective 1 - Define Agribusiness

Since the term agribusiness was created to describe a new area that agriculture was into, many changes have occurred. It went from an application to coordinate all the new technologies the farms were implementing in order to face the new environment at that time, to a well synchronised system that includes all the activities related to it in nowadays.

Therefore agribusiness is now being treated as any other type of business with some particular aspects that affect differently the business and therefore need to be managed in different ways. Animal breeding and the seasons of vegetables and fruits are some variables that need to be taken into consideration to better manage the business.

As any other business, agribusiness organizations also want to improve their competitiveness, flexibility and agility through industrialization of production, using

standardized technology and new management techniques to reduce costs and improve the quality of their products and services in order to reach new markets.

7.2.2 Objective 2 - Study the Use of Logistics and its Application in Agribusiness

After studying the theory of logistics and the supply chain with the main focus on its application to the dairy environment, the conclusion that as a food producer both companies know that quality of their products and service are important to distinguish them from their competitors and it's one of the things their customers value the highest.

As all other types of business, agribusiness firms do also need to move, handle, process, and store their products from producer to consumer. Therefore a well integrated logistics system that is able to deal with all the coordination and planning of agribusiness activities and also able to keep up with new technologies and introduce it to the system, is the key for the success and survival of the business.

Companies are now trying to minimise logistics costs, mainly transportation, as there exists an opportunity to obtain a competitive advantage. The agribusiness managers are aware of the importance of controlling logistics activities and ensuring an efficient system to have a cost effective operation implemented. This requires an understanding of the logistics operations applied to the agribusiness to face any issues that can emerge in logistic operations of the agribusiness.

7.2.3 Objective 3 - Determine Which Problems are Faced by the Logistics of Milk Collection

The logistics of milk collection faces many problems and challenges on a daily basis. Even though the companies are placed in different environments, the problems are much the same, with just a few differences.

The assignment of a run to the milk tankers is one of the main issues that companies have to deal with. The schedulers must consider some aspects before starting to run the DSS. Aspects such as weather conditions, road conditions, drivers' breaks and preferences, farmers milking time, factories schedules and last minutes issues can complicate the scheduling.

One of the main problems in New Zealand is due to the variation on the quantity of milk daily produced. In this case, the schedulers take in consideration the average of milk collected in the last 6 days to assign the run for the milk tankers. In order to calculate this average they must look at last 6 days carefully as some times for some reason such as milk contamination a farm did not supply milk on a day. In this case, the schedulers must not take this day in consideration.

In Brazil, one of the main problems is the relationship between the company and suppliers. Due to the fact the production is driven by the market demand, so is the milk supplier. Thus farms can "hold" the production in order to get a better price for their milk and the company wants cheap milk whenever possible. Also a supplier can stop supplying milk to the company at any time as there is no contract between the parties. In this case, the schedulers have to keep informed about any changes on the supplier list in order to assign the run.

In both companies, the weather is an important factor in the scheduling process. Even though with all technologies in place, if the road conditions are not adequate it is almost impossible to reach the farms especially in Brazil.

Another point to look at is the quality of the milk collected. Quality is about having control over the factors influencing quality performance, between the companies and their suppliers of services, raw material ingredients and finished products.

The risk of a quality failure exists at each stage of the production cycle, from the production and collection of raw milk, the purchase and delivery of raw materials, the production process, the packaging of products, storage and delivery of finished products to customers and food retailers, right up to the storage and shelving of finished products at the points of final sale.

This study is focused on one of the first stages of the supply chain, that is, milk collection. Both companies are aware of the consequences of not properly collecting and transporting milk to their factories to the final chain. A poor control of their transportation system affects not only the quality of the milk but also increase the final supply chain cost.

Therefore these companies have studied, invested and implemented new technologies so that the raw milk from their suppliers reach their factories maintaining their natural characteristics.

7.2.4 Objective 4 - Identify the Differences Between the Milk Collection Processes

One of the main differences between the companies is the strategy they use to collect the milk. The NZ companies decided to keep the milk collection in house and not outsource it arguing that the milk collection is an import activity for the business.

On the other hand, due to financial issues the Brazilian company decided to outsource its milk collection even though believing that it is one of the most import activities of the business.

In both cases, they decided to give training to the drivers and empower them to decide to not collect milk if they find it suspicious. In this case, both companies avoid the contamination of good quality milk. One difference here is that the drivers of NZ companies are responsible to unload the milk on the site and take the sample to the appropriate place where in Brazil the drivers are only responsible to collect the samples. At the site, there are other employees responsible to unload the milk tanker and take the samples to the laboratory.

7.2.5 Hypothesis

The hypotheses have the function to direct a work and therefore a subject/topic can be introduced and concluded. In this thesis, the hypotheses are tested through the observed comment and bibliographical revision of the subject/topic. The hypotheses are:

H_1 - The milk collection system used by the New Zealand Company is much more developed than the one used by the Brazil Company.

Both companies have invested and are still investing in the logistics of milk collection. Both have to face issues that most of the time are related to the environment they are acting within. However the New Zealand Company, probably due to its size, is more developed than the Brazilian. It seems that their logistics is more integrated, the communications flow through the system better and therefore the

company can respond to any changes quicker. Also due to the fact they do not outsource their collection gives them more control of the system.

The Brazilian company due to the capital restriction and its size can not invest as much as the NZ company, however they do understand the importance of having a well implemented system in place.

H2 - The use of Decision Support System (DSS) is essential for the management of milk collection.

Both companies have admitted that nowadays it would be impossible to manage the milk collection without a system to support it. They also understand the system is in place to help schedulers but not to replace them.

H3 - The better the planned collection, the less contact with the milk, the less chance of contamination.

Due to milk being a perishable product special handling is needed to keep its original characteristics and avoid any quality issues that can jeopardize the production plan, both companies have invested in training for their employees and suppliers. They have information about milking and how to keep hygiene up to companies' standards in the milking shed in their website. They also offer support to their suppliers on any issues they have to avoid contamination.

Nowadays there is almost no contact with the milk after it has been pumped to the farmers' silo. Even during the milking part the there is not much contact with milk, especially in NZ where all milking is automatic.

In Brazil, due to the size of some farms the milking is still being done manually however the company do invest on training and also give the farms financial support for them to implement the automatic system in their farms.

All the loading and unloading of milk tankers is done automatically in a way that the drivers to not need to touch the milk at any time.

7.3 Limitations

This study was focused on only two dairy companies, one in each country and therefore was limited to the information obtained from them which cannot represent the total environment, especially in relation to the Brazilian market where there are many more players. Also the companies are different in sizes, market share and structure.

Furthermore, the limited availability of material, through lack of access, time and financial cost, meant the study was only exploratory in nature.

7.4 Future Research

For further research it is suggested a study to be carried out on how to better use the milk tankers in NZ. During the off season most of them are not in use because there is no milk to be collected as the farms produce lower quantities of milk. Therefore a project should be done to find another way to utilise their trucks.

For the Brazilian company, it would be a project to find out a way to better integrate their logistics system. That could be done through a program which will keep the same suppliers for a longer time thereby improving the milk collection.

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Appendix

Introduction Letter

Dear Sir

This letter has the objective to clarify the purpose of this study.

As a master student of the College of Science at Massey University I am required to undertake a major research project. I have decided to carry out research based on the logistics of milk collection.

To be more specific, the research aim is to investigate the differences between the logistics of milk collection done by two different companies based in different countries (Brazil and New Zealand).

In order to complete this research I would like to ask you for some of your time to complete the questionnaire.

All the **answers** will be treated as **confidential** and only aggregated results will be published.

My Supervisor for this project is Dr. Normal E. Marr, Director of Logistics and Supply Chain management at Massey University.

Thank you very much for your time

Best Regards

Luis Pimenta

Questionnaire

Company name:

Employee name (Voluntary):

Employee position (Voluntary):

Section 1 – Company information

- How many people (drivers, schedulers) are involved with the milk collection?

  Drivers: ___

  Schedulers: ___

  Others: ___

- Are they all company employees?

  YES____ NO____, if not what % ____

- How large (number of vehicles) is the company fleet?
- What type of fleet (truck size and models) does the company have?
- Does the company store the raw milk before processing?

  YES ____ NO____

  If yes, what is the storage capacity and how long does the company store the milk before processing?

- When is the peak season and off peak season for the company?

  Peak season _____ Off peak season _____

Section 2 - Logistics Costs

- How much investment does the logistics of milk collection receive per financial year?
- How does the company calculate its logistics cost?
- How much (%) of the milk collection is part of the final cost of the product?
- What is the cost per Km of milk transported?
- What percentage is the cost of the milk collection on the total logistics cost?
- Has the logistics budget been reduced/increased/same recently?

- How is the payment for the milk done?

Section 3 - Milk Collection

- What is the average of milk transported per day?

  Peak season _____ Off season _____
- What is the average milk transported per truck?

  Peak season _____ Off season _____
- Does the company still use churns?

  YES____

  Why:

  NO____

  When did the company stop this type of collection?
- How important is the quality of the milk collected?
- How does the company check the milk quality?
- What happens if the milk does not meet the quality standards?
- Do all the trucks have a refrigeration system?

  YES____ NO____ if no, why not? _____
- Does the company have any plans on having refrigeration system installed into the all fleet?

  YES___ By when____ NO____, Why? ____
- What types of transportation mode (road, rail, water, intermodal) do the company use? What is the percentage usage?
- Does the company have more than one collection a day at the same farm?

  YES____, how many: Peak season ____, Off season____

  What are the criteria?

  NO____
- Does the company have collection point?

  YES___ NO____
- Does the company use any special handling to deal with the milk collection?

  YES___ NO____

  If yes, please describe:
- What are the future plans regarding the milk collection?

Type of vehicles:

Number of vehicles:

People:

Software:

Others:

Section 4 - Routing and Scheduling

- Does the company use software to manage the milk collection?

  YES____ NO___

  If yes, when was in installed
- What are the reasons/advantages that make the company use the milk collection software?
- How much time, distance travelled and money were saved after the implementation of the software?
- How was the milk collection plan done before the implementation of the software? What were the characteristics of the previous system?
- Have any improvements on the milk collection taken place recently?

  YES___ NO____

  If yes, what did you improve and how much time and money were saved?
- What were the problems faced by the company during the implementation of the software?
- Have number of employees working with milk Collection changed after the implementation of the software?

  Reduced ___ How many:____ Increase____ How many:___ Same___
- Has the fleet used in the milk collection after the implementation of the software?

  Reduced ___ How many:____ Increase____ How many:___ Same___
- Does the software cause any problems with other IT software used in the company?

  NO____

  YES____, what were the problems?

- Has the software improved the relationship between members of the chain?
- Has the software improved the company's competitiveness?

  NO___ YES___
- Does the company forecast the milk collection?

  NO____

  YES___, how this forecasting work?
- Do the farms get to know if any change is made on the routing or time of collection?
- How is the coordination between the company producing plan and the milk collection done?

Section 5 - Software

- What routing/scheduling software does the company use?
- Why did you choose this one? What advantages does it have over the other programs?
- How is the collection planned?

  Daily ___

  Weekly ___

  Fortnightly ___

  Monthly ___

  Whole season ___

  Others ___
- Is the collection planned the same way for the peak and off season?

  YES____

  NO___ , What are the differences?
- Can the schedulers change the routes? How much influence do the schedulers have on choosing the route?
- Does the milking time have any influence on the routing/scheduling plan?
- Is the collection done at the same time for each farm/collection point?

  YES___ NO___
- What are the main problems faced by the milk collection?
- What are the proposed solutions?

- What are the main problems faced by the schedulers during their route planning?
- How important is the software for the company's logistics activity?
- Are the farms divided in regions? How is it decided which plant will receive the milk from each region/ farms?

Section 6 - Outsource

- Do you outsource the milk collection?

  YES___ NO___

  Why or why not outsource?

  If yes, what were the reasons to choose this company?

Section 7 - Environmental Conditions

- Are the roads a problem for the milk collection?

  YES____ NO____
- What are the conditions of farms roads?
- How easy or difficult is to reach the farms collection point?

  Very easy ___

  Easy ___

  Neither easy nor difficult ___

  Difficult ___

  Very difficult ___
- Does the company talk to the farms about improvements on the farms road?

  YES___ NO____
- Who is responsible for the maintenance of the access roads to the farms/collection point?

  Farms ___

  Company ___

  Government ___

  Combination of them ___

Section 8 - Farms

- Do all the farms have a refrigeration capability?

  YES___

  NO___, Is the company asking the farms to do so?

- What is the average milk collection per farm?

  Peak season____ Off season____

- What is the variation of production between farms? Does this cause any problems to routing/scheduling plan?
- What type of problems does the company have to collect the milk off the farms?
- Do the farms have a milk quota?

  YES___ NO____

  What happens if the farms exceed their quota?

- Can the farms choose the time for the company collect its milk?

  YES___ NO___

  If yes, How does it work?

- Does the company have any program to help its customers/farms such as development plan to avoid or/and improve milk quality problems?

  YES___ NO___

Section 9 - Milk Reception

- How long does it take to unload the milk from the truck?
- How many reception bays does the company have?
- Do the trucks have to wait to be unloaded?

  YES___How long:____ NO____

- Are the schedulers responsible for the unload planning?

  YES___ NO____

- Has something been done to reduce the unload waiting time?

  YES___ NO____

  What?

Section 10 - World

1- In your opinion, what company in the world has the benchmark on logistics of milk collection and why?
2- How close is your company to reaching the benchmark standards?
3- What are the reasons that jeopardize the company to perform best its milk collection?

THANK YOU FOR YOUR TIME.

Luis Pimenta