Benchmarking Agri-food Supply Chains: A Case of Pakistan and New Zealand Milk Systems

A thesis presented in partial fulfilment of the requirements for the degree of

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DECLARATION

I, Muhammad Moazzam, declare that this thesis entitled *"Learning Lessons Through Benchmarking: A Benchmarking Study of Milk Supply Chain Networks of Pakistan and New Zealand"* submitted to the Massey University for the degree of Doctor of Philosophy is the outcome of my own research work. Acknowledgement is given where material from other resources was used. I also certify that the thesis has not been presented, in whole or partly, for any degrees or diplomas.

Signed………………..….

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ABSTRACT

Businesses are now operating as parts of collaborative networks sharing skills and information synergistically to offer superior value to the customers. In order to stay competitive or surpass competitors, businesses benchmark their performance against industry leaders or best-in-class competitors. A benchmarking study aimed to examine the causes of poor performance of the milk supply chain in Pakistan was undertaken. Fo this purpose the performance of key players of milk supply chain in Pakistan was benchmarked against those of New Zealand. An extensive review of literature was conducted with the objective to choose an appropriate performance measurement framework. For this purpose existing frameworks were evaluated against five criteria characterising performance measurement in agri-food supply chains and not a single framework qualified. This research gap was abridged by developing a framework based on supply chain operations reference (SCOR) model but with certain modifications to food quality.

Pragmatic approach was used to select appropriate research design. Cross-sectional data was collected using survey strategy. A total of 490 respondents were accessed through personal interviews (430 in Pakistan) and online questionnaires (60 in New Zealand). Samples were drawn using a combination of multi-stage and purposive sampling methods. A three-step approach was proposed to address the individual objectives of the overall study. The first-step was to conduct value chain analysis of both the milk supply chains. The second-step was to measure the performance of key players of both the milk supply chains using the performance measurement framework developed as a result of literature review. The third-step was to perform gap analysis of the SCOR metrics for key players of both the milk supply chains and suggest appropriate policy measures for the improvement of milk Supply chain in Pakistan. The data were analysed with statistical package for social scientists (SPSS) and Microsoft Excel.

The value chain analysis was performed to explore the benchmarking milk supply chains as well as to gauge the level of vale addition. The value chain maps discussed the primary functions, activities, operators, facilitators, and enablers in the milk supply chains in Pakistan and New Zealand. Moreover, the analysis of value distribution along the entire chain indicated that the informal chain of milk (unprocessed milk) in Pakistan had 22.39% ex-farm gate value addition, with the largest (almost 82%) share of the value captured by the dairy farmers. Whereas, the formal chain of milk (processed milk)

in Pakistan had 104.23% ex-farm gate value addition, with the largest (51%) share of the value captured by the dairy farmers. The milk supply chain in New Zealand had 216.83% ex-farm gate value addition, with the largest (55.6%) share of value captured by the retailers.

The findings of the gap analysis were:

➢ Pakistani dairy farmers under performed in supply chain reliability, cost of production, and return on working capital as compare to NZ dairy farmers. The majority of the Pakistani dairy farmers were smallholders and due to diseconomies of the scale of their operation they could not afford modern dairy farming technologies such automatic milking, milk storage at controlled temperature, and other precision dairy farming (PDF) technologies.

➢ The Pakistani milk collectors underperformed in perfect order fulfilment, flexibility and cost of milk sold and outperformed in value at risk, SCM cost and return on assets as compared to NZ dairy companies.

➢ The Pakistani milk shops underperformed in cost of milk sold and outperformed in order fulfilment cycle time, flexibility, value at risk, SCM cost and return on assets as compared to NZ dairy companies.

➢ The Pakistani dairy companies underperformed in perfect order fulfilment and flexibility as compared to NZ dairy companies.

On the basis of findings of the value chain analysis, SCOR analysis, and gap analysis, promotion of agricultural cooperatives as a phased-out medium to long term policy intervension was recommended.

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1. INTRODUCTION

1.1 Introduction

This chapter aims to introduce the subject of the research study at large. The chapter is organized into following sections:

- ➢ Section 1.2 justifies the need for a benchmarking study in dairy industry.
- ➢ Section 1.3 proposes to benchmark the performance of milk supply chain in Pakistan with milk supply chain in New Zealand.
- ➢ Section 1.4 states research objectives of the proposed study.
- ➢ Section 1.5 describes the format of overall thesis.
- ➢ Section 1.6 summaries the chapter.

1.2 Benchmarking in Supply Chain Management

Businesses are now operating as part of collaborative networks called supply chains (Kehoe et al., 2007). These networks share information and skills in a synergetic way to offer superior value to the customers. Lee (2004) claims that just fast and cost-effective supply chains are not able to respond to the unexpected changes in demand and supply. Rather, Lee (2004) adds that agility, adaptability, and alignment of a supply chain are necessary to be sustainable. Although all the supply chains are inherently risky, a supply chain's reliability and ability to mitigate risks and disruptions is positively correlated with overall performance (Craighead et al., 2007; Zhang & Wang, 2011). Zhang and Wang (2011) view that supply chains are becoming increasingly robust due to their increasing reliance on the use of information technology.

In order to be successful in increasingly competitive and globalised market place businesses must evaluate, benchmark, and improve their performance (Gomes & Yasin, 2011). Benchmarking is one of the most effective tools for any serious organizational improvement (Andersen et al., 1999; Papaioannou et al., 2006; Yasin, 2002). Businesses benchmark their performance against industry leaders or best in class competitors. In this way best practices driving to the superior performance are adopted. In the past, benchmarking has been used to attain competitive edge or even surpass the competitors.

1.3 The Research Problem

In last decade, international dairy markets have faced unusual price fluctuations. For example, in June 2008, the prices of dairy products reached their highest levels in the world markets for last 30 years and then declined suddenly in 2009 driven by financial crises, emerging world recession and falling oil prices (FAO, 2009). This increase in world food prices challenged the social and political stability of many developing countries of the world. Moreover, the phenomenon lead to a significant increase in the food insecurity in developing countries including Pakistan (FAO, 2008). Figure 1.1 represents the evolution of international prices of food products from 1998-2014. The recurring sharp fluctuations in the international prices of dairy products in subsequent years show that the phenomenon is not yet over.

Figure 1.1   Evolution of FAO Food Price Indices
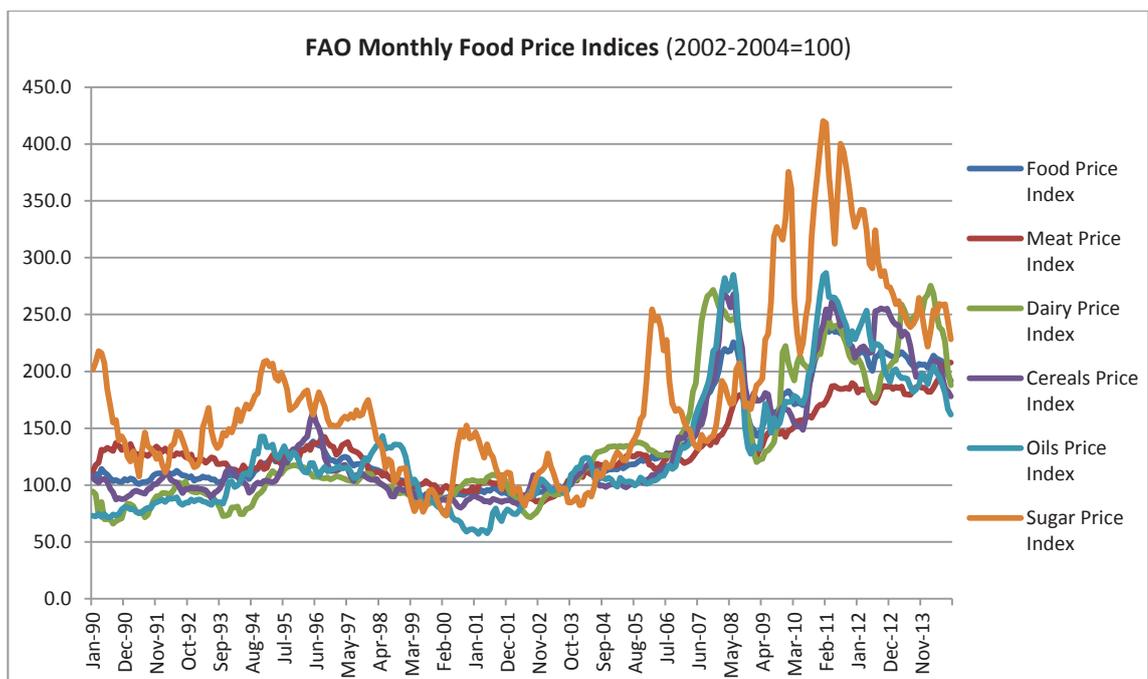
Source: (FAO, 2014)

According to the Food and Agriculture Organization (2009) in addition to many other factors, new bio fuel demands and record high oil prices were the major drivers to this dramatic increase in world food prices. The expansion in bio oil production increased the demand for specific agricultural commodities such as maize (as an alternative source of bio fuel production). This phenomenon directly affected the global food supply chains in many ways. The supply chain costs and flexibility of global food supply

chains were affected the most. Resultantly, the overall production shrunk and product prices escalated ending up with the reallocation of resources. Furthermore, these unexpected increments in demand and/or prices pose serious challenges for the global food supply chains in the future.

The developing countries like Pakistan faced worst effects of unusual fluctuations in world food prices. The food security indicators of Pakistan showed alarming facts. The country's vulnerability to such events was further enhanced by its poor performing agriculture sector. In Pakistan, the number of people with inadequate food consumption (less than 2,100 kcal/capita/day) increased from 72 million (45% of the total population) in 2006 to 84 million (51%) in 2008 (FAO, 2008). This inflation in the food prices along with some socio-political factors led to the riots against the government in Pakistan.

Pakistan is an agrarian economy with agriculture being the largest sector, employing 45% of the total labour force and contributing 20.9% to the national GDP (Ministry of Finance, 2015). The agriculture sector is divided into: major crops, minor crops, and livestock sector. The livestock subsector is the largest contributor to the overall agriculture value added (55.1%) and accounts for 11.5 percent of national GDP (Ministry of Finance, 2015). In spite of its pivotal role in the national economy, Pakistan's dairy industry is facing various issues of strategic importance. A number of researchers have identified the issues responsible for poor performance of the agriculture sector, in general, and dairy industry, in particular (Sarwar et al., 2002; Usmani, 2013; Younas, 2013; Zia, 2006, 2009; Zia et al., 2011). These are:

➢ Smallholder and fragmented agricultural farms.

➢ Low productivity per dairy animal.

➢ Inadequate availability of nutrients to the dairy animals, both in quantity and quality.

➢ High incidence of and poor surveillance, monitoring, and reporting system for the infectious animal diseases.

➢ Lack of temperature control (cold chain) at milk production and transportation stages of the milk chain.

➢ Mal practices by the chain partners to exploit customers.

➢ Seasonal demand and supply patterns.

➢ Lack of access (particularly of smallholder farmers) to the financial services.

➢ Obsolete food safety regulations and hygiene standards for milk production, processing and marketing.

➢ Insufficient institutional capacity in delivering veterinary and extension services to the farmers.

In the light of above-mentioned issues, the research problem is stated as:

Examining the causes of poor performance of milk supply chain in Pakistan.

In order to identify the causes of poor performance of milk supply chain in Pakistan, this study aims to benchmark the performance of key players of milk supply chain in Pakistan with the same in New Zealand. The performance of key players of milk supply chain in New Zealand serves as a benchmark. This benchmarking study should answer two research questions derived from the research problem.

1. *What is/are the performance gap(s) in the milk supply chain in Pakistan as compared to milk supply chain in New Zealand?*

2. *How to improve the performance of milk supply chain in Pakistan?*

1.4 The Research Questions and Objectives

This study primarily aims to benchmark the performance of key players of milk supply chain in Pakistan with the same in New Zealand in order to identify the performance gaps, reasons behind those performance gaps, and suggest appropriate policy measures to improve the overall performance of milk supply chain in Pakistan. To achieve this aim, following research objectives are framed:

Objective 1: to overview dairy industries of Pakistan and New Zealand.

Objective 2: to measure the performance of key players of milk supply chains in Pakistan and New Zealand.

Objective 3: to identify and analyse performance gaps between milk supply chains in Pakistan and New Zealand.

Objective 4: to suggest policy measures for the improvement of milk supply chain in Pakistan.

1.5 Why New Zealand Milk Supply Chain as Benchmark?

Despite being a smaller (8th largest with 2% share of global production) milk producing country, New Zealand is the largest (40% share of global dairy trade) exporter of dairy products (Fonterra, 2015). To justify the selection of New Zealand dairy industry as a benchmark, various indicators of global dairy trade are presented in table 1.1. These indicators encapsulate the share of New Zealand dairy exports in global dairy market. As compared to major dairy exporters New Zealands' share of global exports outweighs its share of global production.

Table 1.1   Global Share of Top Dairy Exporters in 2014

Major Dairy Exporters	Cheese		Butter		Non-Fat Dry Milk		Whole Milk Powder	
	Share of Global Prod. (%)	Share of Global Exports (%)	Share of Global Prod. (%)	Share of Global Exports (%)	Share of Global Prod. (%)	Share of Global Exports (%)	Share of Global Prod. (%)	Share of Global Exports (%)
Argentina	3.08	3.47	0.59	1.60	-	1.17	5.14	6.73
Australia	1.75	9.20	1.23	5.15	4.68	8.73	-	3.79
EU-28	52.27	43.94	23.61	16.49	35.39	34.40	14.62	18.18
New Zealand	1.73	16.94	6.09	64.15	9.02	20.39	29.64	66.50
United States	28.40	22.49	8.84	8.48	23.90	29.07	0.95	0.84

Source: Adapted from (USDA, 2015)

The New Zealand dairy industry is diversified along the value chain into the processing and marketing of high value added dairy products. Table 1.2 shows a comparison of key indicators of dairy farms in top dairy products exporting countries. Truly operating at economies of large scale, New Zealand dairy farms have largest herd size as compared to others. Moreover, New Zealand dairy farmers are low cost producers of milk without any subsidy from government. Dairy production is largely (92%) cooperative enterprise and outdoor pasture-only system (Coriolis, 2014). Similarly, level of per capita consumption of dairy products in New Zealand is significantly higher than top dairy exporters.

Table 1.2   Key Indicators of International Dairy Farm Comparison 2013

Major Dairy Exporters	Farm Size	*Cost of Production	Milk Price	Subsidy	Milk Yield	Consumption	Farmers' Share of Consumer Price (%)
	No. of cows per farm	*US$/100 kg milk ECM*	*US$/100 kg milk ECM*	*US$/100 kg milk ECM*	*1000 kg ME/cow/ year*	*Kg ME per capita*	
Argentina	170	33	38	-	6.19	214	33
Australia	270	31	38	11	5.84	328	27
Canada	80	80	75	-	8.58	249	48
EU-28	n.a.	n.a.	48	n.a.	6.8	294	n.a.
New Zealand	400	37	46	-	4.75	593	32
United States	180	45	46	9	9.44	259	47

Source:Adopted from (Hemme, 2014)
* Cost of milk production represents cash costs and opportunity cost.

Cross-industry benchmarking is an ideal method for maximising learning from others (Stapenhurst, 2009). Various researchers suggest that developing actual benchmarks is better than using the hypothetical ones for benchmarking studies (Garcia et al., 2004; Painter, 2007; Shabani et al., 2012). For example, Painter (2007) compared Canadian and New Zealand dairy farmers and found that New Zealand dairy framers are world cost leaders in the production of milk with comparitively good incomes and net worth. The importance of using actual rather than hypothetical benchmarks and New Zealands' comparatively better performance indicators both support the selection of New Zealand milk supply chain as a benchmark.

1.6 Structure of the Thesis

Chapter one introduces the research topic and highlights the need for a benchmarking study aimed at identifying the performance gaps between the milk supply chains in Pakistan and New Zealand. Moreover, the selection of New Zealand milk supply chain as a benchmark has been justified by comparing the key indicators of international dairy trade and dairy farms in major dairy exporting countries.

Chapter two emphasises the background of the dairy sector at a global level, and at national level of the benchmarking partners, namely Pakistan and New Zealand. The global dairy sector expands on the trends in demand and supply situation over the time. Moreover, the dairy industry profiles of benchmarking partners include: prevalent dairy

production systems, structure of existing milk supply chain network, and the market situation.

Chapter three reviews the literature on benchmarking and performance measurement with particular focus on agri-food supply chains. The chapter is organized into supply chain management, benchmarking in supply chain management, and supply chain performance measurement. The performance measurement systems are critically reviewed against five criteria characterising performance measurement in agri-food supply chains. Finally, an analytical framework based on SCOR model has been proposed to fill the research gap as well as for performance measurement in milk supply chains in Pakistan and New Zealand.

Chapter four discusses the research methodology employed. It gives an overview of the existing research methodologies, the research design, the benchmarking model, and pilot testing of the questionnaires. The survey strategy was employed to gather data from both the benchmarking partners. Face-to-face interviews of the milk supply chain actors were conducted for data collection in Pakistan. However, mixed method (face-to-face interviews and mail questionnaires) was adopted for data collection in the milk SCN of New Zealand. The SCOR model modified to the specific needs of agri-food supply chains was used to measure and benchmark the performance of both the milk SCNs. Finally, the questionnaires were developed for data collection from both the milk SCNs. The questionnaires were pilot tested to calibrate in line of the SC functions and activities being performed by the chain players.

Chapter five presents value chain analysis and SCOR metrics for key players of milk supply chains in Pakistan and New Zealand. The chapter is organized into four sections; value chain analysis, SCOR metrics for dairy framers, SCOR metrics for informal chain of milk in Pakistan and SCOR metrics for dairy companies. The value chain analysis includes mapping of the milk value chains as well as quantification of the value distributed along the entire milk supply chains of the benchmarking partners. The data for 29 SCOR metrics is organized into five SCOR attributes: reliability, responsiveness, agility, cost, and asset.

Chapter six discusses the gap analysis by statistically comparing means from two independent groups (i.e. milk supply chains). Moreover, the results are compared and/or supported with relevant literature. Finally, a phased-out medium to long term policy

intervention was recommended to overcome the issues responsible for poor performance and to improve the overall performance of milk supply chain in Pakistan.

Chapter seven concludes the overall thesis, links results with the individual objectives, identifies the limitaions of the study, adds contribution of this research study, and finally suggests the future research.

1.7 Summary

This chapter introduces the research problem of examining the poor performance of milk supply chain in Pakistan. A number of inherent inefficiencies in milk supply chain in Pakistan identified and highlighted by previous researchers are summarised. However, to quantify the impact of these issues on the supply chain performance a benchmarking study is undertaken. The prime objective of the study is to benchmark the performance of key players of the milk supply chain in Pakistan against key players of the milk supply chain in New Zealand. The selection of New Zealand dairy industry as a benchmark is justified and supported by key indicators of world dairy trade and international dairy farm compraison. The study concludes at identification of performance gaps between the benchmarking partners and recommendation of appropriate policy interventions. Finally, format of the overall thesis is discussed chapterwise.

CHAPTER 2

2. BACKGROUND

2.1 Introduction

This chapter investigates the dairy industry from global as well as national perspectives. For this purpose the chapter is organized into three sections.

➢ Section 2.2 overviews global dairy industry in terms of production, trade, and demand and supply situation.

➢ Section 2.3 explores the structure of milk supply chain in Pakistan.

➢ Section 2.4 explores the structure of milk supply chain in New Zealand.

➢ Section 2.5 summarizes the overall chapter.

2.2 World Dairy Outlook

The world agricultural markets are predominantly driven by economic indicators such as rising per-capita incomes and increasing urbanization leading to dietary changes in most developing countries and generating increased demand for livestock products (OECD-FAO, 2014). Table 2.1 represents world dairy production, trade, and trade share of prod uction over last three years.

Table 2.1   World Dairy at a Glance

	2013	2014 estim.	2015 f'cast	Change 2014-15
WORLD BALANCE	*million tonnes milk equivalent*			*%*
Total milk production	767.5	789.0	800.7	1.5
Total trade	68.7	72.6	71.3	-1.7
Trade share of production (%)	9.0	9.2	8.9	-3.1
SUPPLY AND DEMAND INDICATORS				
Per capita food consumption (kg/yr)	107.2	109.0	109.4	0.4
FAO dairy price index	243	224	163	-31.8

Source: (FAO, 2015)

2.2.1 Global Dairy Production

There is a great variation in the patterns of dairy production worldwide. The biggest dairy producers such as EU, USA, and India are characterised as the biggest consumers of dairy products too. The perishable nature of milk restricts it to local consumption

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unless transformed to highly value added dairy products. Which is why its trade share of global milk production is 9.2% (FAO, 2015). Figure 2.1 shows the trends in the global milk production since 1980. However, the global demand for dairy products is growing faster than milk supply which poses a serious challenge in near future.

Figure 2.1   **Trends in Global Milk Production**
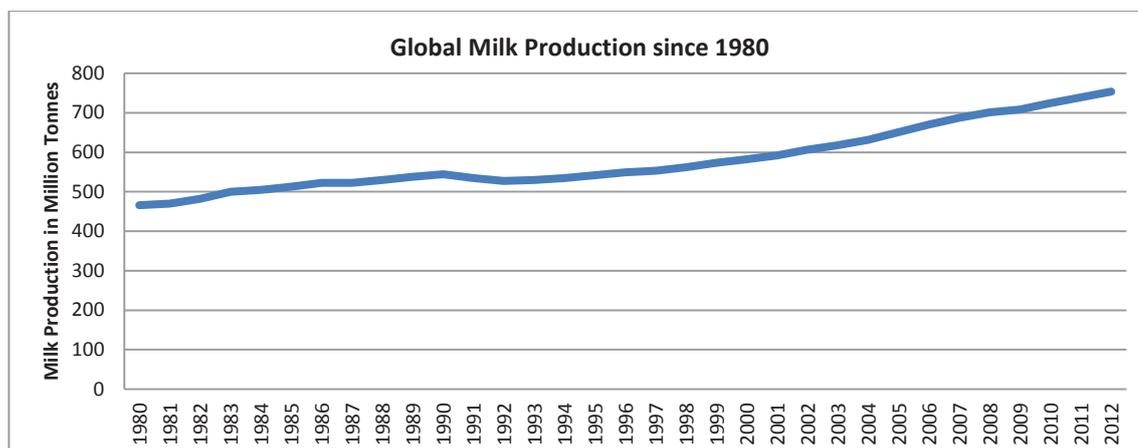
Source: (FAOSTAT, 2014)

The annual growth in world milk production is expected to decrease from 2.2% to 1.9% over the next decade (OECD-FAO, 2014). According to the OECD-FAO (2014) projections, in developing countries like India, China, and Pakistan, the projected growth in production is due to increase in dairy herd while in developed countries like USA, and New Zealand milk yield growth is projected at higher rate than total milk production.

2.2.2 Global Dairy Trade

Milk, being a perishable commodity is not easy to transport. The dairy products are mostly consumed in the country or region where they are produced. Therefore, with 8% share of total production, the global dairy trade is highly localized (FAO, 2015). The dairy products traded internationally fall into four categories: whole milk powder, skim milk powder, butter, and cheese. Figure 2.2 portrays the share of different market players of the world in global dairy trade. The major share of global dairy trade comes from small dairy producers such as New Zealand.

Figure 2.2 Major Exporters of Dairy Products

Top Ten Exporters of Dairy Products in 2013

	Net Trade Surplus in mill t ECM
New Zealand	20.1
EU-28	13.1
USA	5.2
Belarus	3.4
Argentina	2.3
Australia	2.0
Uruguay	1.1
India	0.8
Ukraine	0.4
Switzerland	0.3
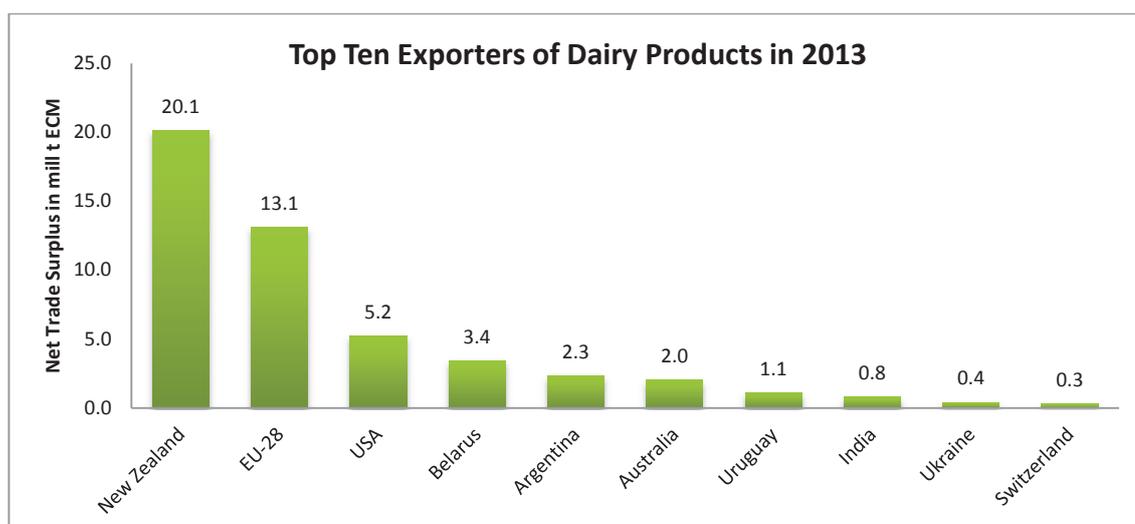
Source: (Hemme, 2014)

The major expoprters of dairy products are New Zealand, European Union, and USA. However, these exports are highly concentrated to Asia and Europe. The major export commodity is cheese, followed by milk powders. Figure 2.3 illustrates the major importers of the dairy products across the globe.

Figure 2.3   Major Importers of Dairy Products

Top Ten Importers of Dairy Products in 2013

	Net Trade Defecit in mill t ECM
China	8.1
Russian Federation	6.6
Mexico	2.6
Japan	2.3
Algeria	2.1
Saudi Arabia	1.9
Indonesia	1.6
Venezuela	1.5
Philippines	1.3
Republic of Korea	1.0
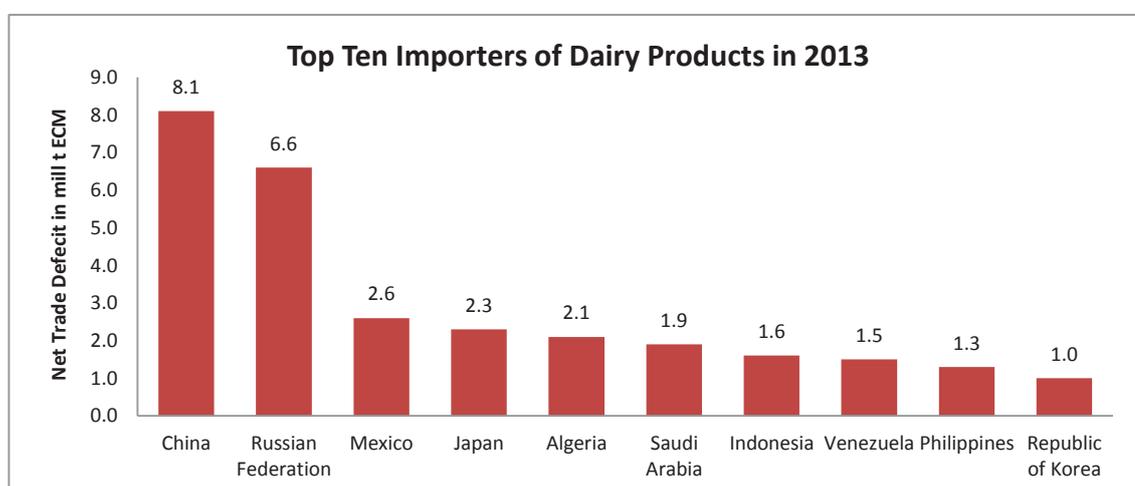
Source: (Hemme, 2014)

The trade in dairy products is highly volatile, which can be effected by a number of factors: overall economic situation in a country; fluctuations in supply and demand; changing exchange rates; political measures (Knip, 2005). Additional volatility is introduced by the fact that the global dairy market is extremely concentrated in terms of

buyers and sellers; hence, supply or demand shocks are not easily absorbed. A key to determining the likelihood of milk surplus or milk deficit of a country is its population relative to its production of milk. Furthermore, increasing numbers of customer requirements coupled with increasing customer power is constantly pushing world dairy companies in a cut-throat competition. Another challenge the global dairy industry is facing, is the negative impact of financial crisis and recession on the ease of access to credit.

Billions of people around the world consume milk and milk products every day. Milk provides nutrients such as calcium, magnesium, selenium, riboflavin, vitamin B12, and pantothenic acid (vitamin B5) which are essential components of human diet (FAO, 2013). Figure 2.4 shows that per capita supply of dietry nutrition from milk and milk products is less for the people in Africa and Asia as compared to Europe, Oceania, and Americas.

Figure 2.4   Global Per Capita Food Supply from Milk
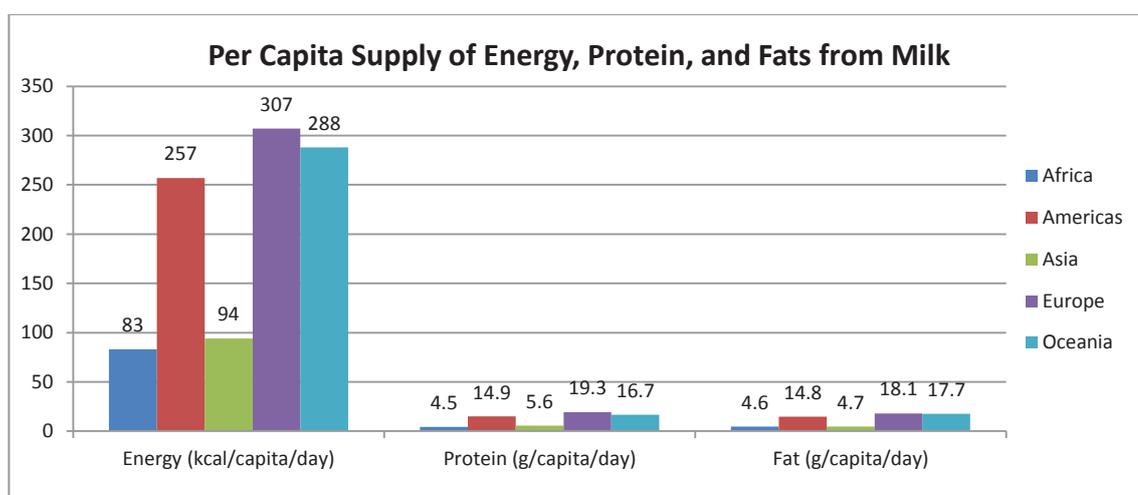
Source: (FAOSTAT, 2014)

Globally, the dairy sector is probably one of the most distorted agricultural sectors. According to FAO (2005) the production and export subsidies are put in place by developing as well as developed countries to encourage surplus production for the world markets. Tariff and non-tariff barriers (TBT's) have been used as a tool to protect domestic dairy industry from global competition. These market distortions are having significant impacts on producers and consumers of other global trade partners, which are however extremely difficult to quantify. A shift in world dairy exports from high

export subsidizing countries, e.g. EU and US towards non-subsidizing countries, e.g. New Zealand has been taking place since 1990 (Knip, 2005).

2.3 Pakistan Dairy Industry

Pakistan is the sixth most populous country of the world with an estimated population of 188 million people growing at a rate of more than 1.95% per annum (Ministry of Finance, 2015). Notwithstanding the structural shift towards industrialization, agriculture is still the largest sector of Pakistan's economy, employing 43.7% of the total labour force and contributing 20.9% to the national GDP (Ministry of Finance, 2015). The agriculture sector comprises of three sub sectors: major crops, minor crops and the livestock. The livestock sub sector with annual growth rate of 2.9%, is the single largest contributor to the overall agriculture value added (55.9%) and to the national GDP (11.6%) (Ministry of Finance, 2015).

2.3.1 Dairy Production in Pakistan

Pakistan is the fourth largest milk producing country of the world, with dairy as one of the fastest growing industries. Table 2.2 describes the milk production and consumption in Pakistan. Umm-e-Zia, et al. (2011) report that with the current increase in demand driven by the population growth, the consumption of milk is forecasted to surpass its total production in 2020 with an estimated deficit of 55.5 million tonnes.

Table 2.2   Milk Production and Consumption ('000' Tonnes)

Sources	2010-2011	2011-12	2012-13	2013-14
Gross Production	*46,440*	*47,859*	*49,400*	*50,990*
Cow	16,133	16,741	17,372	18,027
Buffalo	28,694	29,473	30,350	31,252
Sheep	36	37	37	38
Goat	759	779	801	822
Camel	818	829	840	851
Human Consumption	*37,475*	*38,617*	*39,855*	*41,133*
Cow	12,906	13,393	13,897	14,421
Buffalo	22,955	23,579	24,280	25,001
Sheep	36	37	37	38
Goat	759	779	801	822
Camel	818	829	840	851

Source: (Ministry of Finance, 2015)

Milk production in Pakistan had been least commercialized enterprise since 1947 (Zia, 2009). Unlike Europe and other developed countries characterised by corporate farms,

70 percent of Pakistani dairy farms have less than 5 animals (PDDC, 2006). In 2013, milk productivity of dairy animals in pakistan was 21.4% and 23.5% of milk yield per cow in USA, and Canada, respectively (Hemme, 2014). Moreover, the dairy farming business in Pakistan is considered to be a by-product of cropping. Dairy farming provides relatively quick returns for small-scale livestock keepers as compared to the cropping system. The prevelant dairy production systems in Pakistan are summarised in Figure 2.5.

Figure 2.5 Dairy Production Systems in Pakistan

Smallholder subsistence production system (average 3 dairy animals)

Smallholder rural farmers (with average number of 3 dairy animals per farm) lacking access to urban markets, produce for their family needs only. This traditional system mainly depends on non-cash resources such as family owned land and labour. Some 70 percent of smallholder farmers fall in this category.

Smallholder market-oriented production system (average 5 dairy animals)

Smallholder rural farmers (with average number of five dairy animals per farm) having access to urban markets are the main source of milk supply to the market. The milk extra to the family needs is sold in the nearby market through various channels such as milkman, milk contractor, or milk collection centre of a dairy company. Smallholder farmers (including above category) make up almost 92 percent of the overall farming community.

Rural commercial production system (average 50 dairy animals)

Some recent public sector interventions in dairy and livestock farming have encouraged some progressive farmers to invest in mixed enterprise, crop-livestock farm business. With relatively large herds with more than 50 dairy animals per farm, these farmers contribute small overall total milk supply as they are a small population of 1 percent of the overall farming community.

Peri-urban production system (10 – 200 dairy animals)

Located around almost all of the big cities of the country, these dairy farms are highly commercial in nature and harvest high rewards for growing fresh raw milk demand in urban areas. With average herd size of 50 dairy animals with 90% buffalos, these farms employ family and hired labour and deliver milk to the market twice a day. Milk is either sold direct to the retail shops or through intermediaries.

Source: (Afzal, 2008; Zia, 2006; Zia, et al., 2011)

According to the Pakistan Livestock Census held in (2006), among the total of 8.4 million farms, 51% had 1-4 dairy animals (Zia, 2009). Figure 2.6 portrays the distribution of dairy animals by households. Among the national dairy herd, buffalo is the major milk producing animal. Almost 80% of the milk in the country is collectively produced by rural commercial and rural subsistence producers. The peri-urban producers account for 15% of the total production whereas urban producers contribute only 5% (Zia, 2009). Despite of the very slow introduction of technological advanced farm practices and smallholder farming, the overall milk production has increased over the years. Figure 2.6 exhibits the trend in the milk production in Pakistan since 1980.

Figure 2.6   Trends in the Milk Production in Pakistan

Trends in Milk Production in Pakistan
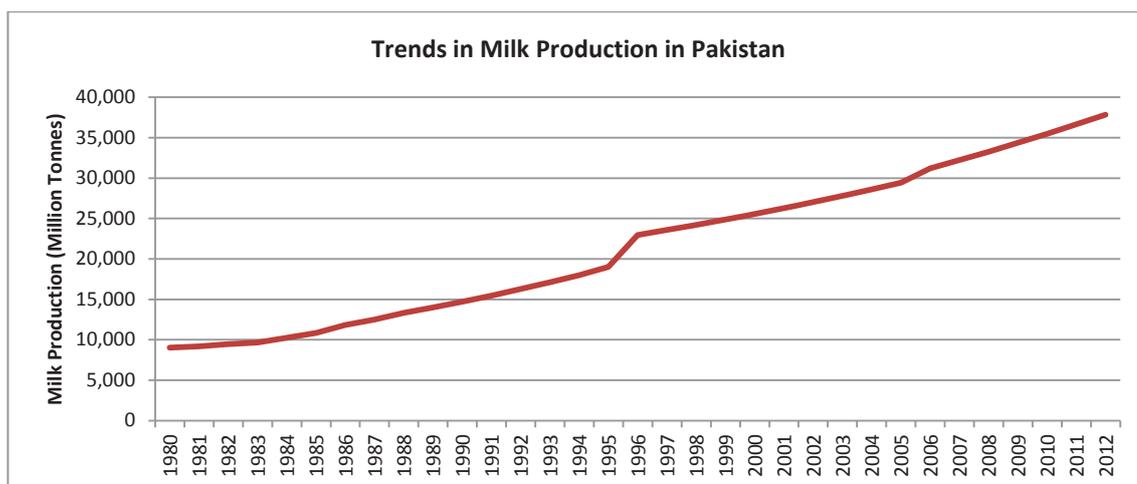
Source: (FAOSTAT, 2014)

The country's production base is highly fragmented and dairy enterprise is dominated by the private sector, with the government playing a regulatory role. The major portion of the national livestock herd is distributed in small units throughout the country with buffalos and cows as major milk-producing animals. According to the Pakistan livestock census conducted in 2006, the national herd is comprised of almost 27 million dairy animals (mainly water buffalos and cows) out of which 65.4% are raised at subsistence level farms (with herd size 1-6 dairy animals). These subsistence level farms make up almost 92% of the total farms in Pakistan. Figure 2.7 represents the geographical distribution of national herd in all the four provinces.

Figure 2.7 Dairy Farms in Pakistan by Geographical Location and Herd Size

Dairy Farms by Herd Size
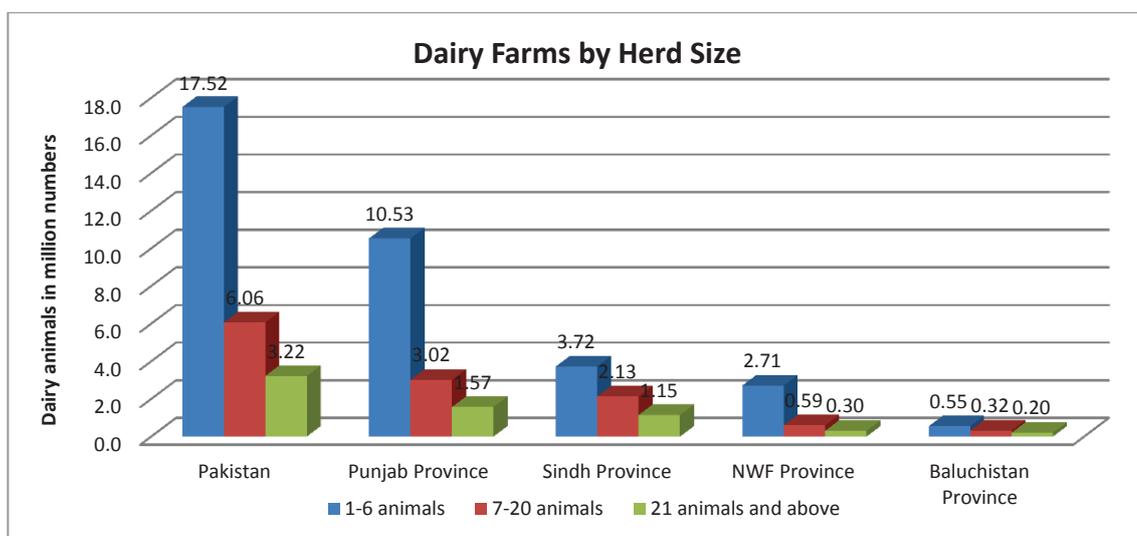
Source: (Pakistan Bureau of Statistics, 2006)

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Over 56.4% of the national herd is kept in Punjab province followed by the remaining 26.1% in Sindh, 13.5% in NWF province (the name of North Western Frontier province has been changed to Khyber Pakhtunkhwa), and 4% in Baluchistan province. Zia, et al. (2011) compared herd size of 1996 and 2006 censuses to understand the trends in dairy production systems in Pakistan and observed increasing fragmentation which means that a greater percentage of the national herd is reared at small farms. The reasons for this increase in fragmentation are attributed to the increase in the cost of production and division of agricultural land due to the law of inheritance.

The government, after initially ignoring the dairy sector, has now realized its importance and embarked upon a number of initiatives to boost the sector. To speed up the pace of development in livestock sector, the Ministry of Livestock and Dairy Development has initiated seven mega development projects as a part of reform agenda and political commitment of government to improve: public-private partnership led development; national economic growth; poverty alleviation; food security; to improve livestock service delivery; and to expand opportunities for livelihood needs of farmers.

The Government livestock policy focus is "private sector-led development with public sector providing enabling environment through policy interventions. Capacity building for improved livestock husbandry practices, improving per unit animal productivity, and moving from subsistence to market oriented and then commercial livestock farming in the country to meet the domestic demand and surplus for export are the basis of the agenda. The Ministry of Industries, Production & Special Initiatives established a Strategy Working Group (SWOG) on dairy to chalk out a strategy and suggest institutional arrangements for promoting the dairy sector in the country. In 2005, SWOG recommended the establishment of Pakistan Dairy Development Company (PDDC) on the lines and model of Dairy Australia.

2.3.2 Dairy Trade of Pakistan

The standard milk processing in Pakistan started in the mid sixties when 23 milk pasteurization plants were installed around the three big cities to cater the needs of rapidly growing urban sector (Anjum et al., 1989). These plants were intended to provide pasteurized and recombined milk under the World Food Program. Eventually, all these plants, except the one at Lahore, were closed down. In addition to the operational problems, the poor acceptance of pasteurized and recombined milk by the

consumers was the major reason of the failure (Anjum, et al., 1989). The second-generation dairy processing plants started with experimental production of UHT milk in 1977 which was successful due to the extended shelf life of the product. After the successful experiment, the first UHT processing plant was established at Sheikhupura as a joint venture by Milkpak and Tetra Pak Limited.

Pakistan's share in global dairy trade is very small primarily due to the high local demand driven by the high population growth rate. Moreover, ex-farmgate losses are very highy. According to Government of Pakistan (2015), almost 80% of the total milk produced is consumed locally, whereas, the remaining is lost either by poor transportation system or by calving. Due to the difference in international parity prices, Pakistan exports a very little amount of least value added dairy products to Afghanistan and UAE. Figure 2.8 describes the value of exports of milk and milk products to and from Pakistan.

Figure 2.8 Trends in Dairy Exports of Pakistan
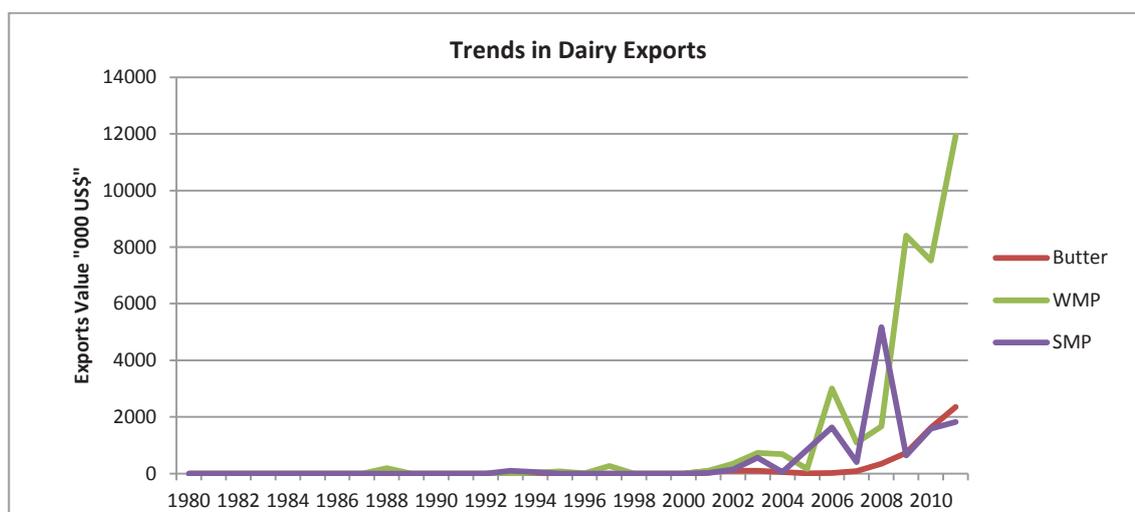
Source: (FAOSTAT, 2014)

On the other hand, due to poor quality control and lack of value addition, Pakistan imports cheese and milk powders to cater the growing demand for highly value added dairy products. According to Economic Suvery of Pakistan, the dairy import for the year 2013-14 were of value 132.4 US$ million (Ministry of Finance, 2015). Figure 2.9 shows the trend in Pakistan's dairy imports.

Figure 2.9   Trends in Dairy Imports of Pakistan
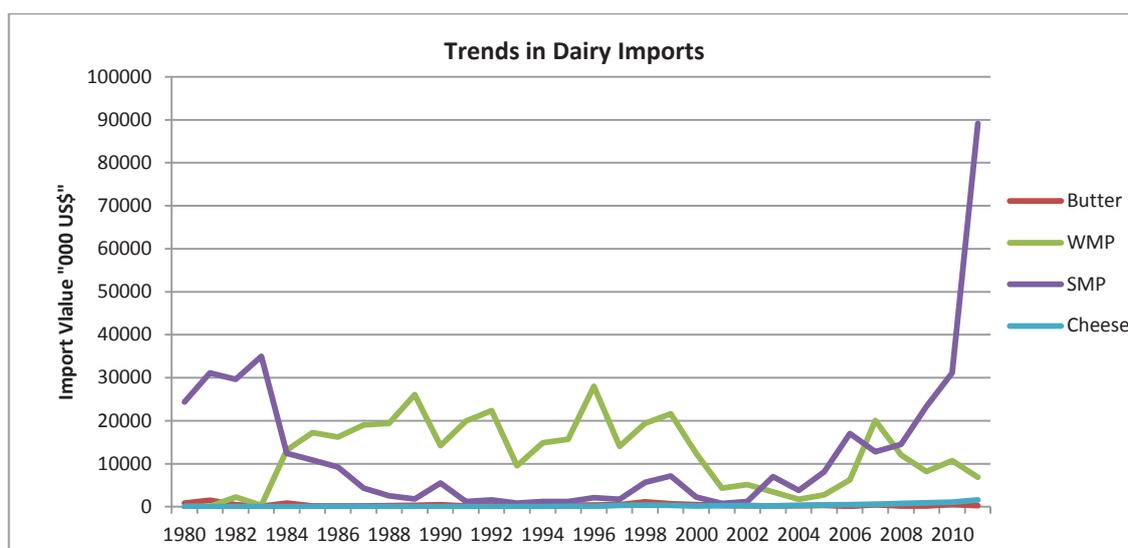
Source: (FAOSTAT, 2014)

Pakistan is traditionally a high milk consuming country with 253 kg milk equivalents per capita per year consumption of dairy products for the year 2013 (Hemme, 2014). A major proportion of the total milk produced in Pakistan is consumed in the form of traditional dairy products such as *Lassi* (buttermilk), yoghurt, milkshake, and *Mithai* (sweets) (Zia, et al., 2011). Buffalo milk, due to its more fat contents, density, color, and taste is preferred over cow milk.

2.3.3 Milk Supply Chain in Pakistan

In Pakistan, milk is second highly consumed food after cereals. Milk reaches the ultimate customers by two channels: the formal and the informal. Almost 70% of the milk is consumed in liquid form by the farming community itself and remaining 30% goes to the urban markets through informal or formal chain (PDDC, 2006). Almost 95% of the marketable milk reaches the ultimate urban consumers through the informal chain as unprocessed milk or locally processed into traditional dairy products. The remaining 5% is marketed as standard processed dairy products through the formal chain (Zia, 2009). Both the chains of milk start from the milk production at dairy farm and end at ultimate consumption by the final customers. The informal chain of milk is further divided into the rural and peri-urban chains. Figures 2.10 and 2.11 represent the rural and peri-urban chains of milk, respectively.

Figure 2.10   Rural Marketing Chain of Milk in Pakistan
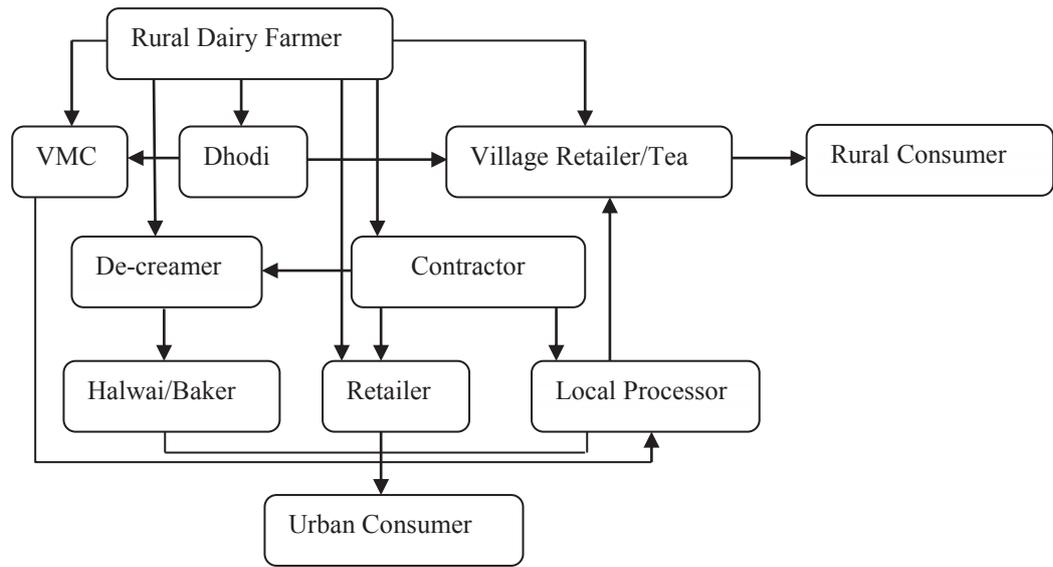
Source: (Zia, 2009)

Figure 2.11   Peri-Urban Marketing Chain of Milk in Pakistan
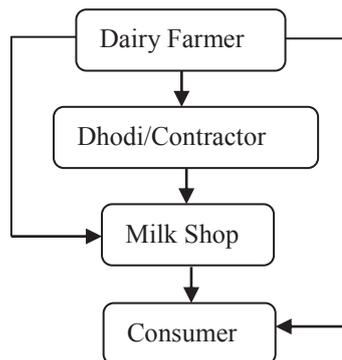
Source: (Zia, 2009)

After dairy farmer, the major player in the informal chain of milk in pakistan is milk collector. The milk collectors collect milk mainly from the individual dairy farms and transport to nearby town where they sell it to the milk shops, and milk collection centres and private contractors of the dairy companies. The milk collectors are classified into three categories based on their scale of operation (Zia, 2006; Zia, et al., 2011). Table 2.3 describes these categories briefly. The small scale milk collectors collect an average of 100 litres of milk from up to 20 farms daily. Bicycle or motorcycle is generally used to collect and transport milk. *Kutcha Dodhis* advance payment to the farmers to secure un-interrupted supply of milk, especially during summers, as risk management strategy. *Pucca Dodhis*, on the other hand, collect between 400 − 800 litres of milk daily. In addition to individual dairy farms, *Pucca Dodhis* source milk from *Kutcha Dodhis* as

well. *Pucca Dodhis* use motorcycle to collect and transport milk. Large scale milk collectors are very few in number and operate at large scale. For example, a typical contractor uses van to carry between 1600 – 2800 litres of milk usually sourced from small to medium scale milk collectors.

Table 2.3   Types of Milk Collectors in Pakistan

Types of Milk Collectors	Daily Milk Volume	Marketing Channel
Small scale milk collectors (Kutcha Dodhi)	Less than 200 litres per day	Collect milk from individual dairy farms and sell to medium and large scale milk collectors, milk shops, urban households, and dairy processors.
Medium scale milk collectors (Pucca Dodhi)	200 – 1000 litres per day	Collect milk from dairy farms and/or small scale milk collectors and sell to large scale milk collectors, milk shops, urban households, and dairy processors.
Large scale milk collectors (Contractor)	Above 1000 litres per day	Source milk from small and medium scale milk collectors and sell to milk shops and dairy processors.

Source: (Zia, 2006; Zia, et al., 2011)

The third major player in the informal chain of milk in Pakistan is the retailer of fresh milk and locally processed milk products called milk shop. The milk shop represents a wide range of retailers of fresh milk and milk products as described in the table 2.5.

Table 2.4   Retail Sale of Fresh and Locally Processed Milk in Pakistan

Milk Shop Category	Milk Products Sold
Fresh Milk Shop	Unprocessed (*Kaccha Doodh*) and processed (*Ubla Doodh*) milk, tea, flavoured drinks, milk shake, *Khoya*, yoghurt, and *Lassi*.
De-Creamers	Cream
Canteens/Cafes	Milk shake, *Doodh Soda*, tea, yoghurt, *Lassi,* and ice cream.
Sweets and Bakery Shops	All sorts of traditional sweets, cakes, ice cream, *Falooda*, and other bakery products

Sources: (Zia, 2006)

The formal chain of milk in Pakistan represents the standard processes of milk collection and processing into finished goods. The dairy companies are the major players of formal chain of milk. Every dairy company has its own network of milk collection. Punjab and Sindh are the major milk producing provinces. Currently, there are more than 25 dairy processing plants, producing mainly UHT milk, butter and

cream. Figure 2.12 shows top dairy processors in Pakistan. With exception to Engro Foods, almost all the dairy processing plants are located in Punjab province.

Figure 2.12   Milk Processors in Pakistan
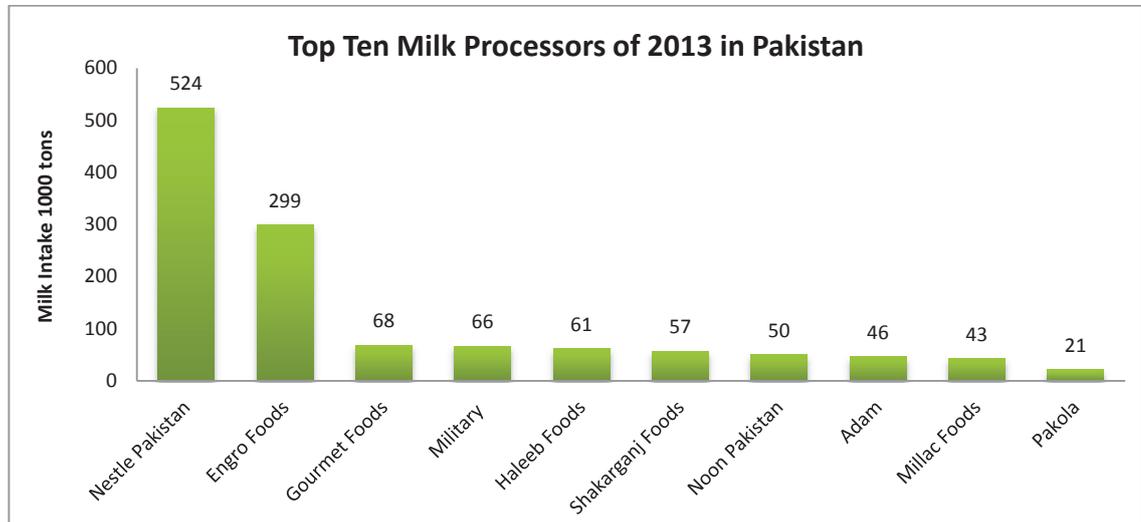
Source: (Hemme, 2014)

The fresh milk from multiple sources incldung registered dairy farmers, milk collectors, and private contractor is received at every village level milk collection center (VMCC) and stored at less than 2^0C in chilling plant until the milk collection vehicle delivers it to the main centre called milk collection centre (MCC) from where the milk tanker transports it to the processing plant.

At plant, milk is received in big silos after quality testing where it is cleaned for impurities and then poured into the production process for various products. The production cycle time for different products is different ranging from least for milk pasteurisation to the longest for cheese. Packaging is the last stage of production process, after which the finished goods are stored at room temperature, such as ambient dairy products or at chilling temperature, such as chilled dairy products. However, some other dairy products such as yoghurt are kept in incubation for as long as up to three days. The customers orders are shipped either as ambient or chilled dairy products in truck loads or less than truckloads (LTL) depending upon the distance to delivery location and size of the orders. The order fulfilment cycle time for the ambient dairy products is higher than chilled dairy products due to the consolidation of ambient dairy products into truck loads and inventory holding at distributors' warehouse level, whereas, the consignments of chilled dairy products are directly delivered to the

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distributors or wholesalers through specialized transport system. The distributors registered with the dairy companies own the product and promote to the wholesalers and retailers to maximise their sales revenue. Almost every company follows a different and unique marketing channel for milk collection from fragmented production base but a generalized supply chain for UHT milk is presented in figure 2.13 (Zia, 2009).

Figure 2.13   Supply Chain of UHT Milk

```
                    ┌─────────────────────────┐
                    │ Subsistence Rural Farmers│
                    └─────────────────────────┘
                       │                  │
                  ┌────────┐          ┌────────┐
                  │  VMC   │          │ Dhodi  │
                  └────────┘          └────────┘
                       │                  │
                       │            ┌────────────┐
                       │            │ Contractor │
                       │            └────────────┘
                       │                  │
              ┌──────────────────────────────────┐
              │ Procurement-Agent of Processor    │
              └──────────────────────────────────┘
                              │
   ┌─────────────────────┐   ┌──────────────────┐
   │ Imported Powder Milk │──▶│ Processing Unit  │
   └─────────────────────┘   └──────────────────┘
         │                          │
    ┌─────────┐              ┌────────────┐
    │ Bakers  │              │ Warehouses │
    └─────────┘              └────────────┘
         │                          │
         │    ┌───────────────────────┐
         └───▶│ Wholesale Distribution │
              └───────────────────────┘
                  │                │
      ┌────────────────────┐  ┌────────────────────┐
      │ Retail Store (Urban)│  │ Retail Store (Rural)│
      └────────────────────┘  └────────────────────┘
                  │                │
              ┌──────────────────────┐
              │      Consumer        │
              └──────────────────────┘
```
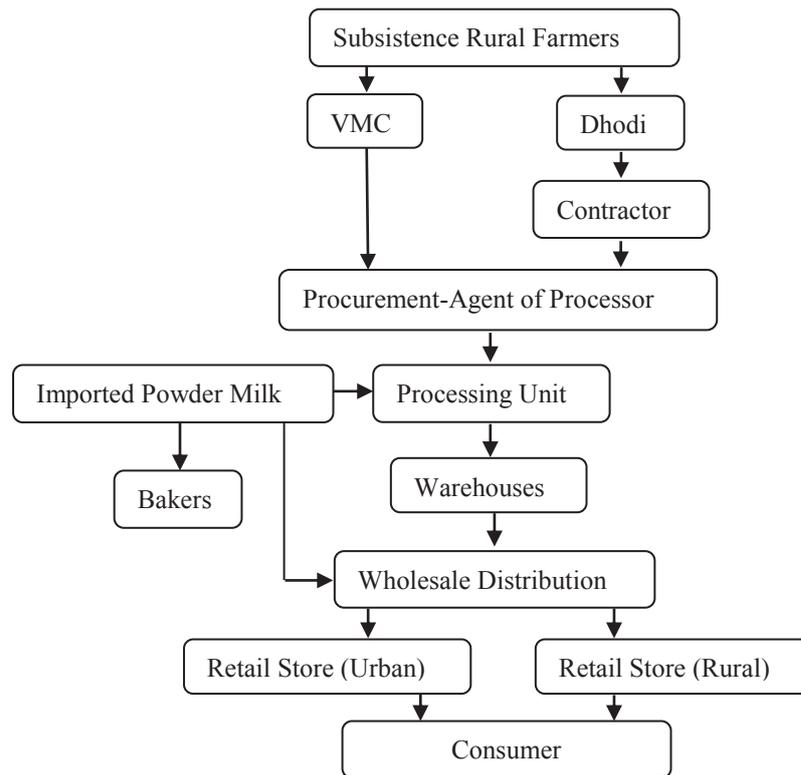
Source: (Zia, 2009)

The milk being a highly perishable commodity needs special refrigerated transportation but unfortunately the whole of the informal sector's milk collection and transportation system is non-refrigerated. Pakistan's dairy industry faces multiple challenges with smallholder and fragmented farmers at one hand and poor rural infrastructure on the other hand. Some of the milk supply chain problems seem to have common roots i.e. transportation and quality losses are related to fragile infrastructure. Tariq et al, (2008) categorized prime factors affecting milk marketing into: traditional production and marketing channels, poor milk production practices, unorganized farmers' community, seasonal fluctuations, lack of access to financial services, monopolistic and exploitative role of middlemen, poor infrastructure, price fixation and unsatisfactory role of government agencies.

2.4 New Zealand Dairy Industry

New Zealand is a market economy with GDP 211.6 NZ$ billion (Statistics New Zealand, 2014c). Its population of 4.5 million is growing at the rate of 0.89% (Statistics New Zealand, 2014c). International trade is essential to the New Zealand economy. Exports of goods and services make up the largest share (29.2%) of GDP (Statistics New Zealand, 2014c). With 18.6% share of the total exports, the dairy industry is New Zealand's biggest export earner. New Zealand population has one of the world's highest per capita consumption (593 Kg ME per capita per year) of dairy products (Hemme, 2014). The New Zealand dairy industry is predominantly an export business with only less than 5% of production consumed domestically whereas the remaining 95% goes to over 150 countries of the world with key markets in China, the US, Japan and the EU (Fonterra, 2015). With around 2% share of global milk production, the New Zealand is the world's largest exporter (almost one third of global market) of dairy products (Fonterra, 2015).

Dairy farming is part of a long and proud agricultural tradition in New Zealand (DCANZ, 2014). Since its inception in late nineteenth century, the New Zealand dairy industry got comparative advantage over many of its competitors due to New Zealand's temperate climate (New Zealand Treasury, 2005). After the colonization of New Zealand, the dairy production served only domestic markets with a little export to Australia (Conforte et al., 2008). With the development of refrigeration technology, its exports entered European markets (UK) around 1919. The companies' numbers kept increasing from 23 factories in 1885 (Pimenta, 2010) to more than 400 individual dairy cooperatives by the 1930's operating throughout the country (DCANZ, 2014). In 1961, New Zealand Dairy Board (NZDB) was established by the government to market dairy products (Conforte, et al., 2008).

The New Zealand, dairy companies have always been export driven, however, since the 1970s there has been significant diversification in both dairy products and markets (DCANZ, 2014). In 1973, only butter and cheddar cheese were exported (Conforte, et al., 2008). Later on dairy cooperatives began to expand their manufacturing capabilities, shifting from butter and cheese (the mainstay of exports to the UK) to begin investing in the infrastructure to manufacture the milk powders which are an important part of today's product mix (DCANZ, 2014). This diversification of product lines and markets led to the increased investments in the dairy sector. By 1995, the New Zealand Dairy

Board became the world's biggest marketing network which was later on dissolved in 1996 and transferred ownership of its assets to the country's 12 dairy co-operatives (DCANZ, 2014).

In search of efficient manufacturing processes, the companies started consolidation and integration of their operations. As a result, by the year 2000, more than 95 per cent of the industry was represented by the two largest dairy companies New Zealand Dairy Group and Kiwi Co-operative Dairies. Farmer's strong ideology towards control and ownership of downstream manufacturing and marketing activities led to vertical integration and continuous institutional and organizational changes (Conforte, et al., 2008). In 2001, the dairy industry deregulated and the two largest dairy companies merged to form Fonterra (Pimenta, 2010).

2.4.1 Dairy Production in New Zealand

The New Zealand dairy farming is characterised as the lowest cost producer at the farm gate due to the ability to feed on grass all-year-round and the absence of a need for winter housing of stock. The production base of New Zealand dairy industry has shown tremendous growth over the last three decades. Figure 2.14 shows the long term trends in milk production in New Zealand.

Figure 2.14   Trends in Milk Production in New Zealand
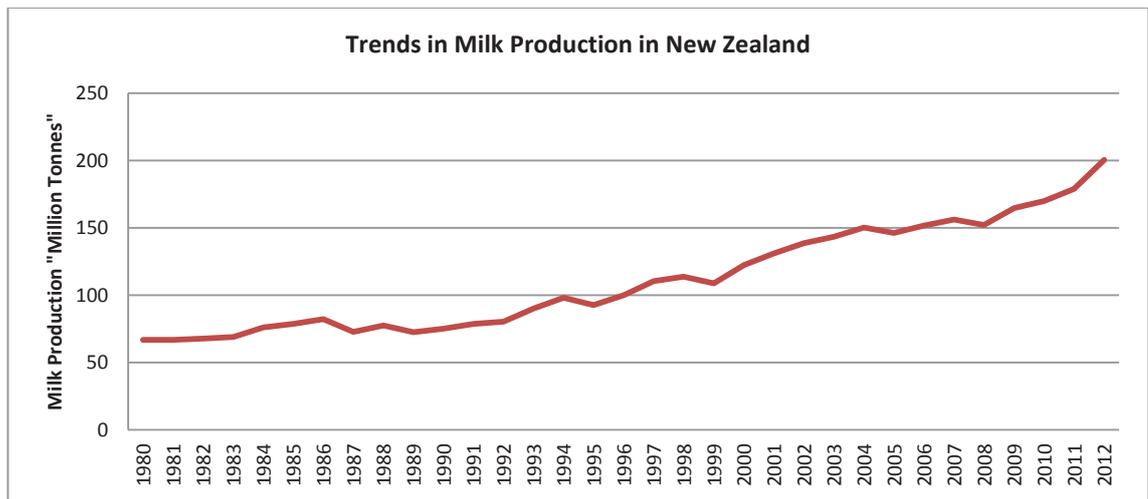
Source: (FAOSTAT, 2014)

The New Zealand's predominately pasture based milk production system follows a seasonal pattern where cows are in milk from July to early May. The seasonal milk production system of New Zealand dairy industry relies predominantly on highly

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productive, rotationally grazed pasture and herds of high genetic merit. It is this system that enables farmers to produce milk substantially below average world costs, giving New Zealand its advantage over global competitors. Dairy New Zealand classifies the dairy farms into five production systems, system-1 being "all grass selcontained" whereas system-5 "imported feed used all year". Figure 2.15 illustrates distribution of dairy cows across New Zealand.

Figure 2.15   Regional Distribution of Dairy Cows in New Zealand
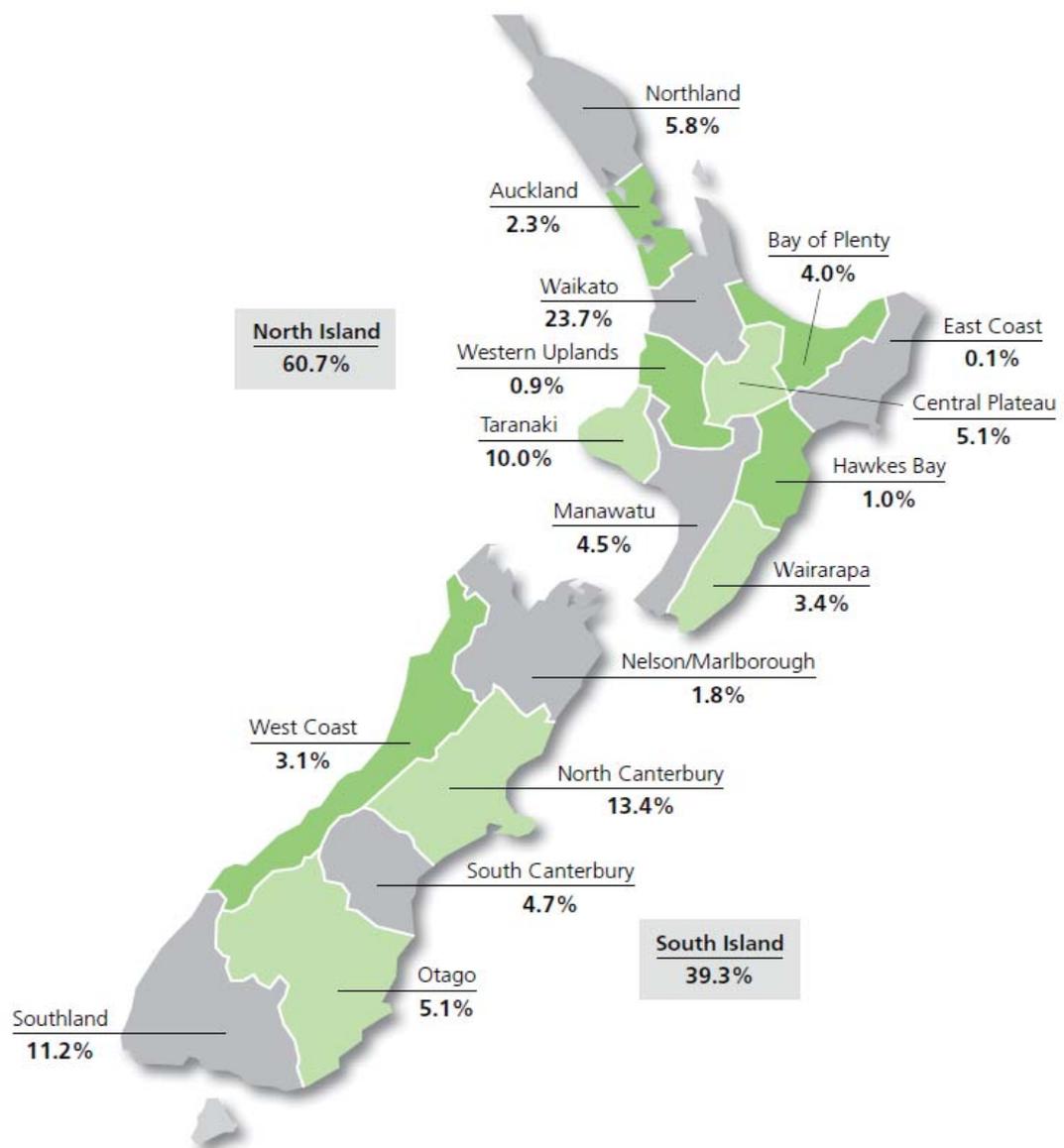
Source: (DairyNZ, 2014)

The dairy season in New Zealand starts from June and ends in May. Over the years husbandry practices have been managed in such a way that all the dairy cows dry up in May and calving season starts from the end of July. This reproductive pattern adheres to

the grass production dependent on weather. Figure 2.16 shows the pattern of milk production in New Zealand.

Figure 2.16   New Zealand Milk Production Pattern
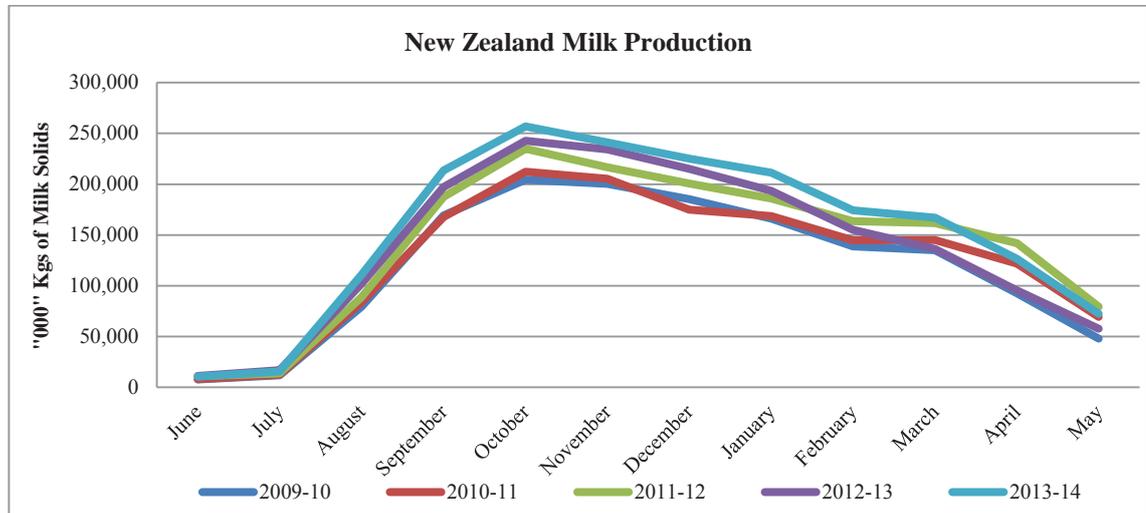
Source: (DCANZ, 2014)

According to Dairy Companies Association of New Zealand the total number of herds has decreased whereas the herd size has increased over the years (DCANZ, 2014). The continuous decline in the total number of dairy farms is due to economies of the large scale production and technological advances leading to consolidation. Figure 2.17 illustrates the trends in number of dairy farms and herd size over the last three decades.

Figure 2.17   Trends in Number of Herds and Average Herd Size
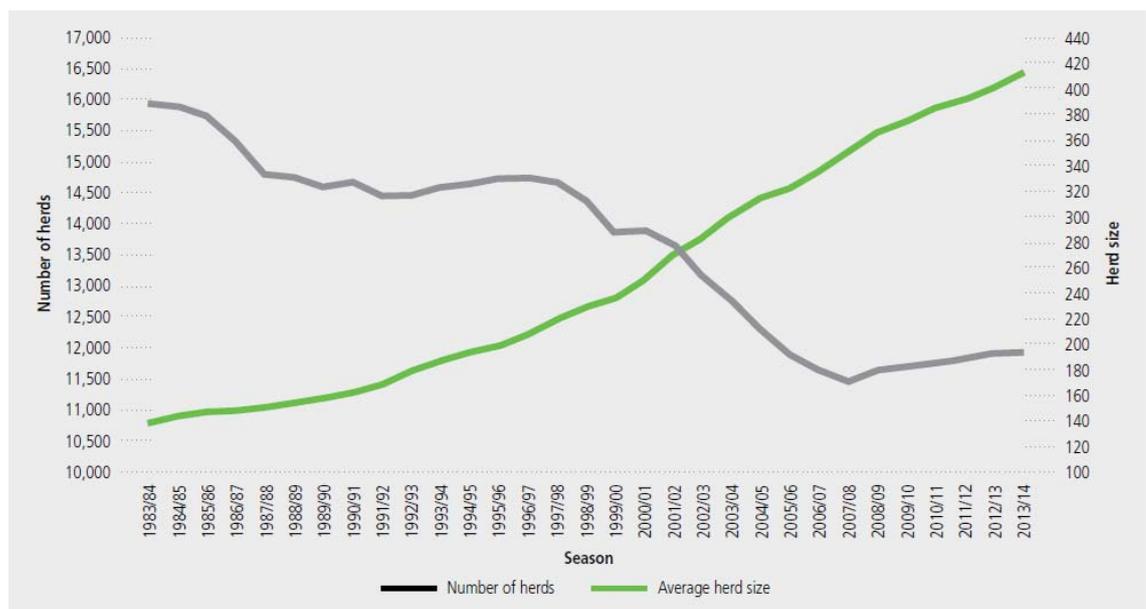
Source: (DairyNZ, 2014)

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2.4.2 Dairy Trade of New Zealand

The New Zealand dairy system is recognised internationally as a supplier of world's best quality milk and milk products in terms of food safety, processibility and intrinsic value. Despite the fact that most countries in the world have huge long-term potential to increase milk supply, there are no countries with both the ability and incentive to compete with New Zealand by rapidly increasing export supply or decreasing cost of production (Dairy NZ, 2010). The dairy exports includes highly value added and innovative dairy products in almost all categories of dairy trade. The mix of exported dairy products: milk and cream, cheese and curd, and casein and caseinates varies by country of destination. Among the exports of dairy products, the whole milk powder and skim milk powder are predominantly exported to developing countries, whereas butter, cheese and casein are mainly exported to developed countries. Figure 2.18 shows the trend in dairy exports of New Zealand over the last three decades. Despite the fact that per capita consumption (593 kg milk equivalents per capita per year) of New Zealand population is significantly higher than most countries of the world, dairy exports show an increasing trend.

Figure 2.18   Trends in Dairy Exports of New Zealand
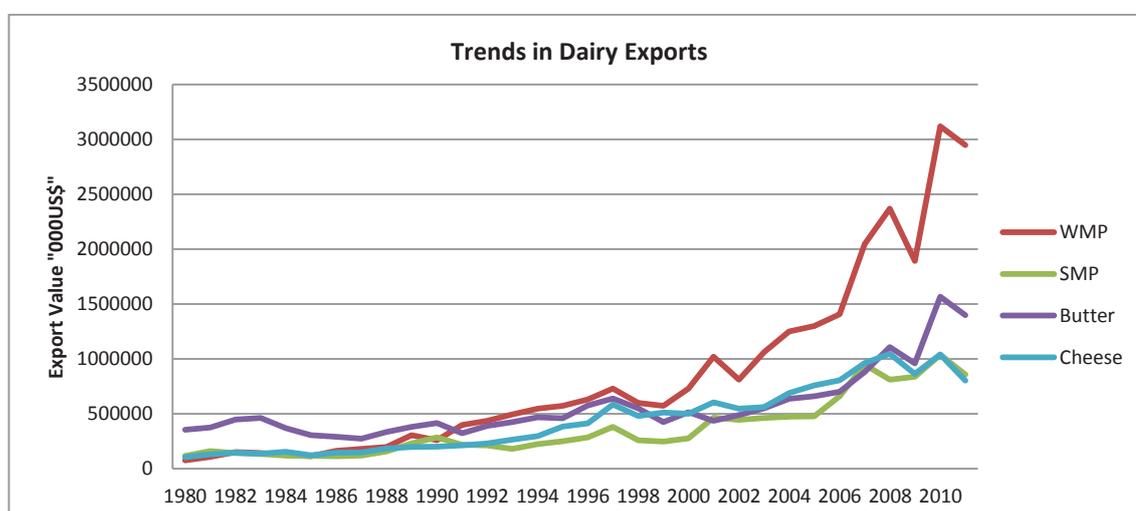
Source: (FAOSTAT, 2014)

The US and EU have cost of production above average export returns as a limiting factor whereas the forecasts of increase in milk production in China, India, Pakistan and Russia will meet their increasing consumption only (OECD-FAO, 2014). Therefore, New Zealand relies heavily on the operation of markets and minimizes government

interventions. New Zealand government does not use such measures as production quotas, intervention purchasing or public storage, export refunds, or direct subsidy assistance to farmers (except "green box" provisions).

2.4.3 Milk Supply Chain in New Zealand

Milk being a highly perishable commodity must be processed within a couple of hours after production unless kept at a low temperature at which it can be stored for 2 or 3 days before processing (Pimenta, 2010). In 2013, almost 92% of the milk produced was collected by four dairy cooperatives. Fonterra, the single largest (with 88% share) of the four dairy cooperatives is a government-mandated monopsony owned by over 10,000 dairy farmers (Coriolis, 2014). The rest of 8% of raw milk was collected by four private companies. The rest of all the private dairy companies sourced raw milk from the Fonterra. Figure 2.19 represents dairy value chain in New Zealand.

Figure 2.19   Dairy Value Chain in New Zealand
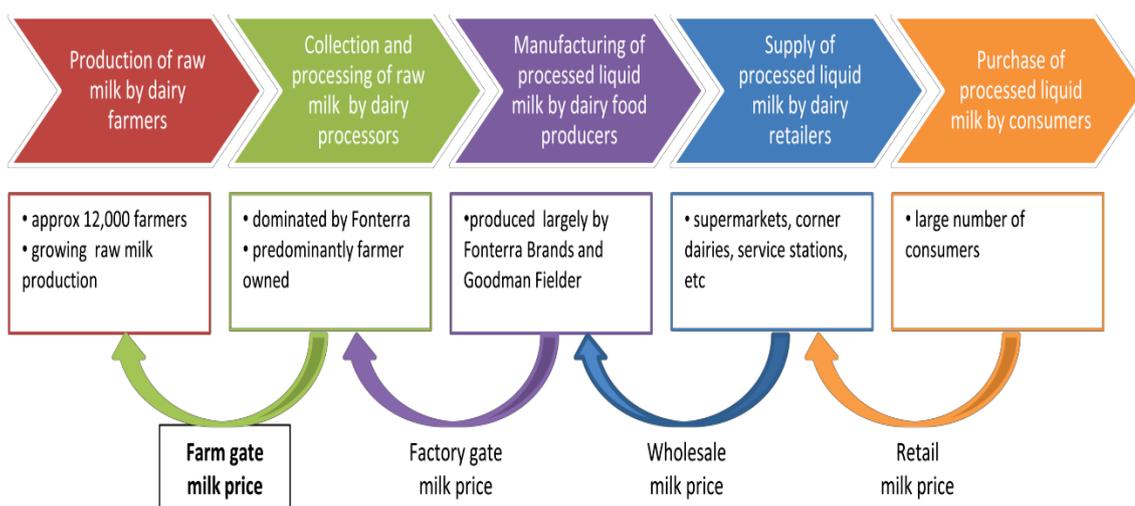
Source: (Commerce Commission New Zealand, 2013)

The number of dairy products manufacturing companies in New Zealand have increased significantly since 2008. According to Statistics New Zealand (2014a) there were 139 dairy companies in New Zealand in 2013. Figure 2.20 categorically illustrates the trend in number of dairy companies in New Zealand since 2000. The dairy cooperatives provide a set of services to support dairy farmers and industry as a whole in coordination with other organizations such as DairyNZ and livestock improvement corporation (LIC).

The New Zealand dairy companies process raw milk into value added and premium quality dairy products for which there is a continuously growing demand across the globe. In additon to fulfilling local demand in New Zealand, most of the dairy products manufacturing companies export to overseas markets such as USA, UK, China, and Russia. Dairy companies have their own fleet of vehicles to collect milk from individual farms and transport final products to the distribution centres (for domestic sale) or to the port (for export). Dairy farms are located sparsely throughout both the islands.

Figure 2.20   Dairy Products Manufacturing Enterprises in New Zealand
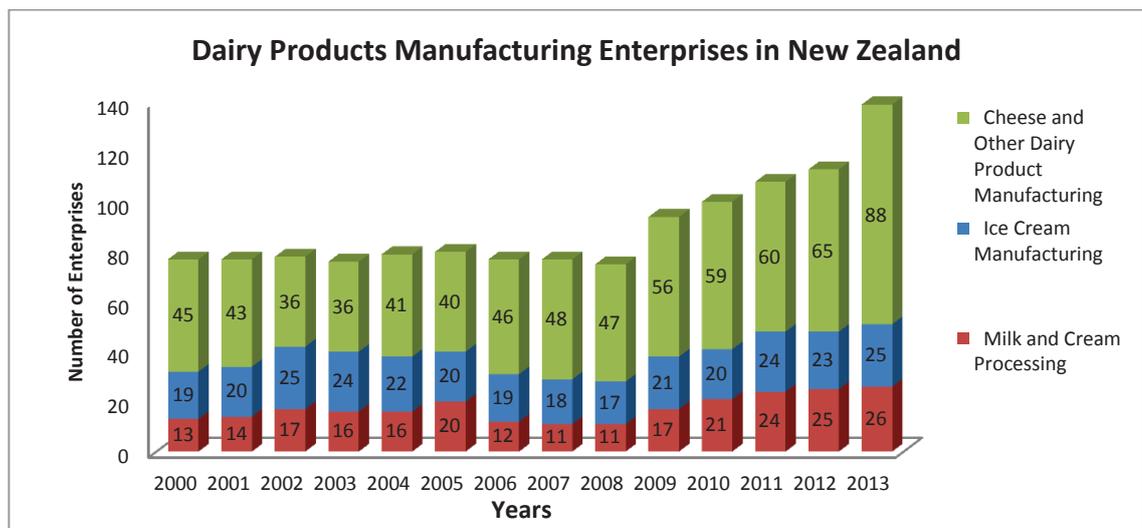
Resource: (Statistics New Zealand, 2014a)

In New Zealand both road and rail modes of transportation are used by the dairy companies to transport raw milk and finished goods (Pimenta, 2010). The collection of milk from dairy farms and its reception at the processing plant is carried out according to the approved criteria of New Zealand Food Safety Authority (2008). The regulations set by NZFSA (2008) involve the minimum quality standards of farm facilities, equipment, raw milk and record keeping.

The milk collection team consists of truck drivers, schedulers and a number of others who are responsible for placing the right quantity of milk in factory silos (Pimenta, 2010). Due to the variation of quantity of daily milk collected from each dairy farm, every company follows the forecasts, routing, and scheduling efficiently. Big companies (like Fonterra) use specialized routing and scheduling software programs (like decision support systems) to optimize the processes (Pimenta, 2010). The vehicles after collecting milk from individual farms drive to the bay where they transfer the milk to

big silos. The milk from these big silos is pumped and transferred into the train which carries it to the milk processing plant. Almost all the milk from dairy farms reaches the consumers through formal supply chain network. In New Zealand, under the dairy industry regulatory act (DIRA) 2001, all the dairy companies are required to perform regular QAS audit of the dairy farm premises supplying raw milk in addition to standard operating procedures (SOPs) for milk quality testing.

The dairy products produced by dairy companies are marketed through a network of supermarkets, grocery stores, and food service stores having direct interaction with the ultimate customers. The retailers are vertically and horizontally integrated with the distributors through fourth party logistics (4PL) providers. The 4PL companies provide batch consolidation, freight, and other logistics solutions to the manufacturers as well as the retailers. Figure 2.21 shows the number of food retailing businesses in New Zealand since 2000.

Figure 2.21   Food Retailing Entreprises in New Zealand
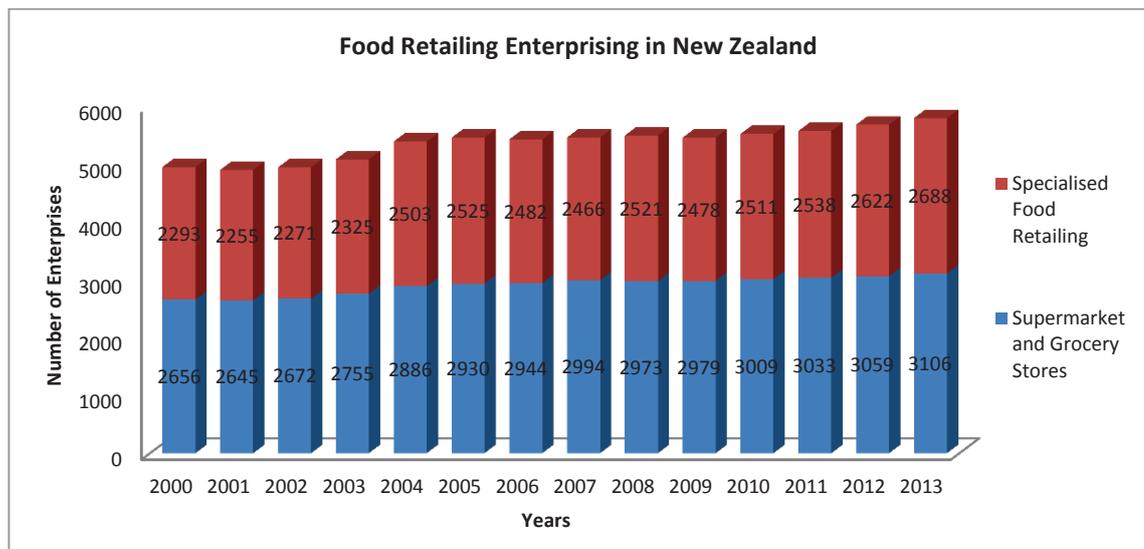
Source: (Statistics New Zealand, 2014a)

With minimal state regulation of milk contracting, the New Zealand dairy processors and farmers freely determine the terms and conditions for milk supply that best suit their respective needs (New Zealand Government, 2010). The cooperatives require their member farmers to buy shares equal to milk supply mentioned in the contract. The cooperatives maintain a share standard by establishing a relationship between milk supplied and a number of shares required to be held (New Zealand Government, 2010). For an individual farmer, the only way to increase its milk supply to the cooperative is

to buy additional shares of that cooperative. The investor owned companies, on the other hand, offer farmers long term supply contacts (ranging from 3-6 seasons) rather than requiring them as suppliers (to purchase shares in the company).

According to the New Zealand dairy industry restructuring act (DIRA) 2001, the dairy cooperatives are required to allow free exit to its member farmers (New Zealand Government, 2010). The dairy cooperatives in New Zealand are required to offer "fair value" share price to its farmers otherwise their suppliers will switch to the other companies. The result is that the cooperatives have strong incentives to efficiently price raw milk prior to the start of each season. These provisions nullify the need to impose a regulated milk price (New Zealand Government, 2010).

2.5 Summary

The background chapter provides exploratory basis for the overall study. This chapter is directly linked with the first research objective of investigating the milk SCN of Pakistan and New Zealand to develop deeper understanding of the structure of dairy industry. The chapter emphasises the background of dairy industry at global level as well as the benchmarking partner's national levels. The overall patterns of global milk production, dairy trade, and consumption of dairy products are discussed. The international terms of trade between the major exporters and importers of dairy commidities are described.

Subsequently, the dairy industries of Pakistan and New Zealand are described from milk production, dairy trade, and demand and supply mechanism of the dairy produucts persepectives. The milk production system of Pakistan is fodder-based smallholder, whereas, in New Zealand its Pasture-based cooperative farming. Moreover, the dairy processing, distribution, and retail sale is predominantly done by an integrated and collaborative network of producer and consumer cooperatives.

CHAPTER 3

3. LITERATURE REVIEW

3.1 Introduction

This chapter reviews the literature on supply chain management (SCM), performance measurement (PM) in SCM, and benchmarking. The chapter is organized into following sections.

➢ Section 3.2 focuses on SCM literature, in context of definitions and evolution of SCM over the years.

➢ Section 3.3 presents the literature on benchmarking in SCM. This section covers introduction to benchmarking, history of benchmarking, benchmarking frarmeworks, and benchmarking in agri-food supply chains.

➢ Section 3.4 critically reviews the literature on performance measurement in SCM. This section expands on definitions, evolution of SC performance measurement, performance measurement in agri-food supply chains, selecting a performance measurement framework for agri-food supply chains, and SC performance measurement systems (PMS).

➢ Section 3.5 discusses potential research gap and the way forward.

➢ Section 3.6 introduces the proposed analytical framework for agri-food supply chains.

➢ Section 3.7 presents the summary of the overall chapter.

3.2 Supply Chain Management

Various terms have been used in the history conforming supply chain management such as physical distribution management before 1960's, logistics management in 1970's, and finally supply chain management in 1980's. Supply Chain Management (SCM) is one of the fastest evolving areas of interest in industry and academia. Now the competition is among supply chains, not the individual firms. Supply chains are collaborating to overcome the future challenges such as to optimise costs, reduce risks and improve reliability, responsiveness, agility, and flexibility of the overall supply chain. The use of information technology in the form of various softwares such as EDI, VMI, ECR, MRP, and ERP has played a pivotal role. The literature on supply chain management can be summarised under following subsections.

3.2.1 Supply Chain Management Definitions

In literature, the term supply chain management has been defined as 'supply chain' as well as 'supply chain management'. The definition of 'supply chain' seems to be more common in literature than 'supply chain management' (Cooper & Ellram, 1993; La Londe & Masters, 1994; Lambert, Stock, et al., 1998). The former term is a proposition noun describing an amalgamation of firms involved in the flow of goods, service, and information from a point of initial production to ultimate consumption. Whereas, the later term describes the management of integrated business processes responsible for creating and transferring value at all the links in an overall supply chain.

The most common definitions of supply chain are presented in Appendix-A. These definitions of supply chain focus on few common elements. These are: flow of goods from source of production to ultimate consumer; value addition conforming to the dynamic customer demands; manufacturing perspective; integration of supply chain processes and activities at intra-firm and inter-firm levels; relationship management with suppliers and customers; exchange of information; and holistic/system's approach of solving problems. The flow of goods and services and integration of processes is the overall focus of almost all the definitions of supply chain. Earlier definitions such as given by (Cavinato, 1992) emphasise on relationship management while others focus on customer value (Christopher, 1998), information sharing (Lummus & Vokurka, 1999; Mentzer et al., 2001; Quinn, 1997; Van der Vorst, 2000a), manufacturing perspective (Beamon, 1998; Swaminathan et al., 1998), and holistic/system's approach (Lummus & Vokurka, 1999; Quinn, 1997; Van der Vorst, 2000a).

A careful look over the focus of definitions of supply chain yields an evolutionary trend in the concept of supply chain. The focus of earlier definitions is on flow of goods whereas the later definitions include the flow of services and information as well. The integration of all the supply chain activities and decision making units can be seen in late 1990's definitions. Moreover, the concepts of customer value and holistic thinking approach are found in later definitions.

The SCOR model developed by Supply Chain Council in 1996 emphasizes that every supply chain consists of five supply chain processes namely Plan, Source, Make, Deliver, and Return (Stewart, 1997). Lambert, Cooper, and Pagh (1998) on the other hand, view that a supply chain is built on eight business processes: customer relationship management; customer service management; demand management; order

fulfillment; manufacturing flow management; supplier relationship management; product development and commercialization; and returns management. Lambert and Cooper (2000) describe four main characteristics of a supply chain. These are: vertical coordination at intra- and inter-organization levels; relationship management; two-way flow of products, services, and information; and create and deliver high value to the customer with optimal use of resources. What a supply chain comprises of and what it does not, is debatable.

The term 'supply chain management' on the other hand, has been viewed from various perspectives in the literature. For example, Cox (1997) uses it to describe strategic inter-organizational issues, whereas earlier Thorelli (1986) looked over it as an alternative organizational form to vertical integration. Lamming (1993) employs SCM to describe supplier relationships. However, a number of authors claim that the concept 'supply chain management' is not well-understood (Babbar & Prasad, 1998; Cooper et al., 1997; Gibson et al., 2005), and therefore, highlight the necessity of a consensus definition. The commonly found definitions of SCM found in the literature are presented in Appendix-B.

Lambert et al. (1998) believe that supply chain management is a set of management processes rather than functional silos. Mentzer et al. (2001) classify the definitions of SCM found in the literature into three categories: a management philosophy, implementation of a management philosophy, and a set of management processes. Gibson, Mentzer, and Cook (2005) are of the view that all the definitions of SCM found in the literature focus on strategy, activities, and processes or any of their combinations.

The definitions of SCM found in the literature exhibit a series of evolutionary steps towards refinement. The focus of earlier definitions of SCM is on flow of goods (Cooper & Ellram, 1993), and relationship management (Berry et al., 1994; Christopher, 1998). Counter wise the focus of later definitions is on supply chain coordination (Ballou, 2007; Mentzer, et al., 2001; Van der Vorst, 2000a), customer value (Levi et al., 2003; Van der Vorst, 2000a), and holistic/system's approach (Ballou, 2007; Mentzer, et al., 2001; Van der Vorst, 2000a).

This shift in the focus of the definitions of SCM shows evolution towards refinement. However, two elements: the integration of business processes; and efficiency and effectiveness have always been the major focus of most of the definitions. The

integration here means both forward and backward integration at intra-firm as well as inter-firm levels. Efficiency and effectiveness refer to the performance of business activities performed at intra-organization as well as inter-organization levels required to move the goods and services from point of initial production to final consumption. These performance measures include reliability, responsiveness, agility, and flexibility.

3.2.2 Evolution of Supply Chain Management

Supply chain management evolved as war strategy and later on shifted to business domain (Soni & Kodali, 2008). In different periods of history, supply chain management has been referred differently, such as 'physical distribution management', 'logistics management', 'business logistics management', 'integrated logistics management', and 'supply chain management' (Soni & Kodali, 2008, p. 7). The concept of SCM entered in business domain in 1980s' when firms experienced the benefits of collaborative advantage (Cooper, et al., 1997). The globalization of marketplace lead organization to integrate vertically so as to harvest a number of collaborative advantages, such as economies of the scale, sourcing quality material suppliers, and specializing as low cost (Christopher, 2005). A systems' thinking emerged in SCM in order to satisfy dynamic customer demands and to survive in cut-throat competition.

The origin of supply chain management roots from ancient history of mankind. Logistics practices originated due to surplus grains, raw materials, and trade of scarcer and surplus commodities (Soni & Kodali, 2008). The logistics strengths and capabilities have been the determining factor in success or failure of wars in human history (Christopher, 2005). The industrial revolution added to the standardization of the products, and shifted primary production to mass production. In the early part of 20th century, distribution of goods was not considered to be the responsibility of the manufacturer (Rushton et al., 2006). The Ford's highly integrated manufacturing complex in 1917 was a revolutionary initiative in the evolution of SCM in manufacturing. During the World War-I and II the movement of huge amount of supplies further raised the importance of logistics.

Before 1950's the term 'logistics' was used mainly by the military organization and unknown in industry (Ballou, 2007). During 1950's the manufacturers adopted mass production to reduce costs and improve productivity and very little efforts were employed to make supplier partnerships, improving process design and product quality

(Soni & Kodali, 2008). Afterwards, physical distribution management got recognition as a separate department in manufacturing companies with main focus to minimize physical distribution costs (Helson, 1964). The notion of system's approach to problem solving for the accomplishment of organizational goals is a product of physical distribution analysis (Bowersox, 1969).

During 1960s' the share of physical distribution cost in dollar sales was 25-33% because now consisted of materials handling, packaging, finished goods inventory, distribution planning, order processing, transportation, and customer service (Reese, 1961). The vision of physical distribution of that time is much like SCM today as can be inferred from the definition of physical distribution given by Smykay, Bowersox, and Mossman (1961, p. 1).

"Physical distribution can be broadly defined as that area of business management responsible for the movement of raw materials and finished products and the development of movement systems"

In 1970's logistics management emerged as a result of integration of physical distribution and materials management recognizing the need of coordination between inbound and outbound movement of information and goods (Langley, 1986). Ballou (2007) pointed out that the typical firms at that time had fragmented their key activities in terms of responsibilities and objectives for marketing, finance and production. This fragmentation led to the conflict of sub-optimization of costs and customer service among those responsible for the logistics activities. Moreover, the logistics costs on an individual firm level were as high as 32 percent of the sales (La Londe & Zinszer, 1976). On national level, the estimated logistics costs were 15 percent of gross national product in USA (Heskett et al., 1973), and 16 percent of sales in UK (Murphy, 1972).

During 1980s' the use of computers and industrial automation provide basis for centralized distribution and finally resulted in remarkable reductions in stock holdings. Firms realized the benefits of mass production, collaboration and supplier relationships. Third party logistics providers came into being letting the businesses focus their core competencies. With such technological advancements in the logistics environment, supply chain management emerged in 1980s' (Cooper, et al., 1997; Gibson, et al., 2005; La Londe, 1998; Levy & Grewal, 2000; Lummus & Vokurka, 1999; Mentzer, et al., 2001) and was first used in literature by Oliver and Weber (1982). There are two

schools of thought about the emergence of SCM (Ballou, 2007). The authors in favour of first school of thought believe that SCM originated as a result of evolution and compare it with physical distribution and logistics whereas the followers of second school claim that it is a new and bold concept. Figure 3.1 depicts the view of first school of thought.

Figure 3.1 Evolution of Supply Chain Management

Activity Fragmentation to 1960	Activity Integration from 1960 to 2000	2000+

Demand forecasting
Purchasing
Requirement planning
Production planning
Manufacturing inventory
Warehousing
Material handling
Packaging
Finished goods inventory
Distribution planning
Order processing
Transportation
Customer service
Strategic Planning
Information services
Marketing/sales
Finance

Purchasing/Materials Management

Logistics

Physical Distribution

Supply Chain Management

Source: (Ballou, 2007)

The concept of value chain introduced by Porter (1985) is in-line with supply chain management. According to Porter (Porter, 1985, p. 38) "value chain displays total value, and consists of value activities and margins". Figure 3.2 represents a generic value chain.

During mid-1980s' tools for exchanging point of sale information such as electronic data interchange (EDI) were being developed with aim to implement internal integration which later on shifted to external integration. Another development in the field of supply chain management was the introduction theory of constraints (TOC). Goldratt and Cox (1984) introduced TOC as a process of ongoing improvement. The main theme of TOC is that a supply chain is no stronger than its weakest link.

Figure 3.2 The Generic Value Chain

Source: (Porter, 1985, p. 37)

The decade of 1990s' saw tremendous development in supply chain competitiveness due to the rise of global supply chains. Huge investments were made in capital intensive technologies in order to get maximum outcomes from trade liberalization. Countries started specializing in particular markets like US in software, Germany in machine tools, and Japan in consumer electronics. Strategic alliances emerged in the forms of third-party logistics (3PL) providers, retailer-supplier partnerships (RSPs), and distribution integration (DI) (Schonberger, 1996). Moreover various strategies like quick response, continuous replenishment, and vender managed inventory (VMI) are the products of this era. Late 1990s' saw developments in E-Markets where many businesses were established on the basis of B2B automation promising reduced order processing costs. Mass customization replaced the mass production (Pine, 1993). Dell was the first to adopt mass customization in order to distribute its computers in an efficient and effective manner (McWilliams, 1997).

By late-1990s' the organizations strived to optimize logistic processes spanning enterprise and cross-enterprise supply chains (Bullinger et al., 2002). The researchers' emphasis was on collaborating supply chain partners (Barratt, 2004; Corbett et al., 1999; Ellinger, 2000; Kaufman et al., 2000; Raghunathan, 1999), integrating cross-functional processes (Lambert & Cooper, 2000; Petersen et al., 2005), coordinating supply chains (Ballou, 2007; Kim, 2000), setting supply chain goals (Peck, 2000; Wong, 1999), establishing strategic alliances (McCutcheon & Stuart, 2000; Whipple &

Frankel, 2000), outsourcing (Ansari et al., 1999; Heriot & Kulkarni, 2001), and supply chain power relationships (Cox, 1999, 2001a, 2001b, 2001c; Cox et al., 2001) explored new areas of specialization and innovativeness in supply chain management. This era transformed supply chains into value chains (Bovel & Martha, 2000; Christopher, 2005; Rayport & Sviokla, 1995). The concept of value chain emerged and developed side by side with the supply chain and later on overwhelmed the supply chain.

During the first decade of twenty first century, the use of information technology got heavy reliance for gaining and sustaining the competitiveness (Dehning & Stratopoulos, 2003; Gulledge & Chavusholu, 2008; Hidding, 2001; Staley & Warfield, 2007), for example, the use of ERP for quality assurance (Millet et al., 2009). The businesses are now entering into a 'network competition' where challenges would be to better structure, coordinate, and manage relationships with the network partners to deliver higher customer value to the ultimate consumers (Christopher, 2005). The value chains are developing into value chain networks (Peppard & Rylander, 2006).

3.3 Benchmarking in Supply Chain Management

Benchmarking has emerged as an increasingly essential tool for organizational improvement (Andersen, et al., 1999; Dattakumar & Jagadeesh, 2003). Businesses benchmark for variety of reasons including: enhancement of improvement culture, as a short-cut to the improvement, as a driver for improvement, as an aid to planning, as a solution of specific problems, submission for business excellence awards, to build-up network of like-minded people, and to justify proposals (Stapenhurst, 2009). Benchmarking is also considered to be fundamental in successful implementation of business process re-engineering (BPR), total quality management (TQM), and best practices (Bessant & Rush, 1998). Moreover, it has been an effective tool for improving quality (Zairi & Hutton, 1995), performance, and customer service (Yasin & Zimmerer, 1995); identifying operational and strategic gaps; and finding best practices to bridge these gaps (Yasin, 2002). Furthermore, it is more than just comparing performance with competitors, as it includes analysis of how competitors achieved that position (Mathaisel et al., 2004).

Benchmarking has been defined differently by academicians, managers and practitioners. However, the most commonly found definitions of benchmarking are given in the figure 3.3. The definitions of benchmarking given in figure 3.3 are based on

the fundamental idea of evaluating a firms' performance and comparing it with a benchmark with the prime motive of improvement. The key elements include performance measurement, comparison, and continuous improvement.

Figure 3.3 Definitions of Benchmarking

Benchmarking is:

"The continuous process of measuring products, services, and practices against the toughest competitors or those companies recognised as industry leaders" by David T. Kearns, CEO, Xerox Corporation (Camp, 1989, p. 10).

"A continuous systematic process for evaluating the products, services, and work processes of organizations that are recognized as representing best practices for the purpose of organizational improvement" (Spendolini, 1992, p. 9).

"Continuing search, measurement, and comparison of products, processes, services, procedures, ways to operate, best practices that other companies have developed to obtain an output and global performances, with the aim of improving the company performances" (Lucertini et al., 1995, p. 59).

"An ongoing systematic process to search for international better practices, compare against them, and then introduce them, modified where necessary, into your organization" (Parmenter, 2007, p. 16).

"A method of measuring and improving our organizational performance by comparing ourselves with the best" (Stapenhurst, 2009, p. 6).

Bessant and Rush (1998) introduced seven underlying fundamental principles of benchmarking: focus, measurement, differentiation, learning, comparability, integration, and applicability. However, a number of researchers emphasize the principle of comparability of benchmarking data among benchmarking partners (Andersen, et al., 1999; Bessant & Rush, 1998). However, some others suggest normalization of benchmarking data in certain situations when direct comparison is not appropriate (Shah & Singh, 2001; Stapenhurst, 2009). Stapenhurst (2009) introduces six methods to normalize the variation in incomparable benchmarking data. These are: per unit, categorization, selection, weighting factors, modelling, and scoring. Andersen, et al, (1999) argue that the principle of comparability of the benchmarking populations can be sacrificed for the sake of learning lessons. Bhutta and Huq (1999) emphasize that best practices of leading organization should not be implemented by the benchmarking organisation without necessary tailoring according to the internal environment including prevailing culture and human resources.

A number of advantages of benchmarking have been mentioned by various researchers. These include: meeting and/or exceeding customer expectations, pragmatic goals based on the view of external environment, quest for competitive position, significant improvement in performance, and awareness of industry best practices (Camp, 1989;

Shetty, 1993; Spendolini, 1992). Moreover, benchmarking saves time and cost to adopt industry leader's best-practices and advanced technologies (Sekhar, 2010). Conversely, some authors have also identified possible drawbacks of benchmarking practice. For example, Elnathan and Kim (1995) pointed out the hidden costs of benchmarking such as the cost of time and efforts employed to quantify data which is hard to get otherwise. Elmuti and Kathawala (1997) discussed six legal aspects which the benchmarking partners have to deal with. These are: expectation, proprietary information, intellectual property, antitrust and unfair trade practices, evidence, and disparagement and trade libel. Cox and Thompson (1998) emphasized the inappropriateness of benchmarking as it carries serious strategic risks, such as possibility to lose sensitive data to competitors. Zairi and Ahmed (1999) highlight some of the issues related to the transferability. These are:

➢ How do we know that 'best practices' are really the best?
➢ How do we assess the relevance of best practices to our business operations?
➢ What is the best approach for cascading down best practices to support our corporate goals?
➢ Is there any particular method for capturing and transferring best practices?
➢ How to deal with a culture resistant to change?
➢ How to instil new ideas in environments where the `not invented here' is very strong?
➢ How do you know that you are succeeding with best practices?

3.3.1 Evolution of Benchmarking

The origin of benchmarking perhaps can be traced back to the human history when a man first compared his hut with that of his neighbours (Stapenhurst, 2009). However, the story of Xerox is the first documented evidence of benchmarking practice in industry (Camp, 1989; Shetty, 1993; Spendolini, 1992). In 1970s' when the Japanese entered the photocopier machine market, Xerox was near to getting out of the market because its copier machines badly failed in the market (Camp, 1989). In 1979, Xerox conducted competitive benchmarking against Japanese machines and found its manufacturing costs significantly higher than Japanese (Camp, 1989). Benchmarking, after conception, was practiced by organizations from different industries. For example, Nissan/Infinity benchmarked its customer service standards against the best practices learned from the survey of McDonalds, Walt Disney Co., Nordstrom, Ritz-Carlton, and Mercedes-Benz (for after-sale services) (Walsh, 1992). The success stories of

Weyerhaeuser (Karch, 1992), ICI Fabrics (Clayton & Luchs, 1994), Texas Instruments (Baker, 1994), and many other organizations are the additional examples.

Initially practiced by the private organizations, benchmarking entered public sector in early 1990s' (Davis, 1998). Watson (1993) summarises evolution of benchmarking practice into five generations: first generation "reverse engineering", second generation "competitive benchmarking", third generation "process benchmarking", fourth generation "strategic benchmarking", and fifth generation "global benchmarking". Kyrö (2003) adds a sixth generation of benchmarking "competence benchmarking/bench-learning" and extends to "network benchmarking". Figure 3.4 summarises the evolution in benchmarking development.

Figure 3.4 Evolution of Benchmarking
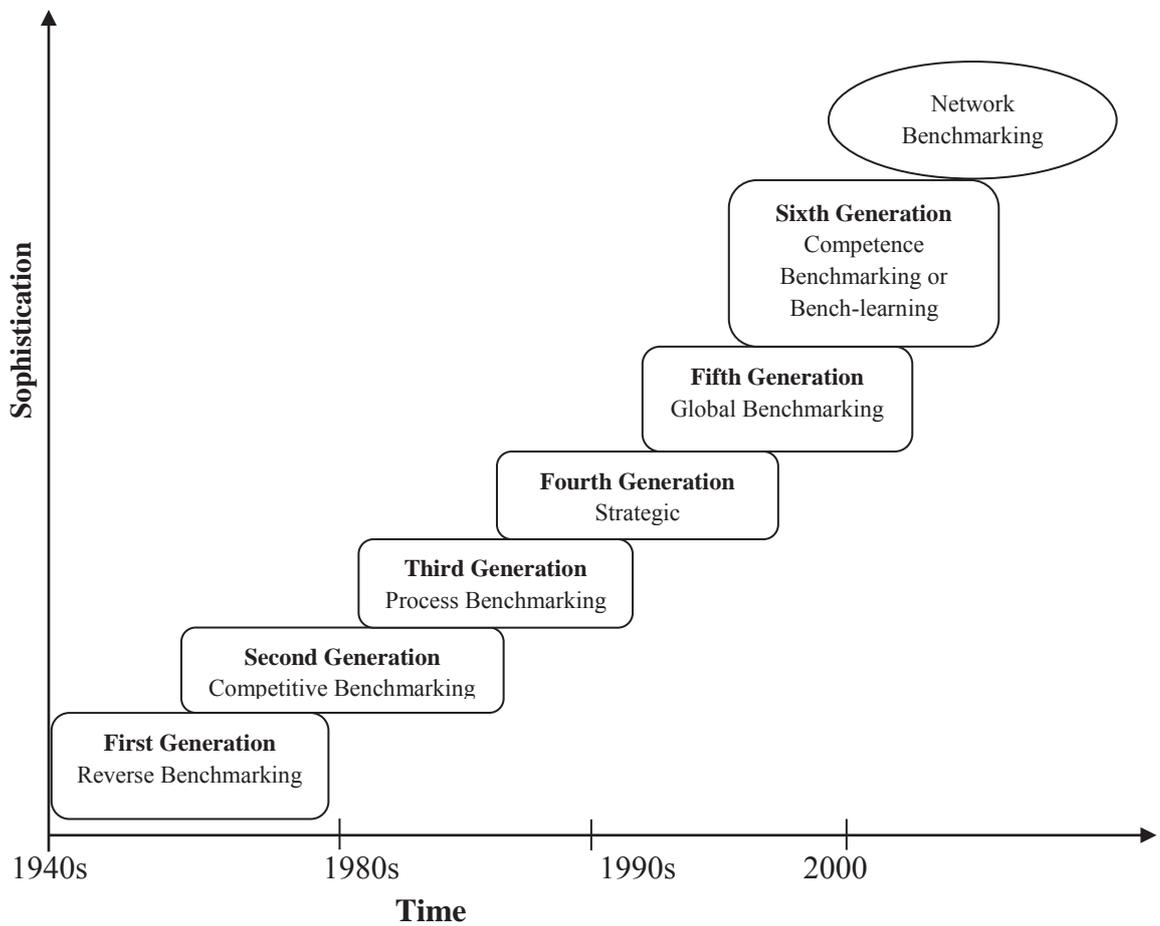
Source: Adopted from Kryo (2003)

3.3.2 Benchmarking Frameworks

A substantial number of benchmarking models developed by academicians, practitioners and independent organizations can be found in the literature (Anand &

Kodali, 2008; Zairi & Ahmed, 1999; Zairi & Al-Mashari, 2005). Zairi and Ahmed (1999) reported that the literature on benchmarking has reached its maturity and criticized that most, if not all, of the benchmarking methodologies preach the same basic rules. Anand and Kodali (2008) identified 60 benchmarking models and classified them into: academic-based models, consultant-based models, and organization-based models. For understanding purposes, the categorization of benchmarking methods given by Stapenhurt (2009) is helpful. Stapenhurst (2009) organized existing benchmarking methods into seven categories: public domain, one-to-one, review, database, trials, survey, and business excellence models. However, one-to-one benchmarking frameworks and business excellence (BE) models are prevalent in literature.

One-to-one benchmarking is performed between two organizations considering one of them as a benchmark. This type of benchmarking is performed by a benchmarking team from the organization being benchmarked. The benchmark organization shares information voluntarily. The Xerox benchmarking methodology developed by Robert Camp (1989) is a well know example of one-to-one benchmarking. On the other hand, BE models refer to a set of standard criteria for comparing performance of organizations by scoring each one against the standard. The subsequent section expands on these two categories of benchmarking.

The literature on benchmarking methods is full of one-to-one methodologies developed by researchers in the past. The commonly used frameworks developed by academicians, practitioners, and individual organizations are presented in table 3.1. Majority of the benchmarking methods are developed and used by practitioners. However, balanced scorecard and SCOR model have been used and validated by academic research as well. Stewart (1995) reported Pittiglio, Rabin, Todd and McGrath (PRTM) as a comprehensive set of performance measures which describes a world-class supply chain of planning, sourcing, making, and delivering activities. The PRTMs' concept of benchmarking supply chains extends to the supply chain operations reference (SCOR) model (Stewart, 1997).

Table 3.1 Benchmarking Frameworks

Benchmarking Frameworks	Remarks
Xerox benchmarking methodology by Robert Camp (1989).	A ten-step process organized into five phases: planning, analysis, integration, action, and maturity.
Balanced Scorecard by Kaplan and Norton (1992)	A performance measurement framework that complements financial indicators with performance measures for customers, internal business processes, and innovation and improvement activities.
Spendolini's five-step benchmarking process (1992).	These steps are: determine what to benchmark; form a benchmarking team; identify benchmark partner; collect and analyze benchmarking data; and take action.
Codling's twelve-step benchmarking process (1992).	Twelve steps are categorized into four operational stages: planning, analysis, action, and review and recycle.
Business Performance Improvement Resource (2012).	The BPIR improvement cycle is a nine-step benchmarking process.
TRADE methodology by Center for Organizational excellence Research (2012)	Ten step TRADE methodology stands for: Terms of Reference, Research, Act, Deploy, and Evaluate.
Supply Chain Operations Reference (SCOR) model version 10 by Supply Chain Council (2012)	A cross-industry reference model structured around five processes: Plan, Source, Make, Deliver, and Return and four levels of process detail.

Gilmour (1998) developed a framework comprising of 11 capabilities in order to benchmark supply chain operations. Simatupang and Sridharan (2004) acknowledged SCOR model as the most suitable for benchmarking purposes due to its comprehensiveness and standard process and metrics definitions which enable companies to evaluate and improve performance at individual as well as entire supply chain levels. Moreover, the model has been used by a number of researchers for benchmarking at supply chain level (Eryuruk et al., 2014; Jolly-Desodt et al., 2006; Reiner & Hofmann, 2006).

Business excellence models are fundamentally diagnostic in nature and focus on identifying, developing, and promoting best practices leading to superior performance at organization level. The key performance indicators used by BE models focus individual firms and not the network of businesses such as supply chains which ultimately leads to local optimization. The conflict of local versus global optimization provides the basis for performance measurement in supply chain management. Moreover, BE models are poor in replication best practices having potential for incomplete or inaccurate analysis

leading to dubious conclusions for individual organizations (Stapenhurst, 2009). Renowned BE models are given in table 3.2.

Table 3.2   Business Excellence Models

Business Excellence Models	Administered By
Global Benchmarking Network	Informationszentrum Benchmarking (IZB) Germany
Process Classification Framework	American Productivity and Quality Center, USA
Baldrige Criteria for Performance Excellence	National Institute of Standards and Technology, USA
European Foundation for Quality Management (EFQM) Excellence Model	European Foundation for Quality Management, Europe
Singapore Quality Award (SQA) Framework	SPRING Singapore, Singapore
Canadian Framework for Business Excellence	National Quality Institute, Canada
Australian Business Excellence Framework	Australian Quality Council, Australia

Source: (BPIR, 2014)

According to Andersen et al. (1999) the core interpretation of almost all of the benchmarking processes found in literature is a four step process: measuring ones' own and the benchmarking partners' performance; comparing performance levels, processes, practices etc.; learning from the benchmarking partners' best practices; and improving ones' own organization.

3.3.3 Benchmarking in Agri-Food Supply Chains

The literature on benchmarking in agri-food supply chains is limited. Prado (2001) benchmarks quality assurance system of Spanish companies from different sectors. Garcia et al. (2004) develop a three dimensional benchmarking framework to assess quality performance gap in food standards of international supply chains. Tuominen et al. (2009) use supply chain balanced scorecard to benchmark Russian and Finnish food industry supply chains. Major emphasis of this study is on finding out the reasons for low productivity in Russian food industry. Yakovleva et al. (2009) develop a framework based on analytical hierarchy process (AHP) for benchmarking sustainability of food supply chains in UK and found that financial indicators solely are not sufficient to gauge the long term competitiveness of a supply chain. A voluntary group in New Zealand dairy industry develops a benchmarking system for dairy farmers mainly focusing the KPI's: cash (liquidity), profit, and wealth creation (Shadbolt, 2009).

Iribarren et al. (2011) use life cycle analysis (LCA) and data envelopment analysis (DEA) to assess and benchmark the environmental and operational efficiency of 75 Spanish dairy farms. They are of the opinion that combined approach can be adopted to integrate management system tools for better decision making. Shabani et al. (2012) develop an output oriented linear pair model for developing actual benchmarks for sales agents in Iranian dairy industry. They view that developing actual benchmarks is better than using the hypothetical ones for benchmarking studies. Tiwong et al. (2012) benchmark Thai mango supply chain with respect to Japanese market using supply chain integration (SCI) model and integration definition for function modelling (IDEFO) and find that like other emerging economies, food quality and food safety are the weakest links in Thai mango supply chain. Dolman et al. (2014) benchmark the economic, environmental, and societal performance of nine Dutch dairy farms internally recycling nutrients against the benchmark dairy farms and find that dairy farms internally recycling nutrients are using less renewable energy, having higher soil organic carbon content, and receiving higher payments for agri-environmental measures.

The overall effectiveness of a benchmarking practice is based on its performance measurement framework. Therefore, selecting a benchmarking framework implies selecting a performance measurement framework. This argument leads to the next section providing an extensive review and selection of appropriate performance measurement framework for agri-food supply chains.

3.4 Supply Chain Performance Measurement

Measuring the performance of an activity or a business is as important as the activity or business itself. *"Anything measured improves; what you measure is what you get; anything measured gets done;* and *you can't manage what you do not measure"* are some of the common adages in support of performance measurement (Lapide, 2000, p. 287). Neely (1998) identified seven important reasons for measuring performance such as dynamic nature of work, increasing competition, specific improvement initiatives, international quality standards, changing organizational roles, changing customer demands, and the power of information technology. The literature on supply chain performance measurement (SCPM) is divided into four sub-sections: supply chain

performance measurement (SCPM) definitions, evolution of SCPM, SCPM systems, and issues in SCPM.

3.4.1 Supply Chain Performance Measurement Definitions

Performance measurement has been defined from two different perspectives. Some authors define performance measurement in terms of efficiency and effectiveness of performing tasks (Mentzer & Konrad, 1991; Neely et al., 1995) while others think it a systematic way of evaluating resource utilization and output (Harbour, 2009; Lockamy, 1995). All the definitions of performance measurement are aimed at providing information necessary for decision making at task as well as organization level. The definitions of performance measurement reflecting both the perspectives are represented in figure 3.5.

Figure 3.5 Performance Measurement-Definitions

Performance measurement is "an analysis of both effectiveness and efficiency in accomplishing a given task" (Mentzer & Konrad, 1991, p. 33).

Performance measurement is "the process of quantifying the efficiency and effectiveness of action" (Neely, et al., 1995, p. 81).

Performance measurement is "the process of quantifying the efficiency and effectiveness of organisations and actions" (Li et al., 2007, p. 1131).

Performance measurement is "the process of measuring actual outcomes, or the end goals of performance, as well as the means of achieving that outcome as represented by in-process measures" (Harbour, 2009, p. 10).

A substantial number of performance measures are mentioned in the literature (Beamon, 1999; Lapide, 2000; Van Amstel & D'hert, 1996) but the measures spanning the entire supply chain do not exist (Lambert & Pohlen, 2001; Lee & Billington, 1992) and the logistics and related measures are unable to adequately address to the scope of SCM (Caplice & Sheffi, 1995). Various authors have highlighted the need for limited number of measures to be employed in order to avoid administrative complicacies (Chan & Qi, 2002; Lapide, 2000). Parker (2000) classified the existing performance measures into four major categories: outcome measures, action measures, input measures, and diagnostic measures. Van der Vorst (2000b), on the other hand, made a distinction between performance indicators at three levels namely supply chain network, organization, and process. Beside all the prescriptions given in literature, the enigma of how to select the most appropriate set of measures is still there.

Individual performance measures are often used in comibination of same dimension called as performance attribute and a group of performance attributes is called as a performance measurement system. A performance measurement system has been defined differently in the literature. The most commonly found definitions are shown in the figure 3.6.

Figure 3.6 Definitions of Performance Measurement System

A performance measurement system is:

"A systematic way of evaluating the inputs, outputs, transformation, and productivity in a manufacturing or non-manufacturing operation" (Lockamy, 1995, p. 56).

"The set of metrics used to quantify both the efficiency and effectiveness of actions" (Neely, et al., 1995, p. 81).

"A graphical and numerical information system (often referred to as a performance dashboard or scorecard) used to monitor, assess, diagnose, and achieve desired performance levels (Harbour, 2009, p. 10).

Neely et al. (1995) gave the general and broader definition whereas Lockamy (1995) defined PMS from relative and operational aspects. However, Harbour (2009) described PMS as an information system.

3.4.2 Evolution of Supply Chain Performance Measurement

Performance measurement roots from early accounting systems of pre-industrial organizations (Johnson, 1981). The first modern and mechanized business organizations were cotton textile factories that appeared in England and US in 1800 (Johnson, 1981). Post-industrial organizations developed management accounting system between 1850s' to 1920s' in USA (Johnson, 1972). In 1903, three Du Pont cousins completely reorganized the American explosives industry and installed an organizational structure that incorporated the 'best practices' which are currently used in managing big business (Chandler, 1977). Between 1925 and the 1980s' no significant developments were made in management accounting (Johnson & Kaplan, 1987). During 1980s' traditional measures of gauging business performance, were under severe criticism from a number of researchers (Berliner & Brimson, 1988; Goldratt & Cox, 1984; Hayes & Abernathy, 1980; Hiromoto, 1988; Johnson & Kaplan, 1987; Miller & Vollmann, 1985; Schmenner, 1988).

By 1980s' the organizations and markets had become much more complex that financial measures lost their appropriateness for being the sole criteria of measuring success

(Kaplan & Norton, 1992; Kennerley & Neely, 2002). Kaplan and Norton (1992) reported the misleading behavior of traditional financial accounting measures as they report on past performance rather than suggesting future improvements. Moreover, traditional cost accounting practices focus on controlling processes in isolation and do not recognize the need for integrating the business processes (Bititci, 1994). Non-financial measures like quality, delivery flexibility, and responsiveness were employed by majority of the managers, practitioners, and academicians during late 1990s' to gauge the business performance (Gunasekaran et al., 2001; Kennerley & Neely, 2002; Stewart, 1995).

The criticism on the traditional accounting system resulted in the shift in philosophy of performance measurement which lead to the development of new methods of valuing businesses, such as, the activity-based costing (Johnson & Kaplan, 1987), throughput accounting (Galloway & Waldron, 1988), the performance measurement matrix (Keegan et al., 1989), SMART performance pyramid (Lynch & Cross, 1991), the balanced scorecard (Kaplan & Norton, 1992), economic value-added (Young & O'Byrne, 2001), logistics scorecard (Frazelle, 2002), and the performance prism (Neely et al., 2002). The integrated and collaborative performance measurement systems were proposed by a number of authors (Bechtel & Jayaram, 1997; La Forme et al., 2007; Li & O'Brien, 1999; Li, et al., 2007; Lockamy, 1995). The Supply Chain Council developed a standard process-based measurement system, the SCOR model in 1997 (Stewart, 1997). Methods of valuing shareholder profitability, such as customer profitability analysis, shifted the focus of supply chain management to the management of relationships in order to be more profitable for the all the shareholders (Christopher, 1998).

Innovative ways of measuring business value, like performance of activity (POA) method (Chan & Qi, 2003a), and performance based costing system (Gunasekaran et al., 2005) were introduced. Various graphical (for instance, kiviat graph, spider diagram, and radar diagram) and spreadsheet-based tools for measuring and comparing performance were devised (Vanteddu et al., 2006). The predominant focus of the recent literature on performance measurement is on measuring sustainability (Bourlakis et al., 2014; Mohezar & Nor, 2014; Rota et al., 2012; Van der Vorst et al., 2013; Wiengarten & Longoni, 2015), integration (Bourlakis, et al., 2014; Manzini & Accorsi, 2013;

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Wiengarten & Longoni, 2015), and risk assessment (Leat & Revoredo-Giha, 2013; Zubair & Mufti, 2015) in agri-food supply chains.

3.4.3 Performance Measurement in Agri-Food Supply Chains

An agri-food supply chain consists of various stages of production and distribution that an agricultural product goes through before reaching the final consumer (Bijman, 2002). Over the time, changes in the marketplace like reduced transaction costs and risks, increased product innovation and differentiation, efficient exchange of information, and the shift from production orientation to market orientation have led to a closer vertical coordination in agri-food supply chains (Hobbs & Young, 2000; Ziggers & Trienekens, 1999). Gunasekaran et al. (2001) pointed out that the integration of firms is not followed by simultaneous development of effective performance measures and metrics. According to Norina (2004) the frequent focus of SCM analysis is on large manufacturing chains, and therefore, very limited research is done on agri-food chains. The reasons of this negligence are a number of specific characteristics of agri-food chains which make them unique and complex (Aramyan et al., 2006; Van der Spiegel, 2004; Van der Vorst, 2000a). Table 3.3 summarises these unique characteristics of agri-food chains.

Van der Vorst (2006) reported a number of fundamental changes in business environment, especially in agri-food supply chains, such as increasing consumer demands on attributes of food such as quality (guarantees), integrity, safety, diversity and associated information (services). Some related issues, like the use of pesticides and other chemicals, production methods (such as organic farming), and environmental issues have affected the buying behaviour of the consumer (Aramyan, et al., 2006). To comply with these changes, food businesses have implemented quality assurance systems like good manufacturing practices (GMP), hazard analysis and critical control point (HACCP), international organization for standardization (ISO), and British retail consortium (BRC) (Van der Spiegel et al., 2004). According to Van der Spiegel, et al. (2004) although these quality assurance certificates are helpful to manufacturers but in practice, none of them guarantees the assurance of product quality and safety.

Table 3.3   Unique Characteristics of Agri-Food Supply Chains

SC Stage	Product and Process Characteristics
Overall	➤ Shelf life constraints for raw materials, intermediate and finished products, and changes in product quality level along the SC (decay). ➤ Recycling and reverse logistics of materials.
Producer	➤ Long production throughput times (producing new or additional products takes a lot of time). ➤ Seasonality in production.
Auction / Wholesaler /Retailer	➤ Variability of quality and quantity of supply of farm-based inputs. ➤ Seasonal supply of products requires global (year-round) sourcing. ➤ Requirements for conditioned transportation and storage means.
Food Industry	➤ Variability of quality and quantity of supply of farm-based inputs. ➤ High volume, low variety (although the variety is increasing) production systems. ➤ Highly sophisticated capital-intensive machinery focusing on capacity utilization. ➤ Variable process yield in quantity and quality due to biological variations, seasonality, random factors connected with weather, pests, and other biological hazards. ➤ A possible necessity to wait for the results of quality tests (quarantine). ➤ Alternative installations, alternative recipes, and product-dependent cleaning and processing times. ➤ Necessity to value all parts because of complementarity of agricultural inputs (for example, beef cannot be produced without the co-product hides). ➤ Necessity for lot traceability of work in process due to quality and environmental requirements and product responsibility ➤ Storage buffer capacity is restricted, when material, intermediates or finished products can only be kept in special tanks or containers.

Source: Adopted from (Van der Vorst, 2000a)

3.4.4 Selecting a Performance Measurement System for Agri-food Supply Chains

The literature on supply chain performance measurement is too large and multi-dimensional to develop a clear understanding from all aspects. Different researchers view supply chain performance from different aspects. For example, Christopher (1995) view supply chain as a series of functions and emphasize to align the performance of each function. Christopher introduced average cost model to consolidate cost drivers for manufacturing functions at firm level. A substantial number of researchers evaluate supply chain performance measurement from different dimensions such as agility, quality, cost, flexibility, responsiveness, time, and innovativeness (Aramyan et al., 2007; Aramyan, et al., 2006; Beamon, 1999; Joshi et al., 2012; Neely, et al., 1995). Various researchers employ balanced scorecard to measure supply chain performance (Bhagwat & Sharma, 2007b; Bigliardi & Bottani, 2010; Brewer & Speh, 2000; Kaplan

& Norton, 1992; Varma & Deshmukh, 2009). Balanced scorecard complements traditional financial indicators with performance measures for customers, internal business processes, and innovation and improvement activities. Few researchers organize performance measures at various levels of organizational hierarchy such strategic, tactical, and operational levels (Bhagwat & Sharma, 2007a; Chan & Qi, 2003b; Fattahi et al., 2013; Gunasekaran et al., 2004; Gunasekaran, et al., 2001; Li & O'Brien, 1999; Li, et al., 2007; Rangone, 1996). A growing number of researchers use SCOR model to quantify performance at supply chain process level (Huang et al., 2005; Irfan et al., 2008; Millet, et al., 2009; Stewart, 1997; Widyaningrum & Masruroh, 2012). Lambert and Pohlen (2001) view supply chain as a series of different interfaces and devised a framework to align the performance of each link within the supply chain. This link-by-link approach aims to optimise the performance at individual links level as well as the supply chain as a whole. Several researchers analyse supply chain performance from one or more perspectives (Gerbens-Leenes et al., 2003; Leat & Revoredo-Giha, 2013; Li et al., 2005; Otto & Kotzab, 2003; Van der Vorst, et al., 2013; Yakovleva, 2007).

In selection of appropriate performance measures, a number of researchers evaluate existing performance measurement frameworks against a set of criteria (Beamon, 1999; Gunasekaran, et al., 2001; Neely, et al., 1995; Van der Spiegel, et al., 2004; Varma & Deshmukh, 2009). For example, Van der Spiegel, et al. (2004) developed a criteria-based approach for the selection of appropriate measurement framework for food quality systems. They evaluated performance measurement frameworks against six quality dimensions namely product quality, availability, costs, flexibility, reliability, and service. This study uses five criteria to evaluate existing performance measurement frameworks and choose the appropriate one for agri-food supply chains. These criteria are briefly discussed as following.

A. Balance between Financial and Non-financial Performance Measures

A substantial number of researchers emphasize that there is need for balance while selecting between financial and non-financial performance measures (Aramyan, et al., 2007; Beamon, 1999; Chan, 2003; De Toni & Tonchia, 2001; Gunasekaran, et al., 2004; Holmberg, 2000; Van Aken & Coleman, 2002; Van der Vorst, 2006; Vanteddu, et al., 2006). Beamon (1999) viewed that existing supply chain performance measurement systems are inadequate as they heavily rely on the use of financial measures as a

primary (if not sole) criteria. According to Gunasekaran et al. (2001) the firms or supply chains using performance measures focusing purely on financial or operational aspects deprive themselves of the benefits that would accrue from adopting a balanced approach. Similarly, Van der Vorst (2006) urged the need to develop a balanced set of financial and non-financial food supply chain indicators that reflect the inter-dependencies of different areas at the right aggregation level. According to Van der Vorst, a balanced approach must consider account chain network structure (such as total value added, ROI, etc.), chain business processes and management structure (such as lead time, responsiveness, inventory levels, delivery reliability, product quality, etc.), and chain resources (such as process yield, degree of utilization, human wellbeing, perseverance, etc.).

B. Holistic to Entire Supply Chain

Multi-echelon food supply chains consist of cross-industry processes involving different players with goals conflicting with supply chain strategy. The use of single firm performance measures results in local optimization. This conflict between local and global optimization highlights the need for systems thinking. Therefore, numerous researchers have emphasized the need for a framework of holistic nature spanning the entire supply chain rather than single firm (Chan, 2003; Chan & Qi, 2003b; Lambert & Pohlen, 2001; Van der Vorst, 2006; Vanteddu, et al., 2006). Moreover, a holistic framework aligns the performance of individual players with supply chain strategy.

C. Food Quality Focus

Food quality is an inherent characteristic of agri-food supply chains which distinguishes them from general supply chains. Van der Spiegel, et al. (2004, p. 505) defined quality in food production systems as "to comply with the expectations of the user or consumer, while the production process is optimally organized, utilized, and controlled". A number of researchers have emphasized on measuring food quality as part of overall performance measurement system. For example, Aramyan et al. (2006) developed a performance measurement framework for agri-food supply chains by grouping relevant performance indicators from best-know methods in to four: efficiency, flexibility, responsiveness, and quality. They classified agri-food chains in to two: 1) supply chains of fresh products such as dairy, fruit, and vegetables; 2) supply chains of processed food products such as canned fruits. The supply chain of processed food products can further

be divided on the basis of perishability and shelf-life. These are: the supply chain of highly perishable commodities such as milk and dairy products; and less perishable such as fruits and vegetables.

Knura et al. (2006) classified food quality into intrinsic (such as taste, nutritional value, freshness, appearance, sensory properties, shelf-life, safety, and health) and extrinsic (such as the use of pesticides, the type of packaging material, a specific processing technology, and the use of preservatives) quality attributes. In order to maximise customer value, the product quality must be ensured at each stage along the entire agri-food supply chain. Therefore, the measurement tool must incorporate appropriate performance indicators related to food quality at various stages of the supply chain.

D. Risk Assessment

The second most important characteristic of agri-food supply chains is risk assessment. Inherently, food products are prone to various types of risk at almost all stages of an agri-food supply chain. The negative impact of supply chain risks on supply chain performance has been evidenced by Wagner and Bode (2008). A number of researchers highlighted the importance of risk in agri-food supply chains and developed performance measurement frameworks accordingly. Tummala and Schoenherr (2011) developed a supply chain risk management process (SCRMP) to help SC managers identify, assess, evaluate and control risk to improve supply chain performance. In an attempt to measure risk in agri-food supply chains Leat and Revoredo-Giha (2013) organized performance measures related to risk into individual level and supply chain level. Zubair and Mufti (2015) identified eighteen risk perspectives in supply chain of dairy products in Pakistan and developed a risk matrix based on probability and impact scores in order to prioritize these risk perspectives.

E. Environmental Sustainability

Environmental sustainability, another feature of agri-food supply chains has gained predominant focus recently. The recent literature is full of performance measures on sustainability at individual echelon of agri-food supply chains. For example, Rota et al. (2012) provided a theoretical framework of life cycle analysis for measuring collaboration and sustainability at various stages of agri-food supply chains. Manzini and Accorsi (2013) proposed a conceptual framework to integrate supply chain design and management for simultaneous control of quality, safety, sustainability, and logistics

efficiency of the food products and processes along the whole food supply chain. Van der Vorst et al. (2013) used triple bottom line framework to assess the sustainability of food supply chain logistics in Dutch food industry. Bourlakis, et al. (2014) integrate a plethora of performance indicators related to efficiency, flexibility, responsiveness, and product quality to develop an integrated framework for measuring SC sustainability in Greek dairy sector. They report that the large manufacturers are true champions of sustainability.

3.4.5 Supply Chain Performance Measurement Systems

This section critically evaluates supply chain performance measurement frameworks found in the literature against five criteria mentioned in the previous section. Moreover, the frameworks are organized in to seven categories, as shown in Appendix-C. The framework suitable to evaluate agri-food supply chains should satisfy all the five selection criteria.

A. Function Based Measurement System (FBMS)

A FBMS measures the performance of an individual function performed in an organization. The average cost model given by Christopher (1995) is the first FBMS which measures the performance of the individual functions in an organization. The major purpose of average cost model is to consolidate the cost drivers for manufacturing functions at firm level. Figure 3.7 illustrates the industry average cost model for measuring performance.

According to Lapide (2000) the industry average cost model is diagnostic in nature and therefore is helpful in identifying problem areas. However, in FBMS each function is evaluated in isolation from the supply chain which leads towards the local optimization at the cost of entire chains' performance (Lapide, 2000). Ramaa et al (2009) discussed that the approach is easy to implement and is suitable when individual departments' performance is needed to be optimized. The FBMS given by Christopher (1995) can be replicated at supply chain level.

Figure 3.7 Industry Average Cost Model
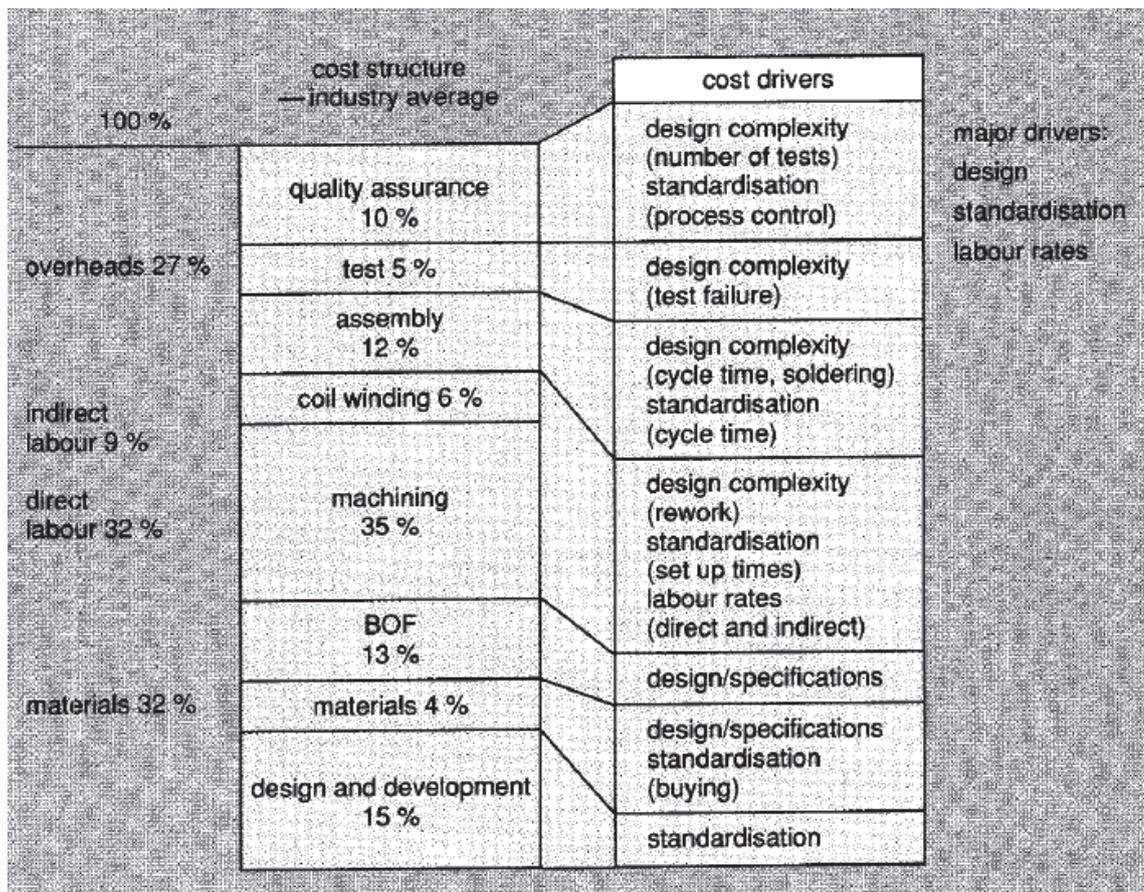
Source: (Christopher, 1995)

B. Dimension Based Measurement System (DBMS)

A substantial number of researchers view supply chain performance measurement from different dimensions (Aramyan, et al., 2007; Aramyan, et al., 2006; Beamon, 1999; Joshi, et al., 2012; Neely, et al., 1995). The review of dimension based performance measurement systems found in literature and their assessment against five selection criteria is given in Appendix-C. To highlight the issues associated with the design of performance measurement systems, Neely et al. (1995) identified performance measures as individual measures, part of a PMS, and related to internal or external environment. They organized the existing performance measures under four measurement dimensions namely quality, time, flexibility, and cost. The proposed framework is a balanced approach and adequately focuses food quality. However, it is not holistic as was primarily designed for individual organizations. Moreover, the framework does not consider risk assessment and environmental sustainability.

In an attempt to develop a framework for the selection of supply chain performance measures, Beamon (1999) suggested that a PMS consisting of single firm performance measures is inadequate and inappropriate for evaluating supply chains. Beamon (1999) developed a framework for manufacturing supply chains by organizing performance measures under resource, output, and flexibility attributes. The framework is balanced, holistic, and focuses product quality. However, it does not take into account risk assessment and environmental sustainability, as shown in Appendix-C.

Van der Vorst et al. (2000) developed a method for modelling dynamic behaviour of multi-echelon food systems and evaluating alternative designs of the supply chain infrastructure and operational management and control by applying discrete-event simulation. They used case study of an actual food supply chain of chilled salad in Netherlands, comprising of one producer, one distribution centre, and one retailer of 100 retail outlets to validate the model. They found thet for increasing ordering and delivery frequencies, reducing the producer's lead time and introducing new information systems improved supply chain performance. The model is holistic in nature and focuses food quality adequately but it is not a balanced approach and does not include risk assessment and environmental sustainability related measures. However, the simulation model involves computer-assisted ordering (CAO) and EDI which indicate its capacity to expand and customize as required.

In order to develop a flexible conceptual framework for measuring performance in agri-food supply chains, Aramyan et al. (2006) highlighted advantages and disadvantages of best-known performance measurement methods namely activity based costing (ABC), balanced scorecard (BSC), economic value added (EVA), multi-criteria analysis (MCA), life-cycle analysis (LCA), data enevelopment analysis (DEA), and supply chain operations reference (SCOR) model. They grouped performance measures from selected methods especially SCOR model and balanced scorecard in to four: efficiency, flexibility, responsiveness, and quality. The performance measures relevant to food quality in agri-food supply chains were adopted from Lunning et al. (2002). Figure 3.8 describes measurement dimensions of this framework.

Figure 3.8 Conceptual Framework for Agri-food Supply Chain Performance
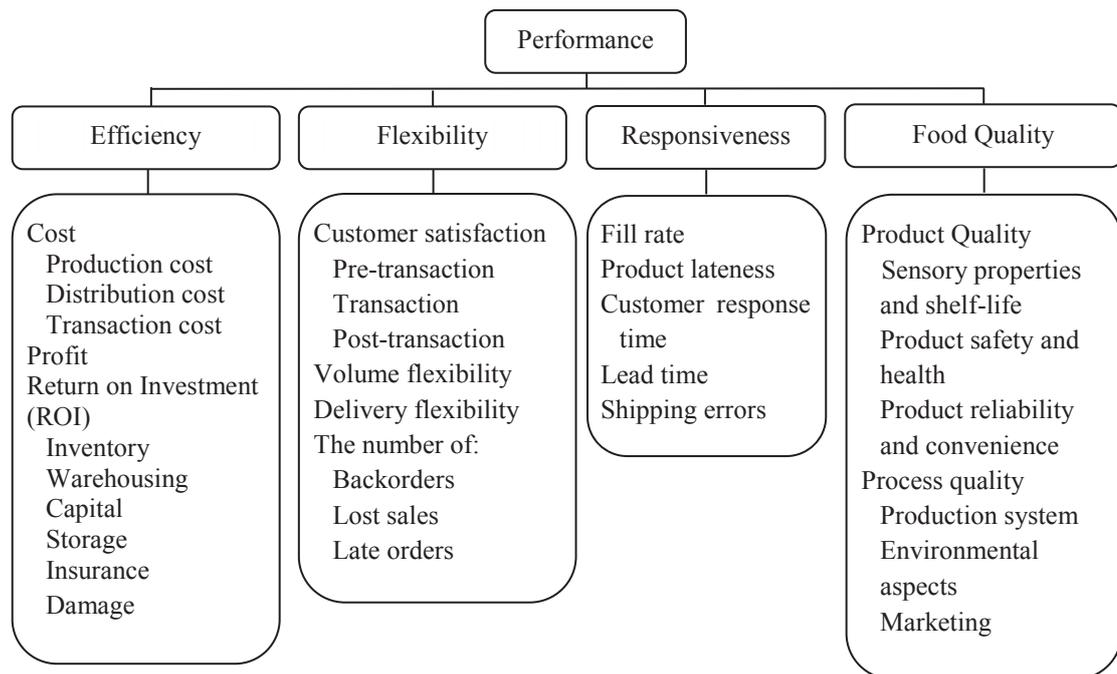
Source: Aramyan et al. (2006)

Aramyan et al. (2007) tested and validated this framework with empirical data from Dutch tomato supply chain. Aramyan et al. (2009) applied the same model to measure the impact of quality assurance systems on the performance of tomato supply chain in Netherlands. The framework is a balanced and holistic approach and adequately addresses the food quality in agri-food supply chains. Moreover, environmental sustainability is implicitly measured as part of process quality. However, the framework does not focus risk assessment which is an inherent component of agri-food supply chains.

Ho (2007) proposed an integrated method, total related cost measurement, to evaluate multi-echelon ERP based supply chains in terms of lot-sizing rule, lead time uncertainty, and cost ratios. They validated the model with simulation experiment on a three-echelon supply chain comprising of one plant, two warehouses and three distribution centres. On the list of five, the model given by Ho (2007) meets only one selection criteria, the holistic approach. Cai et al. (2009) identified gap between application and research in supply chain performance measurement and improvement. To abridge this gap they proposed and implemented a performance measurement system for a chinese company having more than 800 retail outlets. The framework organised a long list of performance indicators in to five categories, resource, output, flexibility,

innovativeness, and information. The framework is a balanced and holistic approach but does not focus the remaining three criteria. Hofmann and Locker (2009) developed a value-based PMS to link supply chain activities with value creation expressed as economic value added (EVA). The frawork is structured around lead times, capacity utilisation, on-time production, efficiency in production, inventory stocks, freight costs, and local and global overheads. The framework is balanced and holistic but does not focus on food quality, risk assessment, and environmental sustainability.

To identify key performance attributes (KPA) and key decision factors (KDF) in evaluating cold chains and implementing continuous improvement, Joshi et al. (2012) introduced a framework comprising of performance measures grouped as, cost, quality and safety, traceability, service level, return on assets, innovativeness, and relationship. They used consistent measurement scale to rate and select most consistent attributes from the list of 27. Moreover, they used twin-graph theory (TFT) and sensitivity analysis to facilitate decision makers to quantify the performance index as well as understand the complex relationships among relevant cold chain attributes. The framework comprises of a comprehensive set of performance indicators making it balanced and holistic which adequately focuses food quality in cold chains. However, it does not include risk assessment and environmental sustainability.

Overall, DBMSs are diverse and majority of them are well balanced and holistic in nature. A few of them also focus food quality and environmental sustainability in agri-food supply chains. However, risk assessment which is a necessary part of performance measurement in agri-food supply chains is completely missing in DBMSs.

C. Supply Chain Balanced Scorecard (SCBS)

Balanced scorecard was developed by Kaplan and Norton (1992) as a decision making tool for managers to help from which to choose measures. Figure 3.9 depicts how the balanced scorecard complements traditional financial indicators with performance measures for customers, internal business processes, and innovation and improvement activities. Balanced scorecard has been appreciated for: balance between financial and non-financial performance measures; and alignment of performance measures with organizational strategy (Kaplan & Norton, 1996; Lapide, 2000; Varma & Deshmukh, 2009).

Figure 3.9 The Balanced Scorecard
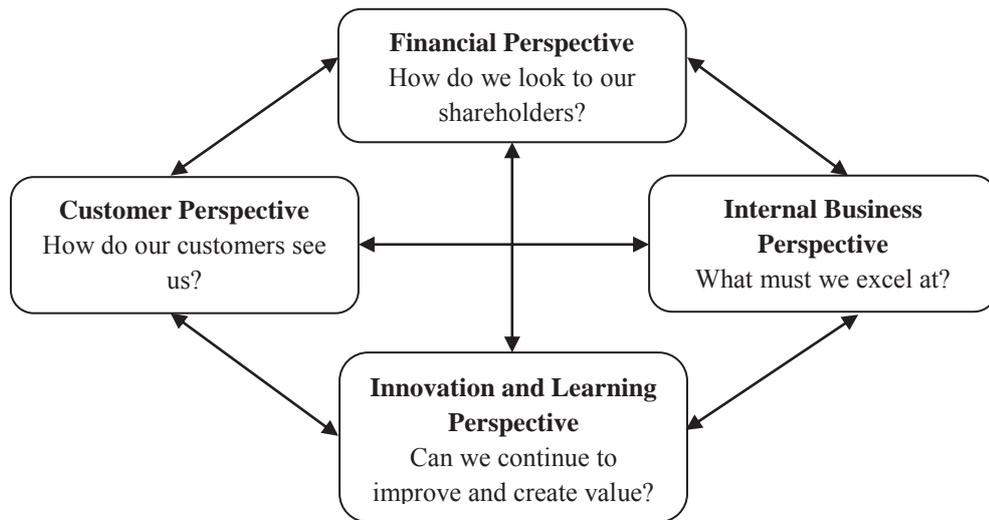
Source: (Kaplan & Norton, 1992)

Despite of various advantages, balanced scorecard has a number of shortcomings too. For example, balanced scorecard does not provide adequate assistance for the process of designing a performance measurement system and competitive benchmarking (Neely, et al., 1995; Varma & Deshmukh, 2009). Moreover, the original framework does not provide a holistic view spanning entire supply chain rather it captures the performance of individual organization (Aramyan, et al., 2006; Gilmour, 1999; Lambert & Pohlen, 2001; Lapide, 2000).

A number of researchers have tried to link balanced scorecard to supply chain performance measurement, thus making it more holistic in nature. For example, Brewer and Speh (2000) developed a supply chain performance measurement framework based on balanced scorecard by integrating appropriate inter-functional and inter-firm level performance measures related to SCM goals, customer benefits, financial benefits, and SCM improvement with four measurement perspectives shown in figure 3.6. Bhagwat and Sharma (2007b) conducted a comprehensive review of SCM performance metrics and distributed into four balanced scorecard perspectives. In addition to being balanced and holistic approach, the framework developed by Bhagwat and Sharma considers quality in supply chains but does not suffice the needs of agri-food supply chains.

The use of balanced scorecard in supply chain performance is becoming more and more popular. In order to evaluate and benchmark Petrolium supply chain in India, Varma and Deshmaukh (2009) identified and overcome three major shortcomings of balanced scorecard. These include: balanced scorecard not define the relative importance of

metrics; it does not allow benchmarking with competitors; and it does not allow dissimilar metrics to be combined. The framework developed by Varma and Deshmukh is quite comprehensive, balanced, holistic, measures risk, and focuses product quality implicitly. Bigliardi and Bottani (2010) included food quality related performance measures to the BSC based framework developed by Bhagwat and Sharma (2007b) to evaluate agri-food supply chains. Bigliardi and Bottani used Delphi technique to examine and validate the proposed framework.

Overall, the balanced scorecard developed by Kaplan and Norton (1992) is a balanced approach but not holistic as it was originally developed as a decision making tool for single firms. Subsequantly, balanced scorecard has been promoted at supply chain level which makes it holistic as well. However, it assumes quality implicitly and does not consider risk assessment and environmental sustainability at all.

D. Supply Chain Operations Reference (SCOR) Model

Supply chain operations reference (SCOR) model is a standard process-based measurement system developed by Supply Chain Council (2012). The SCOR model after release of its first version in 1996 has undergone several updates in the form of improved versions. The latest version is SCOR 10.0 which is structured around five processes namely Plan, Source, Make, Deliver, and Return and four levels of process detail. Level-1 defines these five processes for a supply chain whereas level-2 specifies the configurations of these processes, for example, the 'Make' process is decomposed into make-to-stock (M1), make-to-order (M2), or engineer-to-order (M3). Level-3 further describes the process categories of level-2 into detailed elements and activities of implementation. Level-4 describes the industry specific activities. The performance measures are organized under five performance attributes: reliability, responsiveness, agility, cost, and asset. The performance attributes reliability, responsiveness, and agility are customer-focused, whereas cost and asset are internal-focused. Product quality and environmental sustainability are measured as level-3 metrics under reliability attribute.Table 3.4 summarises performance attributes and relevant strategic level SCOR metrics.

Table 3.4   SCOR Model Performance Attributes

Performance Attribute	Strategic Metrics
Reliability	Perfect order fulfilment
Responsiveness	Order fulfilment cycle time
Agility	Upside supply chain flexibility Upside supply chain adaptability Downside supply chain adaptability Overall value at risk
Costs	Supply chain management cost Cost of goods sold (COGS)
Asset	Cash-to-cash cycle time Return on supply chain fixed assets Return on working capital

Source: Supply Chain Council (2012)

SCOR model is popular for its cross-industry supply chain processes, process configuration, and a comprehensive list of well documented performance metrics organized at four levels of process detail. A number of researchers have highlighted various advantages of SCOR model. For example, Stewart (1997) viewed SCOR model as the first cross-industry reference model and recommended it for evaluating and improving supply chain performance. Lapide (2000) added that SCOR model provides strategic visibility to the performance of entire supply chain. Lockamy and McCarmack (2004) believed that SCOR model can be used to investigate relationship between SCM planning practices and supply chain performance. Simatupang and Sridharan (2004) emphasized that SCOR model is the most suitable for benchmarking purposes due to its comprehensiveness and standard process and metrics definitions which enable companies to evaluate and improve performance at individual as well as entire supply chain levels. Aramyan et al. (2006) referred SCOR model as a holistic and balanced approach to measure supply chain performance from multiple dimensions.

Apart from aforementioned advantages, a bunch of researchers also mentioned disadvantages of using SCOR model. For example, Ellram et al. (2004) pointed out that separate SCOR processes, particularly the 'Return' do not fit the services business. Moreover, the SCOR model is an operations-oriented approach and does not focus relevant business processes/activities such as sales and marketing, research and development, product development, and after-sale customer service (Aramyan, et al.,

2006). Furthermore, it assumes but not sufficiently address food quality, information technology, training, and administration (Aramyan, et al., 2006). Burgess and Singh (2006) criticised SCOR model for not being comprehensive enough to understand the complex social and political factors which are integral part of certain supply chains.

In past, the SCOR model has been extensively used by the researchers to measure SC performance (Huang, et al., 2005; Hwang et al., 2008; Irfan, et al., 2008; Jamehshooran et al., 2015; Li et al., 2011; Liu, 2009; Millet, et al., 2009). Every version of SCOR model was improved to overtime the shortcomings identified in the previous version by the researchers. This gradual improvement can be evidenced in Appendix-C. For example, while explaining the configuration of computer-assisted supply chain based on SCOR version 5, Huang et al. (2005) analysed its strengths and weaknesses and argued that SCOR model must consider change management as the companies and markets change with time. Hwang et al. (2008) investigated the sourcing processes and accompanying performance metrics of SCOR model 7.0, extended them on sourcing processes of level 3, and recommended the institutionalization of SCOR model. Moreover, Hwang et al. validated that SCOR model is feasible and valuable to supply chain managers in decision-making on various industries.

Irfan et al. (2008) discussed state-of-the-art SCOR-based supply chain management system developed by Pakistan Tobacco Company to optimise its cross-country management processes. They believe that the system is scalable to an enterprise's unique process configuration. Examining the effect of implementing ISO/TS-16949 on SC performance of 54 Taiwanese automobile companies using SCOR model, Liu (2009) employed multiple regression analysis and found positive correlation. Millet et al. (2009) critically analysed and reviewed SCOR version 7 according to its contribution to the alignment of business processes and information systems. Millet et al developed a SCOR-based alignment reference model which supports a more efficient 'multi-view' methodology of business process mapping, especially for ERP-implementation projects. Li et al. (2011) tested and validated SCOR model by evaluating the integration of quality assurance in five SC processes each of which had positive impact on both customer-facing SC quality performance and internal-facing firm level performance.

The SCOR model up to version 9 was balanced, holistic, and assumed but did not sufficiently address food quality. However, its 10th version incorporates risk assessment and environmental sustainability, in addition to the first three criteria for selection. The

risk assessment is measured as value at risk (VAR) metric under the supply chain agility attribute, whereas, *greenSCOR* implies the performance metrics on environmental sustainability. Thus, according to the five selection criteria SCOR 10 with certain modification for appropriate food quality metrics, is the most suitable PMS for agri-food supply chains.

E. Hierarchical Based Measurement System (HBMS)

A hierarachical based measurement system comprises of performance measures related to various levels of organizational hierarchy such as strategic, tactical, and operational. A number of researchers developed hierarachical based measurement systems (Gunasekaran, et al., 2004; Gunasekaran, et al., 2001; Rangone, 1996; Van der Vorst, 2000b). For example, Rangone (1996) used analytic hierarchy process (AHP) to measure and compare the overall performance of different hierarchical levels of manufacturing departments. Rangone used multi-attribute financial and non-financial performance criteria to develop performance hierarchy of independent and homogeneous criteria and sub-criteria. The framework pose a balanced approach and focuses quality and environmental sustainability, but it is neither holistic and nor does it assess risk.

Li and O´Brian (1999) suggested a model to measure and improve efficiency and effectiveness at supply chain level as well as operations level under four criteria, profit, lead time performance, delivery promptness, and waste elimination. At the chain level, assumptions associated with the criteria were set for each SC stage so that the SC performance can meet the customer service target and the best SCM strategy is selected. At the operations level, manufacturing and logistics activities were optimised under the given targets. The model is helpful in evaluating integrated decision making to assess potential partners in a supply chain. The measurement model is a balanced as well as holistic approach but does not meet the remaining three criteria for selection.

Gunasekaran et al. (2001) developed a framework for measuring the strategic, tactical, and operational level performance in a supply chain. Apart from three hierarchical levels, Gunasekaran et al. classified performance measures into financial and non-financial. Gunasekaran et al. (2004) extended the framework developed by Gunasekaran et al. (2001) and aligned the performance metrics into four processes: plan, source, make, and deliver that mainly constitute a supply chain. Moreover, they tested the

framework with empirical data from 21 British companies and found positive impact of SCM practices on overall performance. Table 3.5 represents this framework from the perspective of supply chain processes and hierarchical levels of management. Bhagwat and Sharma (2007a) view that the framework given by Gunasekaran et al. (2001) is helpful in selecting the appropriate metrics and costing methods at different levels in an organization. The framework is balanced and holistic in selecting performance measures. Moreover, it assumes quality but not sufficient to the specific requirements of agri-food supply chains. However, the framework does not consider risk assessment and environmental sustainability at all.

Table 3.5   Supply Chain Metrics Framework

Process	Strategic	Tactical	Operational
Plan	Level of customer perceived value of product, Variances against budget, Order lead time, Information processing cost, Net profit versus productivity ratio, Total cycle time, Total cash flow time, Product development cycle time	Customer query time, Product development cycle time, Accuracy of forecasting techniques, Planning process cycle time, Order entry methods, Human resource productivity	Order entry methods, Human resource productivity
Source		Supplier delivery performance, supplier lead time against industry norm, supplier pricing against market, Efficiency of purchase order cycle time, Efficiency of cash flow method, Supplier booking in procedures	Efficiency of purchase order cycle time, Supplier pricing against market
Make	Range of products and services	Percentage of defects, Cost per operation hour, Capacity utilization, Utilization of economic order quantity	Percentage of Defects, Cost per operation hour, Human resource productivity index
Deliver	Flexibility of service system to meet customer needs, Effectiveness of enterprise distribution planning schedule	Flexibility of service system to meet customer needs, Effectiveness of enterprise distribution planning schedule, Effectiveness of delivery invoice methods, Percentage of finished goods in transit, Delivery reliability performance	Quality of delivered goods, On time delivery of goods, Effectiveness of delivery invoice methods, Number of faultless delivery notes invoiced, Percentage of urgent deliveries, Information richness in carrying out delivery, Delivery reliability performance

Source: Adopted from (Gunasekaran, et al., 2004)

Li et al. (2007) postulated an integrated performance measurement approach to evaluate a supply chain from structure and operational levels. The approach is both balanced and holistic, but does not consider food quality, risk assessment, and environmental sustainability. In order to develop a PMS for meat supply chain in Iran, Fattahi et al. (2013) considered six criteria base the unique characteristics of agri-food supply chains. These are: financial, quality and safety, customer service, efficiency, flexibility, and chain coordination. The framework has been structured around balanced scorecard and uses Delphi technique to allocate selected performance indicators at strategic and tactical levels, thus making it of hierarchical nature. On the list of five, this framework meets four criteria, as shown in Appendix-C.

F. Interface Based Measurement System (IBMS)

Lambert and Pohlen (2001) devised a framework to align the performance of each link within the supply chain. This link-by-link approach looks at the supply chain as a series of different interfaces and aims to optimise the performance at individual links level as well as the supply chain as a whole. The IBMS given by Lambert and Pohlen (2001) has been appreciated by the researchers for a variety of reasons. For example, Pohlen (2003) emphasized that interfaces can be used to demonstrate the outcome of supply chain collaboration. Gaiardelli et al. (2007) suggested that Lambert and Pohlen's framework is helpful in managing customer relationships and supplier relationships at each link in the supply chain. Apart from being holistic Lambert and Pohlen's framework does not fulfil the remaining four selection criteria.

G. Perspective Based Measurement System (PBMS)

A PBMS evaluates a supply chain from one or more perspectives. Otto and Kotzab (2003) developed a framework to measure supply chain performance from six possible perspectives: system dynamics, operations research, logistics, marketing, organization, and strategy. Hofmann (2006) viewed that the framework given by Otto and Kotzab can be employed to identify standard problems, their possible solutions, and most importantly to optimize the trade-off of measures among the perspectives based upon the perceived dominancy of perspectives in a supply chain. However, Papakiriakopolous and Pramatari (2010) argued that existence of different perspectives makes it difficult to identify the significance level of different areas of performance

measurement in a supply chain. Table 3.6 provides an overview of various perspectives of the framework given by Otto and Kotzab.

Table 3.6   Perspectives to Derive the Goals of SCM

Perspective	Purpose of SCM	Area of Improvement
System dynamics	Managing trade-offs along the complete supply chain.	Order management
Operations research	Calculating optimal solutions within a given set of degrees of freedom.	Network configuration and flow
Logistics	Integrating generic processes sequentially, vertically, and horizontally.	Integration of processes
Marketing	Segmenting products and markets and combine both, using the right distribution channel.	Fit between product, channel, and customer
Organization	Determining and mastering the need to coordinate and manage relationships.	Intra-enterprise segmentation
Strategy	Merging competencies and relocating into the deepest segments of the profit pool.	Ability to partner; positioning in the chain

Source: (Otto & Kotzab, 2003)

A substantial number of researchers have measured supply chain performance from one or more perspectives. For example, Gerbens-Leenes (2003) developed a framework for measuring environmental sustainability across the multi-echelon food supply chain. Li et al. (2005) developed a measurement instrument for studying supply chain management practices from six possible perspectives, strategic supplier partnership, customer relationship, information sharing, information quality, internal lean practices, and postponement. In an attempt to analyse collaborative performance, La Forme et al. (2007) proposed and validated a framework based on two models: a collaboration characterization model and a collaboration-oriented performance model. Yakovleva (2007) proposed a set of sustainability indicators to measure the effects of the multi-echelon food supply chain. Yakovleva tested the assessment model using the empirical data for chicken and potato supply chains in the UK.

To measure and potentially enhance sustainability performance, Van der Vorst et al. (2013) presented a framework for food supply chain logistics including drivers, strategies, performance indicators, metrics and improvement opportunities. They evaluated 17 Dutch food & drinks companies and logistics service providers using this framework. Leat and Revoredo-Giha (2013) examined ASDA PorkLink supply chain and identified key risks and challenges involved in developing a resilient agri-food

supply system. They particularly focused primary product supply, and how risk management and collaboration amongst stakeholders can increase chain resilience. Zubair and Mufti (2015) identified eighteen risk perspectives in supply chain of dairy products in Pakistan and developed a risk matrix based on probability and impact scores in order to prioritize these risk perspectives. Wiengarten and Longoni (2015) surveyed 90 Indian manufacturing companies to assess the impact of supply chain integration on operational, environmental, and social sustainability. They used cluster analysis and analysis of covariance methods and found that coordinative outward-facing integration had positive impact on several operational and sustainability performance dimensions, whereas collaborative outward-facing integration provided significantly higher benefits mainly on the flexibility and sustainability performance dimensions compared to other collaborative integration strategies.

A review of aforementioned PBMSs against five selection criteria is summarized in Appendix-C. All of the reviewed frameworks are holistic in nature, however, majority of them are not balanced. Apart from being holistic, a major limitation of PBMSs is their focus on individual perspectives of supply chain performance. Since, by definition PBMSs focus one or more perspectives and not the overall performance of supply chain, therefore, none of the PBMSs meet all the five selection criteria.

In addition to seven categories mentioned above, a huge number of researchers adopted hybrid frameworks to measure the supply chain performance. For example, Bullinger et al (2002) integrated SCOR model and balanced scorecard to develop a balanced measurement approach. The approach is balanced and holistic but does not focus food quality, risk assessment, and environmental sustainability. Pohlen (2003) proposed a hybrid approach of economic value added (EVA) and activity based costing (ABC) to measure performance in a supply chain. The framework is balanced and holistic but does not focus food quality, risk assessment, and environmental sustainability.

Reiner and Hofmann (2006) used a combination of data envelopment analysis (DEA) and SCOR model to evaluate and benchmark the efficiency of supply chain processes between decision making units. The model developed is balanced and holistic but limited to make-to-stock configuration only. Yao and Liu (2006) integrated economic value added (EVA), balanced scorecard (BSC), and activity based costing (ABC) to balance short-term and long-term factors and to link the strategic performance indexes with process measuring in supply chains. The framework is both balanced and holistic

but does not consider food quality, risk assessment, and environmental sustainability. Bhagwat and Sharma (2007a) integrated balanced scorecard and analytical hierarchy process and organized metrics into strategic, tactical and operational levels of organizational hierarchy. Thakkar et al. (2009) combined balanced scorecard with SCOR model to develop a performance measurement framework for supply chain evaluation and planning in SMEs. The framework is both balanced and holistic but does not consider food quality, risk assessment, and environmental sustainability. Widyaningrum and Masruroh (2012) developed an agri-food supply chain performance measurement framework based on SCOR model and Aramyan et al. (2007). The framework focuses on efficiency, flexibility, responsiveness, food quality, facility and government involvement. Among the PBMSs reviewed in this study, the framework developed by Widyaningrum and Masruroh (2012) is balanced, holistic, and focuses food quality and environmental sustainability. However, like other PBMSs this framework does not consider risk assessment either. A common problem in using hybrid frameworks is the lack of synchronization between the metrics from two different contexts.

3.5 Potential Research Gap and Way Forward

The choice of right performance measurement framework for benchmarking a supply chain very much depends upon the nature of problem(s) that the researcher is going to address. Previous section presents a critical review of literature against five selection criteria. The review revealed that there is no performance measurement framework which satisfies all the five selection criteria. This research gap in performance measurement in agri-food supply chains needs to be abridged by developing a framework comprising of performance measures related to all the five selection criteria.

The review of existing literature also highlighted that according to criteria approach SCOR model (version 10) was the most suitable framework for performance measurement in agri-food supply chains. The SCOR model is a balanced and holistic framework. Moreover, it focuses risk assessment and environmental sustainability which are inherent part of agri-food supply chains. Furthermore, in addition to PM framework, SCOR model is also a benchmarking framework widely used in industry and also validated by academic researchers. However, SCOR model assumes but does not explicitly address food quality, for which it needs to be modified by incorporating relevant food quality metrics. Therefore, SCOR model with certain modifications to

food quality is proposed to bridge the research gap as well as measurement tool for this study.

3.6 Proposed Analytical Framework for Dairy Supply Chain

The SCOR model is a framework that links performance metrics, supply chain processes, best practices, and people in a unified structure. The model is constructed on five supply chain processes e.g. plan, source, make, deliver, and return. Figure 3.10 portrays how these processes make up the whole supply chain.

Figure 3.10   **The SCOR Model Supply Chain Processes**
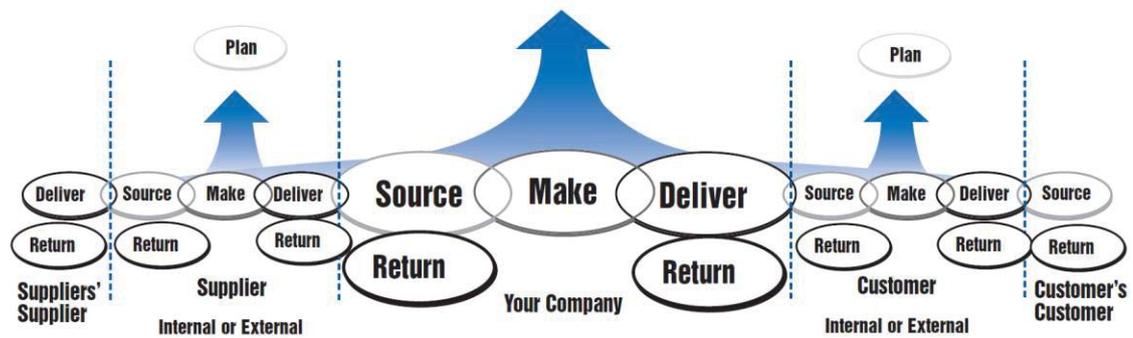
Source: Adopted from (Supply Chain Council, 2012)

The performance section of SCOR model been briefly discussed in previous section. All the SCOR metrics are diagnostic in nature and organised at three levels. Level-1 metrics strategic and diagnostic for overall health of supply chain, whereas level-2 metrics are diagnostic for level-1 metrics. Similarly, level-3 metrics are diagnostic for level-2 metrics.

The SCOR model divides performance attributes of a supply chain into two categories: customer-focused and internal-focused. The customer-focused performance attributes include reliability, responsiveness, and agility, whereas, the internal-focused performance attributes include costs and asset management. The SCOR metrics need to be modified to comply with the performance measurement in agri-food supply chains. The unique features of agri-food supply chains such as food quality implies a specialized quality control mechanism at critical points across the entire agri-food chain. This is one of the important features which is required to be measured in addition to the general supply chain performance attributes. An analytical framework of SCOR model

modified for performance measurement in agri-food supply chains is illustrated in figure 3.11.

Figure 3.11   Analytical Framework for Agri-Food Supply Chains
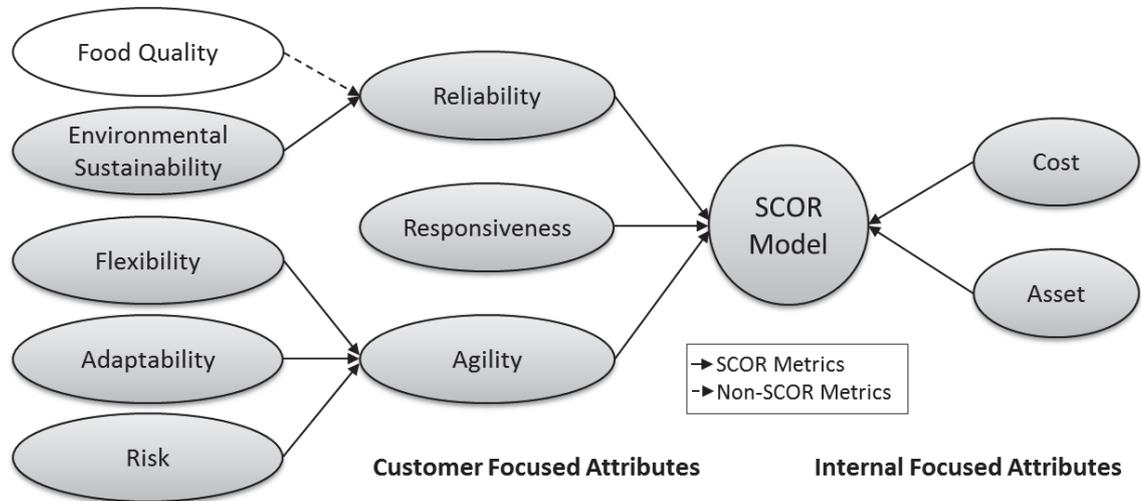
Source: Adopted from Supply Chain Council (2012)

Food quality related metrics are added as level-3 metrics under reliability attribute. These metrics measure food safety and health, shelf life (freshness) and sensory properties (taste, odour, colour, appearance, texture, and sound), convenience (ease of use) and product reliability (compliance to product composition and nutritional information), and process quality (presence of quality assurance system). The environmental sustainability related best practices also called as *Green SCOR* are measured as level-3 metrics under reliability attribute. These metrics are:

> ➢ Carbon emissions
> ➢ Air pollutant emissions
> ➢ Liquid waste generated
> ➢ Solid waste generated
> ➢ Recycled waste

The SCOR model provides a comprehensive framework of managing supply chain risks with the objective to reduce their negative impact on the entire supply chain performance. It helps to identify, assess, evaluate, mitigate, and monitor potential supply chain disruptions in a systematic way. Potential disruptions could be internal to the supply chain (such as poor quality, unreliable suppliers, uncertain demand, and machine breakdown) or external (unfavourable weather, natural disasters, terrorism,

labour strikes). The SCOR model employs the term value at risk (VAR) to measure the level of risk involved at process level. Value at risk refers to the sum of probability of risk events times the monetary impact of events for all supply chain functions. The SCOR attributes and relevant metric selected for performance measurement of dairy supply chain are presented in Appendix-D.

3.7 Summary

The literature review chapter provides an extensive overview of existing literature in the field of supply chain management, and benchmarking and performance measurement in agri-food supply chains. The literature on supply chain management shows a shift in the focus of SCM definitions from the flow of goods and relationship management in 1990's to the supply chain coordination, customer value, and holistic/system's approach afterwards. The evolution of supply chain management from activity fragmentation in 1960's through to activity integration in 2000 and afterwards has been described. Benchmarking practice has evolved from reverse benchmarking in 1940's to network benchmarking in 2000 and afterwards.

The benchmarking frameworks commonly found in the literature were reviewed under one-to-one benchmarking frameworks and business excellence models. The limitations of both the categories were discussed and SCOR models was found as widely used for benchmarking in industry and also validated by researchers. In order to select an appropriate performance measurement system for agri-food supply chains, five criteria were used to evaluate existing supply chain performance measurement frameworks. In addition to five criteria, the PM frameworks were also organized in to seven categories. namely function based measurement systems (FBMS), dimension based measurement systems (DBMS), supply chain balanced scorecard (SCBS), supply chain operations reference model (SCOR), hierarchical based measurement systems (HBMS), interface based measurement systems (IBMS), and perspective based measurement systems (PBMS).

A substantial number of frameworks were reviewed against these five criteria and not a single one of them satisfied all the criteria which points out a potential research gap. The review also revealed that SCOR model version 10 satisfies four selection criteria. However, it assumes but does not explicitly address food quality, for which it needs to be modified by incorporating necessary food quality metrics. In addition to performance

measurement framework, SCOR model is also a benchmarking framework widely used in industry and also validated by academic researchers. Therefore, SCOR model with certain modifications to food quality is proposed as measurement tool for this study.

4. RESEARCH METHODOLOGY

4.1 Introduction

This chapter deals with the research methodology employed. The chapter is organised into following sections

- ➢ Section 4.2 reitirates the research objectives of this study.
- ➢ Section 4.3 schematically represents the research process governing this chapter.
- ➢ Section 4.4 reviews existing research philosophies and presents the one selected for this study.
- ➢ Section 4.5 expands on the research design thereby explaining research category, data collection strategy, sampling design, hypothesis testing, and the issues of validity, reliability and ethics employed in this research.
- ➢ Section 4.6 explains pilot survey performed to callibrate questionnaires in line with the functions and activities performed by the players of milk supply chains in Pakistan and New Zealand.
- ➢ Section 4.7 summarises methodology used in this study.

4.2 Research Objectives

This study aims to examine the causes of poor performance of milk supply chain in Pakistan. For this purpose the milk supply chain in Pakistan was benchmarked against that of New Zealand with following research objectives.

Objective 1: to overview dairy industries of Pakistan and New Zealand.

Objective 2: to measure the performance of key players of milk supply chains in Pakistan and New Zealand.

Objective 3: to identify and analyse performance gaps between milk supply chains in Pakistan and New Zealand.

Objective 4: to suggest policy measures for the improvement of milk supply chain in Pakistan.

4.3 The Research Process

Saunders, Lewis and Thornhill (2012) describe research as a multistage process that the researchers must follow in order to complete a research project. They add that the stages of research process usually include formulating and clarifying a topic, reviewing the literature, designing the research, collecting data, analyzing data, and writing up. Nonetheless, Cooper and Schindler (2014) argue that no one claims that the research requires to complete each step before going to the next. Instead, they believe that recycling, circumventing, and skipping do occur. Figure 4.1 portrays the schematic steps involved in the research process employed in this study.

The research process starts with problem identification, research objectives and research questions to achive those objectives. To construct and refine the research objectives and questions, the exploratory information about the benchmarking partners has been given in the background chapter and about the literature on performance measurement and benchmarking in supply chain management has been given in the literature review chapter. The literature review chapter systematically evaluates performance measurement frameworks against five criteria characterising the performance measurement in agri-food supply chains. The review reveals a potential research gap in literature and introduces an analytical framework to measure and benchmark the performance of milk supply chains in Pakistan and New Zealand. This chapter expands on research philosophies, research design, questionnaire development, data collection, pilot survey, and data analysis techniques used in this study.

The questionnaires are developed and pilot tested before final data collection from the sample respondents. The data sets for key players in the milk supply chains of Pakistan and New Zealand are statistically analysed and compared or supported with relevant literature. Finally, the findings are concluded and appropriate policy interventions are recommended for the improvement of milk supply chain in Pakistan.

Figure 4.1 The Research Process of this Study

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│                         Exploration                               │
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│ Background                   │ Literature Review                 │
│ •Global Dairy Sector         │ •Supply Chain Management          │
│ •Pakistan Dairy Industry     │ •Supply Chain Performance         │
│ •New Zealand Dairy Industry  │  Measurement                      │
│                              │ •Benchmarking in Supply Chain     │
│                              │  Management                       │
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│              Research Objectives and Questions                    │
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│                       Research Design                             │
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│   Data Collection Design     │        Sampling Design            │
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│ Secondary Data               │ Primary Data                      │
│ •Government Reports and      │ •Pakistan                         │
│  publications                │ •New Zealand                      │
│ •Statistical Databases       │                                   │
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│               Data Analysis and Interpretation                    │
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│                Conclusion and Recommendations                     │
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4.4 Research Philosophy and Approach

How best to conduct a research, has always been a debatable topic for scientists and methodologists. This debate always focussed on two fundamentally different and competent schools of thought: the positivists and the interpretive (Amaratunga et al., 2002; Carson et al., 2001; Collis & Hussey, 2014). However, in recent years there is a growing concern that in some cases it is more appropriate to adopt a multi-dimensional set of continua rather than taking extreme positions (Saunders, et al., 2012). This selection of multi-dimensional set of continua is called mixed methods or pragmatism. This section discusses theoretical foundations of the three scientific paradigms and explains which paradigm has been used in this study and why?

4.4.1 Positivism

Positivism is an objectivist approach which assumes that the world is external and objective (Carson, et al., 2001). It originated in the natural sciences and involves a deductive processes with a view to provide explanatory theories to understand social phenomena (Collis & Hussey, 2014). It generally uses quantitative and experimental methods to test theories and hypothetical deductive generalizations (Amaratunga, et al., 2002). The scientific objectivity advocates the need of independence of the observer from the subject being observed (Carson, et al., 2001) that is the researcher remains emotionally neutral and detached from the object of research. The objective of a positivist enquiry is to explain causal relationships with the help of objective facts and statistical analysis (Perry et al., 1999). The approach of measuring and quantifying the phenomena provides basis for deduction about the whole from the analysis of its parts (Myers, 2000).

The quantitative research predominantly uses formalized statistical and mathematical methods of data collection and analysis (Carson, et al., 2001). It seeks to estimate the average effect of causation across the population (Mahoney & Goertz, 2006). Therefore, the sample sizes are greater than those used in qualitative research in order to be true representative of the population and the results to be generalizable (Sale et al., 2002). Moreover, the quantitative research deducts on the basis of objective facts and derives an empirical model which is used to predict within that 'absolute truth' (Davies, 2003). The proponents of quantitative research regard qualitative researchers as soft scientists or even journalists (Denzin & Lincoln, 1994). In support of dominating role of

positivism, quantitative researchers often quote the issue of lack of generalizability of qualitative results (Larsen-Freeman & Long, 1991; Myers, 2000).

4.4.2 Interpretivism

Interpretivism is an anti-positivist approach which states that the world is essentially relativistic, thus one must understand it from the inside rather than the outside (Denzin & Lincoln, 1994). Therefore, the interpretivists emphasise the use of personal process to understand reality (Carson, et al., 2001). Interpretivism emerged in response to positivism and rests on the assumption that social reality is in our minds and it is sujective and multiple (Collis & Hussey, 2014). Interpretivism uses qualitative (or phenomenological) and naturalistic inquiry to inductively understand the reality through observer's personal involvement in context-specific situations (Amaratunga, et al., 2002). Using this approach, it is therefore hard to generate objective knowledge.

The interpretivist view of scientific research is qualitative and subjective (Altheide & Johnson, 1994). In contrast to the quantitative, this paradigm assumes that there are multiple realities based on one's construction of reality (Davies, 2003). The investigator actively seeks interaction with the object of study so that the findings reflect the context of the situation (Denzin & Lincoln, 1994; Guba & Lincoln, 1994). The qualitative researchers like Guba and Lincoln (1994) criticize quantitative research for: context stripping; exclusion of meaning and purpose about human activities; disjunction of major theories with local contexts (the etic/emic dilemma); inapplicability of general data to individual cases and exclusion of discovery dimension in inquiry. Lazaraton (1995) views that the quantification of a data set does not ensure its generalizability to all the contexts. Moreover, in certain contexts, statistical significant findings based on large sample size and random selection are not applicable on individual level especially in medical science (Lazaraton, 1995).

4.4.3 Pragmatism

Pragmatism contends that rather than be constrained by a single paradigm, researchers should be free to mix methods from different paradigms, choosing them on the basis of usefulness for answering the question (Collis & Hussey, 2014). A number of past researchers support the use of a combination of both the research methods (Amaratunga, et al., 2002; Kaplan & Maxwell, 2005; Remenyi et al., 1998; Sale, et al., 2002). For example, King et al. (1994) view that both the methodologies share the unified logic of

understanding the world. According to Morgan (1998) a major reason to use multiple methodologies is to achieve complementary results by using the strengths of one method to enhance the other. The two approaches are complementary to each other; a good qualitative research may be necessary before designing a prospective study which provides statistical power to the research design (Runciman, 2002). Amaratunga et al. (2002) recommend to combine both research methods for the sake of enhanced validity and reliability of the results. Table 4.1 compares the three research philosophies.

Table 4.1   Comparison of Research Philosophies

	Positivism	**Interpretivism**	**Pragmatism**
Ontology: the researcher's view of the nature of reality or being	External, objective and independent of social actors	Socially constructed, subjective, may change, multiple	External, multiple, view chosen to best enable answering of research question
Epistemology: the researcher's view regarding what constitutes acceptable knowledge	Only observable phenomena can provide credible data, facts. Focus on causality and law-like generalisations, reducing phenomena to simple elements	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions	Either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the research question. Focus on practical applied research, integrating different perspectives to help interpret the data
Axiology: the researcher's view of the role of values in research	Research is undertaken in a value-free way, the researcher is independent of the data and maintains an objective stance	Research is value bound, the researcher is part of what is being researched, cannot be separated and so will be subjective	Values play a large role in interpreting results, the researcher adopting both objective and subjective points of view
Data collection techniques most often used	Highly structured, large samples, measurement, quantitative, but can use qualitative	Small samples, in-depth investigations, qualitative	Mixed or multiple methods designs, quantitative and qualitative

Source: (Saunders, et al., 2012)

Instead of moving from theory to data (deduction) or from data to theory (induction), pragmatism advocates abduction which combines deduction and induction (Saunders, et al., 2012). Table 4.2 compares three approaches to research from various aspects.

Table 4.2   Approaches to Scientific Research

	Deduction	Induction	Abduction
Logic	In a deductive inference, when the premises are true, the conclusion must also be true	In an inductive inference, known premises are used to generate untested conclusions	In an abductive inference, known premises are used to generate testable conclusions
Generalisability	Generalisisng from the general to the specific	Generalisisng from specific to the general	Generalisisng from the interactions between the specific and the general
Use of data	Data collected is used to evaluate propositions or hypothesis related to an existing theory	Data collection is used to explore a phenomenon, identify themes and patterns and create a conceptual framework	Data collection is used to explore a phenomenon, identify themes and patterns, locate these in a conceptual framework and test this through subsequent data collection and so forth
Theory	Theory falsification or verification	Theory generation and building	Theory generation or modification; incorporating existing theory where appropriate, to build new theory or modify existing theory

Source: (Saunders, et al., 2012)

4.4.4 The Choice of Research Philosophy and Approach

Existing research philosophies are just like different cultures each of which has its own values, beliefs and norms. Having known the strengths and weaknesses of all research forms, the researcher should use the most appropriate method, given the particular research problem. Keeping in view the prime objective of this study, pragmatic (mixed methods) approach was adopted. There are various justificatiosn to this choice of research philosophy.

a) The exploration of research problem was carried out in the form of:
   - An overview of dairy industries in Pakistan and New Zealand (chapter 2)
   - A critical review of literature to find/develop a performance measurement framework for agri-food supply chains (chapter 3)
   - Pilot survey of the semi-structured questionnaires to explore overall structure of milk supply chains and functions performed by the key players (in chapter 4)
   - Value chain analysis of milk supply chains of Pakistan and New Zealand (in chapter 5).

These are qualitative inquiries and therefore, employ qualitative approach.

b) The performance measurement of key players of milk supply chains in Pakistan and New Zealand in the form of SCOR metrics implies quantitative inquiry.

c) The gap analysis of SCOR metrics included hypothesis testing for comparison of mean values from two independent samples/groups (quantitative approach) and phenomenological discussion of performance gaps (qualitative approach) between the benchmarking partners.

Due to the pragmatist nature of this study, abductive approach was adopted to generate testable conclusions. Abduction uses both inductive as well as deductive approach at different stages (Saunders, et al., 2012). For example, in this study inductive approach was used for the exploration of research problem and development of conceptual model and then deductive approach was used to test a series of hypothesis.

4.5 Research Design

A research paradigm provides a philosophical framework that guides the selection of research design (Collis & Hussey, 2014). A research design provides a framework for the collection and analysis of data (Bryman & Bell, 2015). It includes selection of appropriate research strategy, sampling design, data collection methodology, and data analysis technique. Moreover, it deals with the validity and reliability of measurement and ethical issues related to the research being undertaken. According to Saunders, et al. (2012) the research design should be selected to best answer the research question(s).

4.4.1 Research Category

A number of researchers (Baines & Chansarkar, 2002; Saunders, et al., 2012; Webb, 2002; Zikmund et al., 2013) agree on three basic categories of research: exploratory, descriptive, and explanatory (also called causal or inferential). The degree of formality increases and the degree of flexibility decreases from exploratory through to explanatory research (Webb, 2002). Exploratory research is not an end unto itself rather it is conducted as a first step with the expectation that additional research will be needed to provide a conclusive evidence (Zikmund, et al., 2013). Descriptive research is to gain an accurate profile of events, persons, or situations, whereas explanatory research seeks to establish causal relationship between variables (Saunders, et al., 2012). Desrcriptive research includes measures of tendency, variability, deviation from normality, size, and

stability; crosstabulation and chi square analysis; and comparison of means (George & Mallery, 2014).

This study used exploratory as well as descriptive research categories. In abductive approach conducting exploratory research prior to descriptive or explanatory research is necessary in order to refine the research problem (Collis & Hussey, 2014; Saunders, et al., 2012). This study conducted exploratory research in the form of literature review, interviewing experts in the subject, and conducting in-depth individual interviews (Saunders, et al., 2012). Semi-structured questionnaires with open ended questions were used for in-depth interviews in order to develop a deeper understanding of the research problem as well as the functions performed by the key players in the milk supply chains in Pakistan and New Zealand. The benchmarking practice includes gap anlysis thereby comparing means which comes in the ambit of descriptive research.

4.4.2 Research Strategy and Data Administration

In addition to aforementioned research categories, there are various research strategies associated with the research paradigms as shown in table 4.3. According to Bryman and Bell (2015) true field expriments are rare in business and management research mainly due to the problems of achieving required level of control. Studying businesses, researchers often employ survey strategy to get exploratory and descriptive information characterising the population (Saunders, et al., 2012). The surveys yield corss-sectional or longitudinal data. The data collected in different contexts, but at certain point of time is cross-sectional, whereas the data collected over a long period of time (also called time series data) is longitudinal (Collis & Hussey, 2014).

Table 4.3   Research Categories Associated with Paradigms

Positivism ←——————————————————————→ Interpretivism	
Experimental studies	Hermeneutics
Surveys (using primary or seconday data)	Enthrography
Cross-sectional studies	Participative Inquiry
Longitudinal studies	Action research
	Case studies
	Grounded theory
	Feminist, gender and ethnicity studies

Source: (Collis & Hussey, 2014)

In this study, data from both secondary as well as primary sources was utilised to answer the research questions. Seconday information was gathered from various research organizations, expert persons related to dairy industry, reports, periodicals, and article databases. Secondary information was mainly used for exploration of research problm. To answer the research questions of this study survey strategy was employed to collect primary data (Sreejesh et al., 2014). Survey strategy is often used to answer the research questions 'what', 'who', 'where', 'how much', and 'how many' (Saunders, et al., 2012). The nature of research questions required data on performance indicators of key players of milk supply chains of Pakistan and New Zealand at a certain point of time.

There are three data collection methods: observation, interview, and questionnaire (Saunders, et al., 2012). Table 4.4 describes the data collection methods for scientific research. Every method of data collection has its own advantages and disadvantages, however, the selection of an appropriate data collection method is affected by four major factors: the objectives of the study, available sources of data, time frame, and the cost constraints (Zikmund, et al., 2013).

In this study two methods of data collection, personal interviews and questionnaires were used. Personal interviews offer unique advantages such as opportunity for feedback, probing complex questions, controlling length of interview, and high rate of completed questionnaires, whereas, self-administered questionnaires delivered through internet are quick, cost effective and protect respondent anonymity (Zikmund, et al., 2013). For data collection in Pakistan, structured face-to-face interviews were conducted. Whereas, in New Zealand online questionnaires were used to collect data using internet. The questionnaires developed for each SC operator were comprised of both open ended and close ended questions.

Table 4.4   Data Collection Methods

Data Collection Method	Definitions
Observation	The observation involves: the systematic observation, recording, description, analysis, and interpretation of people's behaviour.
	There are two types of observation:
	Participant observation is qualitative and derived from social anthropology where 'the researcher attempts to participate fully in the lives and activities of members'.
	Structured observation is quantitative and is more concerned with the frequency of actions.
Interview	The purposeful conversation between two or more people, requiring the interviewer to establish rapport, to ask concise and unambiguous questions and to listen attentively.
	There are three types of interviews:
	Structured interview is a data collection technique in which an interviewer physically meets the respondent, reads them the same set of questions in a predetermind order, and records his or her response to each.
	Semi-structured interview is a data collection technique in which an interviewer commences with a set of interview themes but is prepared to vary the order in which questions are are asked.
	Unstructured interview is a loosly structured and informally conducted that may commence with one or more themes to explore.
Questionnaire	All methods of data collection in which each person is asked to respond to the same set of questions in a predetermind order.
	There are two main types or questionnaires:
	Self-completed questionnaires are usually completed bythe respondent such as internet-mediated or mail questionnaires.
	Interviewer-completed questionnaires are recorded by the interviewer on the basis of each respondent's answers such as telephone questionnaires.

Source: (Saunders, et al., 2012)

4.4.3 Sampling Design

A population is "any complete group – for example, of people, sales territories, stores, products, or college students – whose members share some common set of characteristics" (Zikmund, et al., 2013, p. 301). To understand the characteristics or response of the individuals of a population, Cooper and Schindler (2014) provide several reasons for drawing samples rather than a complete census. These reasons are: lower cost, greater accuracy of results, greater speed of data collection, and availability of population elements. A sample is "a subset, or some part, of a larger population" (Zikmund, et al., 2013, p. 301).

The selection of appropriate sampling technique depends on availability of sampling frame, sample size needed, research questions, research objectives, mode of interaction with the respondents and the geographical area (Saunders, et al., 2012). There are two main categories of sampling techniques: the probability (representative) sampling and non-probability sampling. The probability sampling assures that each element of the population has nonzero (or known) chance of selection. Hence, the findings deduced from the probable samples are generalizable to the larger population. Whereas, the non-probability sampling does not assure nonzero chances of selection of each element of the population (Cooper & Schindler, 2014). Figure 4.2 represents sampling techniques in scientific research.

Figure 4.2 Sampling Techniques
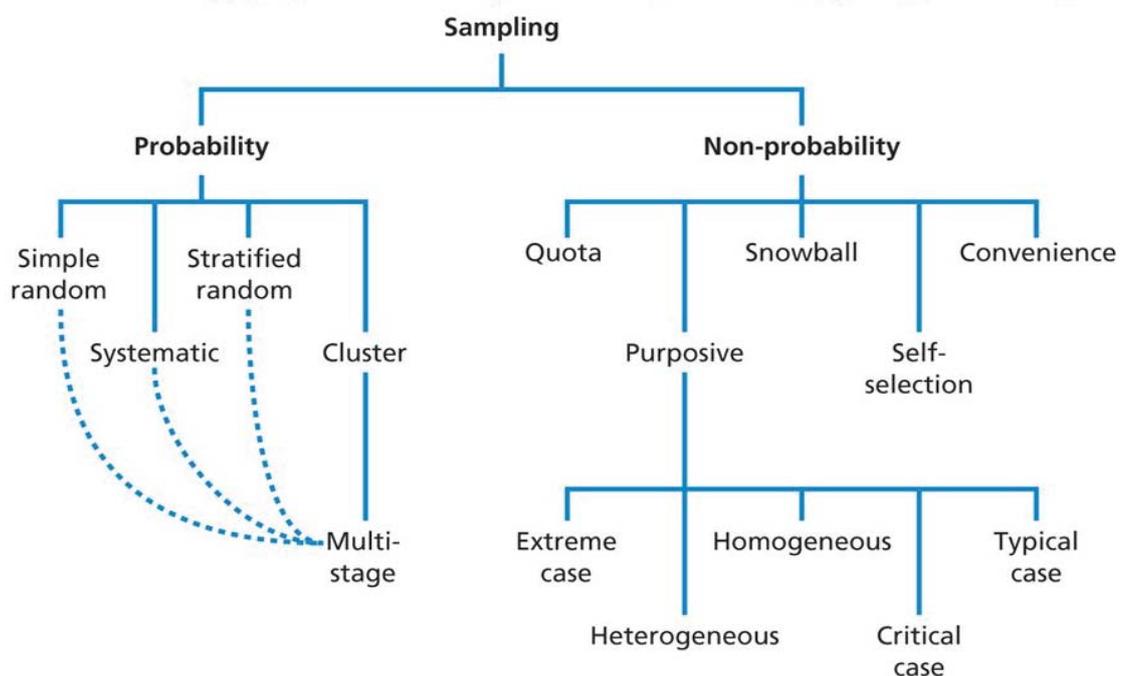
Source: (Saunders, et al., 2012)

Saunders, et al, (2012) believe that it is not possible to draw probable samples without a sampling frame. Sampling frame is a complete list of all the elements in a population (Cooper & Schindler, 2014). However, Zikmund et al. (2013) argue that multi-stage area sampling can be undertaken without sampling frame. Multi-stage area sampling is a probability sampling methods appropriate where members of target population are scattered over a wide geographical area. In multi-stage area sampling, target population can be divided into various geographical areas (homogenous or hetrogeneous). One

geographical area can be selected at random (muli-stage random sampling) or on the basis of population proportion (multi-stage stratified sampling). This process can be repeated several times until the desired level is met. Finally, required number of samples are selected using a probability or non-probability sampling method.

In this study non-probability sampling method was used for Pakistan mainly due to non-availability of the sampling frame characterising the key players of milk supply chain namely, dairy farmers, milk collectors, milk shops. Multi-stage area sampling was used up to two levels and then members of the target population were selected using purposive sampling method. Among the four provinces, Punjab was selected due to its highest share in the national dairy herd and total milk production. Then, three districts Faisalabad, Lahore, and Gujrat located in the Punjab province were selected representing dairy production systems mentioned in chapter 2. Then, samples of dairy farmers, milk collectors, and milk shops were selected using purposive sampling method. Table 4.5 represents sampling methods and sample size used for key players of milk supply chain in Pakistan.

Table 4.5   Sampling Design for Key Players of Milk Supply Chain in Pakistan

Sampling Stage	Sampling Method	Target Population	Selected Sample
Stage 1	Multi-stage area sampling	Pakistan	Punjab province
Stage 2	Multi-stage area sampling	Punjab province	Faisalabad, Lahore and Gujrat districts
Stage 3	Purposive	Faisalabad, Lahore and Gujrat districts	70 dairy farmers, 40 milk collectors and 30 milk shops from each district

Figure 4.3 illustrates the selected districs on the map of Pakistan.

Figure 4.3 Universe of the Study in Pakistan

Source: Adopted from (UN, 2004)

The sampling frame for dairy companies in Pakistan was developed in the light of the information acquired from Pakistan dairy association (PDA), Pakistan dairy development company (PDDC) and other sources in dairy companies. Around 25 dairy companies are operating in Pakistan. All of them were contacted but only 10 of them participated in this study.

The key players of milk supply chain in New Zealand are dairy farmers and dairy companies (as mentioned in chapter 2). Internet survey method was used to gain access to dairy farmers and dairy companies due to time and cost constraints (Zikmund, et al., 2013). For this purpose, qualtrics software was used and the survey link was shared with dairy farmers through their group blog. A total of 50 questionnaires completed by

dairy farmers were used for data analysis. KOMPASS database was used to develop sampling frame for dairy companies in New Zealand. A total of 10 questionnaires completed by respondents from dairy companies were received from dair companies through internet survey.

4.4.4 Hypothesis Testing

The third objective of this study is "to identify and analyse performance gaps between milk supply chains in Pakistan and New Zealand". Gap analysis was performed to compare strategic level SCOR metrics (as shown in table 4.6) for the key players of both milk supply chains. To compare two population means for independent samples two tailed t-test was applied (Weiss, 2012).

Null Hypothesis

H_0: $\mu_1 = \mu_2$ (mean values of a SCOR metric are same for both populations)

Alternate hypothesis

H_1: $\mu_1 \neq \mu_2$ (mean values of a SCOR metric are different for both populations)

Where

μ_1 = mean values of a SCOR metric from table 4.6 for dairy farmers and dairy companies of New Zealand

μ_2 = mean values of a SCOR metric from table 4.6 for dairy farmers, milk collectors, milk shops and dairy companies of Pakistan

Table 4.6   Strategic Level SCOR Metrics

SCOR Performance Attributes	Strategic Level SCOR Metrics
Reliability	Perfect order fulfilment (%)
Responsiveness	Order fulfilment cycle time (hours)
Agility	Upside supply chain flexibility (hours)
	Overall value at risk (%)
Cost	SCM cost (as % of SCR)
	Cost of production (as % of SCR)
Asset	Return on fixed assets (Ratio)
	Return on working capital (Ratio)

For data analysis purpose SPSS version 21 and Microsoft Excel softwares were used.

4.4.5 Validity and Reliability

The validity of a measurement generally means "the extent to which the instrument measures what it is designed to measure" (Wiersma & Jurs, 2009, p. 357). Cooper and schindler (2014) report two major types of validity: external and internal validity. The external validity refers to 'the data's generalized across persons, settings, and time; whereas, the internal validity is the ability of a research instrument to measure what it is purported to measure' (Cooper & Schindler, 2014). On the other hand, reliability refers to "the consistency of the instrument in measuring whatever it measures" (Wiersma & Jurs, 2009, p. 354). Neuman (2006) claims that perfect reliability can rarely be achieved, however, reliability of a measurement instrument can be increased: by clearly conceptualizing the constructs; by using precise level of measurement; by using multiple indicators; and by using pilot survey of the questionnaires.

Apart from the scientific requirements of validity and relaibaility of the measurement instrument, it must be operationally practicle from economic, convienience, and interpretation perspectives. The choice of sampling and data collection method is often dictated by time and budget contraints and administrative capabilities. Testing the validity and reliability of the measurement is dependent on the statistical technique used for data analysis. In this study, a number of research design instruments including larger sample size; calibration of the questionnaires through pilot survey; calibration of the questionnaires with experts of relevant areas; and data collection through face-to-face interviews were used to ensure validity and reliability of the data to the extent possible.

4.4.6 The Research Ethics

The goal of ethics in research is to ensure that no one is harmed or suffers adverse consequences from the research activities (Cooper & Schindler, 2014). Guillemin and Gillam (2004) describe two different dimensions of ethics in research termed as "procedural ethics" and "ethics in practice". The procedural ethics involves seeking approval from a relevant ethics committee through the completion of an application form to undertake research involving humans. They are of the view that procedural ethics describes the measures that researcher/s have put in place in the event of unexpected outcomes or adverse effects. They further argue that firstly, the research ethics committees satisfy an obvious need to protect the basic rights and safety of research participants from obvious forms of abuse. Secondly, it offers researchers an

ethics "checklist" by reminding them to consider such issues as the potential risks to participants, the balancing of the benefits of the research against those risks, the steps needed to ensure confidentiality of data, and the inclusion of consent forms and plain language statements in the material provided to participants. Besides all this, procedural ethics is not the forum in which issues of potential harm and other "ethically important moments" can be fully dealt with.

The second dimension is "ethics in practice" which pertains to the day-to-day ethical issues that arise in doing the actual research (Guillemin and Gillam, 2004). These issues are pervasive and include violating nondisclosure agreements, breaking participant confidentiality, misrepresenting results, deceiving people, using invoicing regularities, avoiding legal liability, and more (Cooper & Schindler, 2014). In this research study the ethical issues in both forms: procedural ethics and ethics in practices are taken care of.

This study adhered to both "procedural ethics" and "ethics in practice". To address the procedural ethics, approval from the Research Ethic Committee of Massey University was taken prior to the data collection. This research study was registered as low risk at register of the Research Ethic Committee of Massey University. To address the ethics in practice, the project debriefing and informed consent were attached to the questinnaires for data collection. Moreover, other forms of ethich in practice such as maintaining the respondent's confidentiality, plagiarism, and fabrication were strictly followed. The approval letter from Research Ethic Committee of Massey University is attached as Appendix-F.

4.6 Pilot Survey

A pilot survey is "a small-scale research project that collects data from respondents similar to those that will be used in the full study" (Zikmund, et al., 2013, p. 54). A pilot survey is helpful in identifying weaknesses of the proposed research instrument (Cooper & Schindler, 2014). Moreover, a pilot survey can provide researcher with the experience of interaction with the respondents and builds a sense of confidence (Bryman, 2008). Saunders et al. (2012) suggest a pilot survey of minimum 10 sample size for an academic research.

A pilot survey was undertaken with the objective to calibrate preliminary questionnaires with first hand information. Moreover, the field visits and interviews with the chain partners enhanced researcher's understanding of the demographic characteristics of

target population and respondents. The key players of both the milk supply chain were interviewed in person with semi-structured questionnaires containing mostly open ended questions. The subsequent section expands on the response from the key players of milk supply chains in Pakistan and New Zealand. The feedback of the respondents from both the supply chains is summarised in the end of this section.

4.6.1 Pilot Survey in Pakistan

The major objective of the pilot study was to test the questionnaires designed to collect data from milk SC players in Pakistan. Initially semistructured questionnaires were developed for face-to-face interviews of SC functionaries such as dairy farmers, milk collectors, milk shops, dairy companies, and grocery retailers. Another objective of the pilot study was to identify the key players and function and activities performed by them in the milk SCN of Pakistan. For this purpose relevant public sector institutions (Pakistan dairy development company), industry associations (Pakistan dairy association), and universities (University of Agriculture, Faisalabad) were visited. The visits to these institutions were aimed at collecting exploratory information about milk systems in Pakistan.

The Pakistan dairy development company (PDDC) is a public-private partnership envisioned to turn Pakistan into one of the top five dairy manufacturing countries in the world. For this purpose, the PDDC aims to meet the needs of dairy farmers, consumers, and the industry. Its key partners in the private sector include packaging companies, dairy processors, and progressive dairy farmers. The model farm and cooling tank programmes of PDDC are successfully in progress. Pakistan dairy association, on the other hand, is representative body of the dairy companies in Pakistan and aims to assist and promote dairy companies and small dairy farmers. The University of Agriculture, Faisalabad is one of the biggest contributor of highly skilled manpower and research and development to the agriculture sector of Pakistan. The university is fulfilling the needs of public as well as private sector by producing graduates in 160 specialized subject related to agriculture.

These vists were helpful in:

- ➢ Understanding the overall structure, business culture, value addition and distribution along the entire chain, and stakeholders operating in the milk SCN of Pakistan.
- ➢ Identifying key operators performing SC functions and activities based on their market share.
- ➢ Locating geographical presence of the target population and how to approach the survey respondents for interview.

In the light of exploratory information acquired from the above mentioned institutions the overall milk system of Pakistan was divided into formal and informal chains. The major players of the informal chain are dairy farmers, milk collectors, and milk shops. The milk collectors source raw milk from individual dairy farms once or twice a day and market it in the local market which is usually a small town or a nearby city. The milk shops represent a wide range of local processors (such as fresh milk shops, cafes, canteens, tea stalls, corner juice shops, decreamers, and sweets and bakers shops) and retailers of milk and milk products.

The major players in the formal chain of milk include dairy farmers, milk collection centres, dairy companies, wholesalers, and retailers. A total of 25 respondents were selected from Faisalabad and Gujrat through convenient sampling and interviewed in person. Table 4.11 shows the operators selected from both the chains for pilot testing of the questionnaires. The dairy farmers respondents included two small, two medium, and one large farmer. Similarly, the milk collectors included two small scale, two medium scale, and one large scale respondents. Whereas, the milk shops included two fresh milk shops, one decreamer, one college canteen, and one tea stall.

Table 4.7   Pilot Survey Respondents

Informal Chain	Respondents	Formal Chain	Respondents
Dairy farmers	5	Milk collection center	1
Milk collectors	5	Dairy companies	1
Milk shops	5	Distributor/Wholesaler	3
		Grocery retail shops	5
Total	15	Total	10

The response from the selected SC operators highlighted various challenges in the data collection in milk SCN of Pakistan. The questionnaires were calliberated for final data collection in the light of these challenges. These challenges are:

1. The vast majority of the dairy farmers, milk collectors, milk shops, wholesalers, and grocery retail shops do not maintain formal accounting records of their business transactions and therefore do not develop periodical financial statements.

2. The dairy farming is predominantly a subsistence level smallholder entreprise with major part of milk production consumed by the farming community itself. Therefore, sales revenue of the dairy farmers is not a true representation of the income generated by dairy activity and should be replaced for the value of total milk produced.

3. The milk collectors were reported to create additional value by diluting the milk with ice or water at the rate of 4 litres per 40 litres of milk and adding some adultrants such as caustic soda, ammonia, urea fertilizer, and water chestnut powder.

4. The respondents from milk collectors and milk shops reported that individual customers prefer switching over to the other retailers for quality constraints rather than complaining formally. This was one of the limitation of measuring product quality in terms of number of complaints per 100 orders fulfilled.

During data collection in Pakistan through semi-structured interviews, a number of problems were faced by the researcher such as:

1. Intercept face-to-face interviews, particularly with milk collectors provided too little time to get sufficient information from the respondents. Therefore, organised interviews were proposed for main data collection.

2. Respondents felt insecure and hesitated to share sufficient and true information with the interviewer. Some respondents such as local processors perceive researcher as a media person who is going to expose their misadventures.

3. There is no system in place to register and maintain record of the incomes of chain functionaries, especially of the milk collector. These SC functionaries also do not pay any tax to the government. Therefore, they perceive a researcher as a tax officer from a government department.

4. Low level of education of the respondents is another issue faced not only while motivating them to participate and share information, but also to make them understand the importance of their information and contents of the questions. Contrarily, the respondents with high education level welcomed and shared sufficient information.

5. The general awareness about food safety standards of the respondents as well as their customers was low compared to the same in New Zealand. For example, the literacy rate (an important indicator of general awareness) of New Zealand according to adult literacy and life skills survey (ALL) 2006 is 93% (Lane, 2011) and that of Pakistan is 60% (Pakistan Bureau of Statistics, 2014).

4.6.2 Pilot Survey in New Zealand

The pilot testing in New Zealand was under taken with the objective to calliberate the questionnaires developed for the key operator of milk SCN of New Zealand in line with the functions and activities performed by the chain operators. For this purpose, three relevant institutions were visited primarily for acquiring secondary information about the milk SCN in New Zealand. Moreover, they were requested to provide help in distributing an online survey link to their member dairy farmers electronically which they declined due to confidentiality of information and privacy rights of their members. Thus, the samples of New Zealand dairy farmers were drawn convieniently. However, for final data collection the questionnaires were sent to the dairy companies through mail.

Apart from the visits to aforementioned institutions, the key SC operators: dairy farmers, dairy processors, distributors, and grocery retail stores were interviewed in person with semi-structured questionnaires. A total of 10 respondents (3 dairy farmers, 2 dairy companies, 2 distributors, and 3 grocery retail stores) were interviewed. These interviews were helpful in identifying the key operators, functions and activities, facilitators and enablers of the milk SCN of New Zealand (discussed in detail in chapter 5). Moreover, the semi-structured questionnaires were finalized as structured with the primary information acquired from the respondents. Furthermore, the porposed sampling farme and data collection method were reviewed for final data collection.

4.7 Summary of Methodology used in this Study

The research methodology used is summarised in figure 4.4. The research process involves selection of appropriate research philosophy and design. Among the three research paradigms, pragmatic (mixed method) approach was selected due to the qualitative as well as quantitative nature of this study. Survey strategy was used to get data of exploratory as well as descriptive nature. To collect cross-sectional primary data, personal interviews were used in Pakistan, whereas online questionnaire for New Zealand population. Samples from both populations were drawn by using a combination of multi-stage and purposive sampling methods. was used and sampling design, data collection, the research model, questionnaires development, and pilot testing of the questionnaires.

Figure 4.4 The Research Methodology Summarised
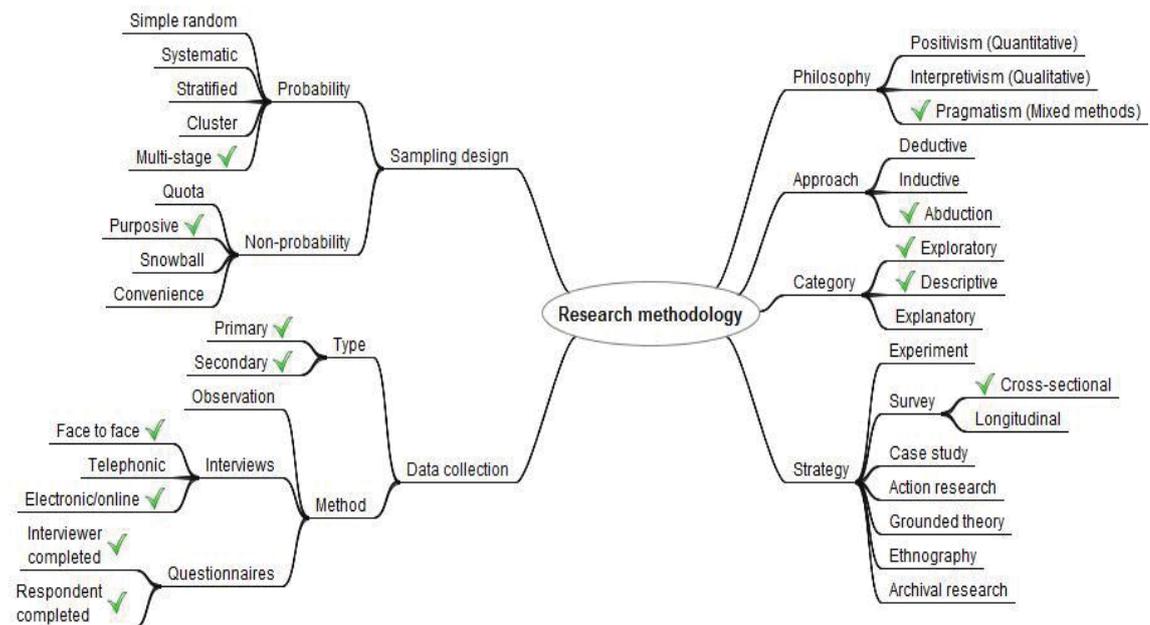
The primary data was collected in two steps. At first step, a pilot survey of the research instrument was conducted in both milk supply chains. The data for pilot survey was collected through face-to-face interviews supported with semi-structured questionnaires. A total of 25 respondents from Pakistan and 10 respondents from New Zealand were interviewed for pilot survey. The final questionnaires were calibrated in line with the feedback from pilot survey.

CHAPTER 5

5. RESULTS

5.1 Introduction

This chapter presents results of the data collected from the key operators in the milk supply chains of Pakistan and New Zealand. Moreover, the results are supported with phenomenological discussion from functions and activities performed by the key players. The chapter is organized into four sections.

- ➢ Section 5.2 provides value chain perspective of both the benchmarking supply chains. The value chain analysis of the milk supply chains of Pakistan and New Zealand include value chain maps and analysis of value distribution along the entire chain.
- ➢ Section 5.3 expands on SCOR metrics for dairy farming in Pakistan and New Zealand. The inherent differences of both the dairy farming systems are discussed phenomenologically.
- ➢ Section 5.4 presents SCOR metrics for key players (milk collectors and milk shops) in informal chain of milk in Pakistan.
- ➢ Section 5.5 comprises of SCOR metrics of dairy companies in Pakistan and New Zealand.

5.2 Value Chain Analysis of Milk in Pakistan and New Zealand

The value chain approach is helpful in understanding structural and dynamic components of a supply chain. The structure of a value chain includes all the firms in the chain whereas dynamics represents the choices these firms make in response to that structure. Value chain analysis (VCA) facilitates an improved understanding of functions and activities performed by chain actors. Moreover, it helps identify relationships among chain actors, coordination mechanisms, and structure of powers and governance in a particular supply chain. The value chain analysis (VCA) of milk supply chains of Pakistan and New Zealand included the value chain maps and analysis of value distribution along the entire network.

5.2.1 Milk Value Chain in Pakistan

Chapter 2 describes that milk supply chain in Pakistan is divided into: the informal chain and the formal chain of milk. The informal chain of milk represents the marketing of unprocessed (fresh) milk and locally processed (into various traditional dairy products) milk. The key SC operators involved in the informal chain of milk are the dairy farmers, the milk collectors, and the milk shops. The formal chain of milk represents the standard processed (pasteurised or UHT tetra pack) dairy products by the dairy companies. The key SC operators in the formal chain of milk are the dairy companies. Figure 5.1 illustrates the SC functions, the activities, the SC operators, the facilitators, and the enablers in the milk supply chain in Pakistan. The dotted arrows represent the weak link between the SC operators.

Figure 5.1 Value Chain Map of Milk Supply Chain Network of Pakistan
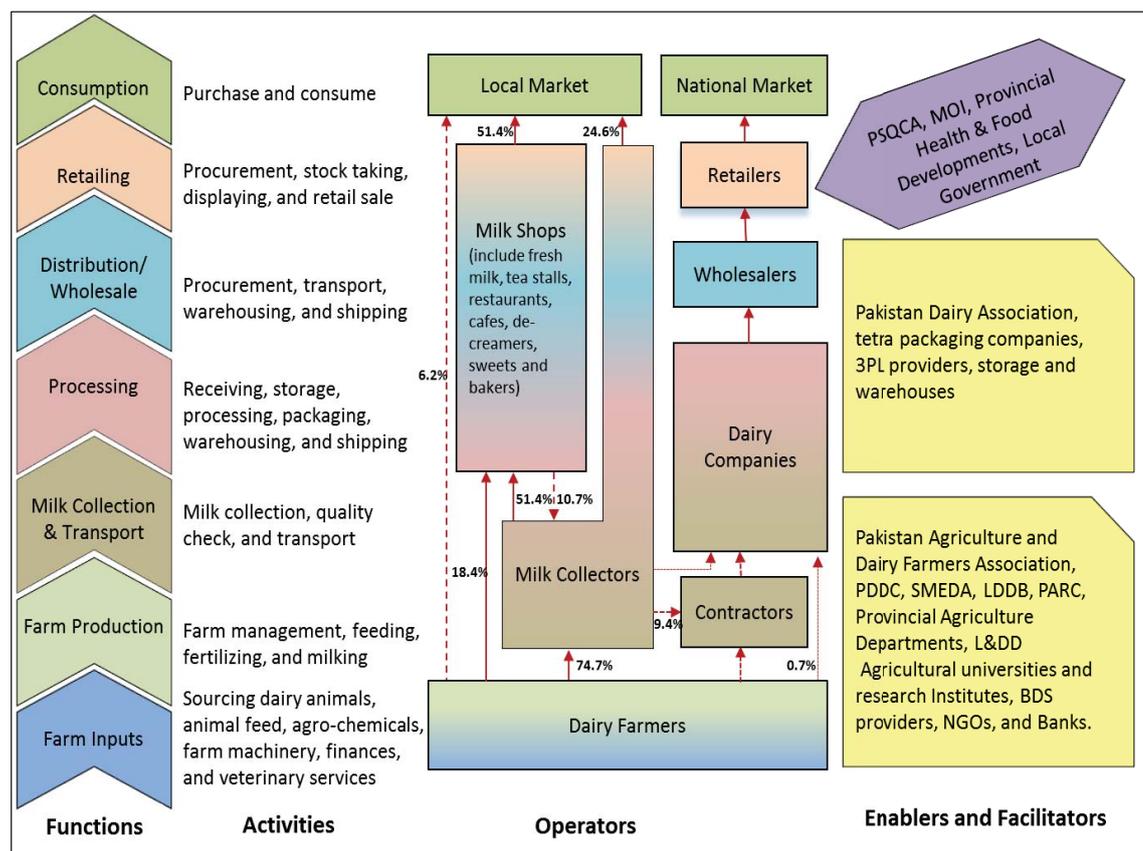
NB: The percentage shares of the operators were calculated from primary data collected in 2012.

Source: Adapted from (Springer-Heinze, 2007)

The SC operators occupy the central role in a value chain map and perform core functions and activities with the support of facilitators and under the regulatory framework from the enablers. The fresh milk in the informal chain reached the urban

consumers through various marketing channels. The common marketing channels reported by the respondents are:

1. Farmer – Neighbourhood + Urban Consumer
2. Farmer – Milk Collector – Urban Consumer
3. Farmer –Milk shop – Urban Consumer
4. Farmer –Milk Collector – Milk shop – Urban Consumer
5. Farmer – Milk Collector – Tea Satlls, Cafes, Canteens, Restaurants, Sweets & Bakers' shops and others traditional processors – Urban Consumer
6. Farmer – Milk Collector – De-creamer –Milk Collector – Urban consumers

The presence of a large number of players make the informal chain more complex as compared to the formal chain. On the other hand, the dairy companies, the key SC operators of the formal chain, had established their own milk collection network. Dairy companies reported to source milk through a combination of suppliers of fresh milk. These sources are:

1. Mega farms – Processor

2. Farmers – Village level milk collection centre (VMCC) – Main milk collection centre (MCC) – Processor

3. Farmers –Milk collectors – Village level milk collection centre (VMCC) – Main milk collection centre (MCC) – Processor

4. Farmers –Milk collectors –Mini Contractors – Processor

5. Farmers – Milk collectors – Mini Contractors – Big Contractors/Strategic Milk Suppliers – Processor

The fresh milk collected at VMCC was assembled at regional milk collection centres from where big tankers delivered it to the processing plants. Dairy companies marketed their finished goods to the retailers through contract distributors who own the product. Dairy companies supplying dairy products at national level divide the country into north zone, central zone, and south zone. The ownership of the product was transferred along the distribution channel.

The facilitators in the milk supply chain in Pakistan represent those associations who perform support activities to help SC operators to perform their functions. These include:

- ➢ Pakistan agriculture and dairy farmers association (PADFA)
- ➢ Pakistan dairy association (PDA)
- ➢ Pakistan dairy development company (PDDC)
- ➢ Livestock and dairy development board (LDDB)
- ➢ Small and medium enterprise development authority (SMEDA)
- ➢ Pakistan agricultural research council (PARC)
- ➢ Provincial livestock and dairy development departments (L&DD)
- ➢ Provincial agriculture departments
- ➢ Agriculture sector universities
- ➢ Non-governmental organizations (NGOs)

The enablers in dairy value chain in Pakistan are the government agencies responsible to regulate and enforce legislative laws. These involve:

- ➢ Pakistan standards and quality control authority (PSQCA)
- ➢ Provincial food departments
- ➢ Provincial health departments
- ➢ Local governments

The analysis of value distribution along the entire value chain is another concept to gauge the level of overall value addition as well as the individual share of the value captured by various SC operators. Figure 5.2 represents the share of value per litre of milk received by each SC operator in the informal chain of milk in Pakistan.

Figure 5.2 Distribution of Value in Informal Chain of Milk in Pakistan
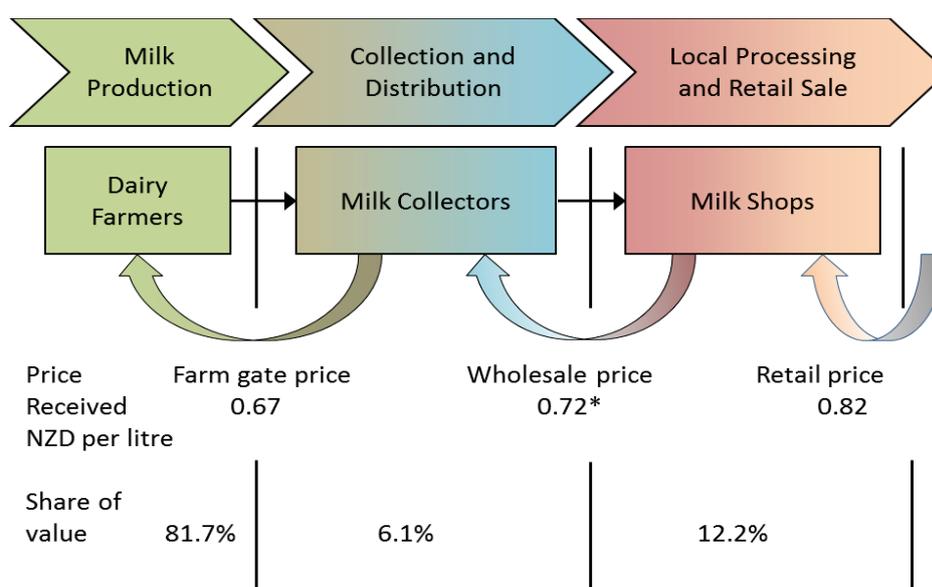
Source: Industry interviews 2012

The largest share (almost 82%) of the overall value was received by the dairy farmers. This concentration of value at one interface of the chain shows; high cost of milk production, diseconomies of the scale; and least level of value addition by the SC operators. Moreover, the informal chain of milk in Pakistan had 22.39% ex-farm gate value addition.

Figure 5.3 illustrates the distribution of value along the formal chain of milk in Pakistan. The farm gate price was the same as for the informal chain but with different farmer's share of value (51%). This difference in the share of farmer receiving the same price was due to the higher level of value addition (104.23% ex-farm gate) in the formal chain of milk in Pakistan.

Figure 5.3 Distribution of Value in Formal Chain of Milk in Pakistan
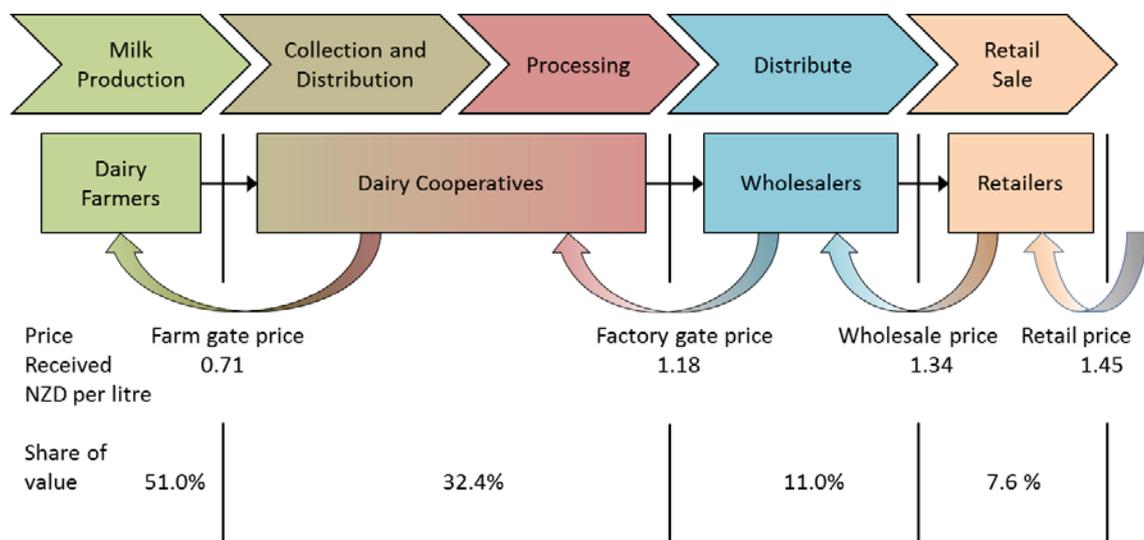
Source: Industry interviews 2012

5.2.2 Milk Value Chain in New Zealand

The dairy industry in New Zealand is predominantly a cooperative enterprise owned by the farmers. The success of New Zealand dairy lies in its natural environment which provides basis to its low cost pasture based dairy production system. Moreover, New Zealand's best-in-class standards of food safety and animal welfare ensure highest quality of milk right from point of production through to the shelf of retail stores. It is due to these food safety standards that New Zealand enjoys strong position in global dairy industry with well established brands. Figure 5.4 portrays the value chain of milk in New Zealand.

The key operators of the milk supply chain in New Zealand included the dairy farmers, the dairy companies, and an integrated network of distributors and retailers. The dairy farmers supplying milk to the dairy cooperatives had to buy cooperative's shares equal to the number of kilograms of milk solids to be supplied. The wealth generated by the cooperatives was distributed among the member farmers in the form of price of milk and dividend per share. The private dairy companies, on the other hand, did not require the dairy farmers to buy shares to supply milk.

Figure 5.4 Value Chain Map of Milk Systems in New Zealand
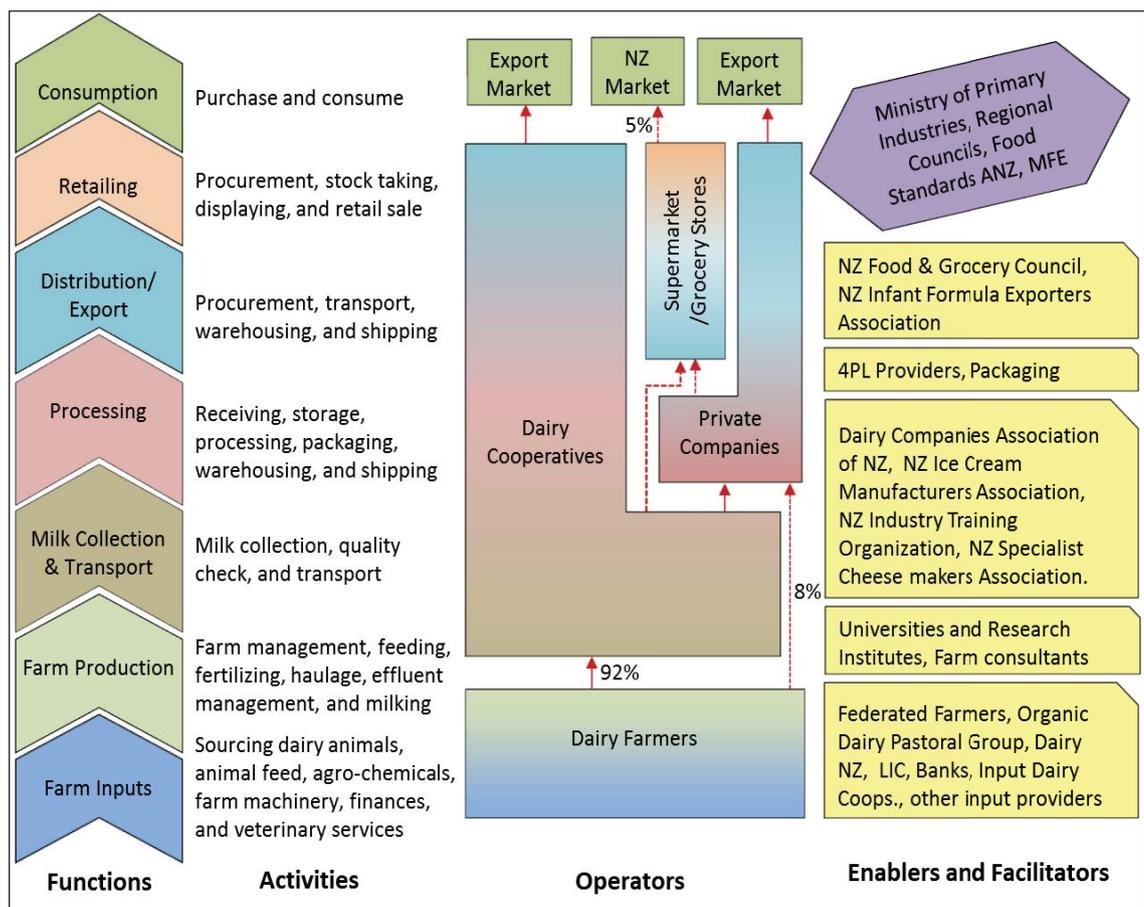
NB: The percentage share of the operators for year 2013 was retrieved from (Coriolis, 2014).

Source: Adapted from (Springer-Heinze, 2007)

In 2013, almost 92% of the milk produced was collected by four dairy cooperatives. The rest of 8% of raw milk was collected by four private companies. The rest of all the private dairy companies sourced raw milk from the Fonterra. According to Statistics New Zealand (2014a) there were 139 dairy processing companies in 2013. The dairy cooperatives provided a set of services to support dairy farmers and industry as a whole

in coordination with other organizations such as DairyNZ and livestock improvement corporation (LIC). These services included those environmental and food safety requirements that assist dairy farmers in meeting regulatory requirements. These services include: annual farm dairy and environmental, assessment; milk quality support; milk temperature management; mastitis support; animal health and welfare; effluent management; nitrogen management; waterway management; and water use management (Fonterra, 2014).

The facilitators perform support functions to help SC operators perform their primary functions effectively. These facilitators were:

- ➢ Federated farmers (association of farmers in New Zealand)
- ➢ Organic dairy pastoral group
- ➢ Dairy NZ
- ➢ Livestock improvement corporation (LIC)
- ➢ Banks and financing institutions
- ➢ Input dairy cooperatives
- ➢ Farm input providers
- ➢ Universities and research institutions
- ➢ Farm consultants
- ➢ Dairy companies association of New Zealand (DCANZ)
- ➢ NZ ice cream manufacturers association
- ➢ NZ industry training organization
- ➢ NZ specialist cheese makers association
- ➢ Third party (3PL) and fourth party (4PL) logistic providers
- ➢ Packaging companies
- ➢ NZ food and grocery council
- ➢ NZ infant formula exporters association

The enablers represent the public sector organizations (ministries or departments) who regulate the functions performed by the operators and facilitators by developing and enforcing legislative laws. The enablers in the milk supply chain in New Zealand were:

- ➢ Ministry of Primary Industries (MPI)
- ➢ Regional councils
- ➢ Food standards Australia New Zealand (FSANZ)

➢ Ministry for the Environment (MFE)

The New Zealand milk supply chain was completely formal, which means all the milk produced in New Zealand is processed before it reaches the ultimate consumers. Figure 5.5 represents the distribution of value along the entire chain of milk in New Zealand. The dairy farmer's share of value (31.6%) was less than that of the retailers (55.6%) due to higher level of value addition, greater power of retailers, and least cost of milk production due to pasture-based production system and economies of the large scale production. The ex-farm gate value addition level in the milk supply chain in New Zealand was 216.83% which is significantly higher than the informal as well as the formal chain of milk in Pakistan.

Figure 5.5 Distribution of Value in Milk Supply Chain in New Zealand
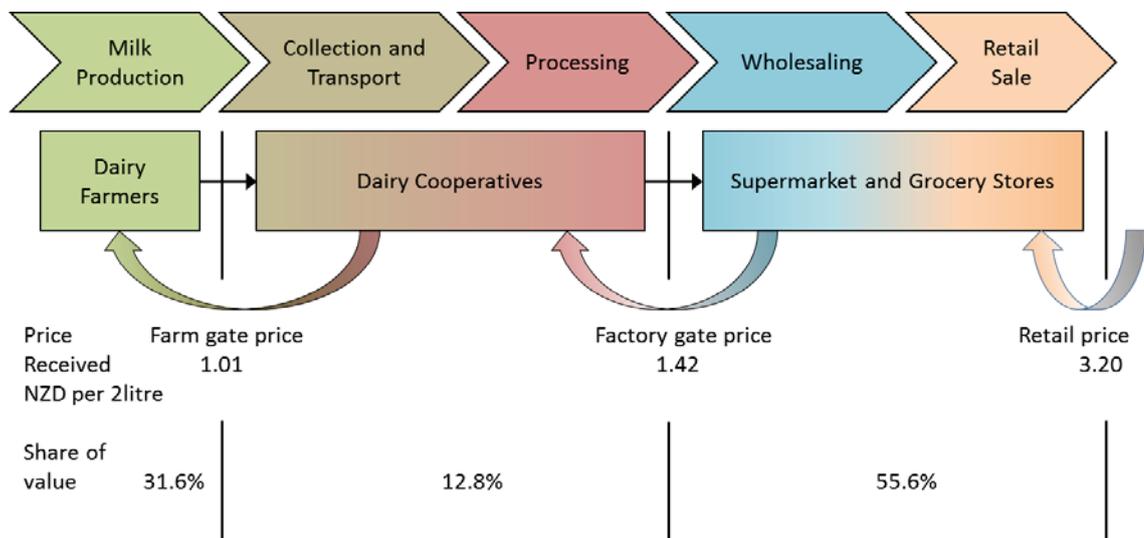
Source: (Fonterra, 2013; Statistics New Zealand, 2014b)

5.3 SCOR Metrics For Dairy Farmers in Pakistan and New Zealand

This section is further divided into two sub sections; dairy farming in Pakistan; and dairy farming in New Zealand. The first subsection expands on demographic characteristics and analysis of SCOR metrics for the selected dairy farmers in Pakistan. Similarly, the second subsection includes demographic features and analysis of SCOR metrics for the respondent dairy farmers in New Zealand.

5.3.1 Dairy Farming in Pakistan

In Pakistan, the dairy farming has been deeply embedded in socio-economic settings of the rural life. The highly fragmented agriculture sector is characterised as smallholder mixed (crop and livestock) farming. Dairy farming in Pakistan is mainly practiced in irrigated areas of the Indus basin. There are some high density milk supply pockets in Punjab and Sindh provinces. Most of these milk supply pockets are located around the peri-urban areas of metropolitan cities such as Karachi, Lahore, and Faisalabad where most of the milk processing plants are located. Dairy farming is practiced as complementary to crop farming mainly as a tool to mitigate the effects of poverty by providing food, income and employment for the family labour, organic manure for crop farming, and source of fuel in the form of animal dung cakes or bio gas. Among the dairy animals water buffalos and cattle are the major sources of milk. The prevalent dairy production systems in Pakistan are discussed in detail in chapter 2.

A   Demographic Characteristics of Selected Dairy Farmers in Pakistan

The demographic characteristics such as farm size, farming experience, and education level of the respondents are important factors in terms of supply chain performance in dairy farming. The farming experience spans the entire life of majority of the Pakistani farmers as they inherit this profession from their forefathers. A sample size of 210 dairy farmers was selected from three high milk producing districts of Punjab province of Pakistan. These districts were Gujrat, Faisalabad, and Lahore. Seventy dairy farmers in each district were approached in person at their dairy farms to collect the first hand information about their routine dairy farming operations. Table 5.1 represents the farm size of the selected farmers on the bases of their herd size.

Table 5.1   Farm Size of Selected Dairy Farmers in Pakistan

Farm Size	Frequency	Percent
Less than 5 dairy animals	80	38.1
5 – 10 dairy animals	52	24.8
More than 10 dairy animals	78	37.1
Total	210	100.0

Farming experience of the selected farmers is shown in Table 5.2. Almost 33 % of the selected farmers had more than 21 years of farming experience, followed by 27.6% with

11-20 years of experience; 21.9% with 0-5 years of experience; and 17.6% with 6-10 years of experience.

Table 5.2 Farming Experience of Selected Dairy Farmers in Pakistan

Farming Experience	Frequency	Percent
0 – 5 years	46	21.9
6 – 10 years	37	17.6
11 – 20 years	58	27.6
21 years and above	69	32.9
Total	210	100

The education level of a person is perceived to have positive relationship with performance level. Most of the selected farmers reported that they inherited farming as profession of their forefathers and therefore, they were in this profession since their childhood. Table 5.3 shows that over half (56.2%) of the dairy farmers had abandoned their formal education after ten years of schooling whereas a number of them (31%) had no formal education.

Table 5.3 Education Level of Dairy Farmers in Pakistan

Education Level	Frequency	Percent
No formal education	65	31.0
School certificate (10 years schooling)	118	56.2
Intermediate or diploma level	14	6.7
Degree	13	6.2
Postgraduate degree or diploma	0	0
Total	210	100.0

The selected farmers reported that they had freedom of choice between a number of options to sell their produce (fresh milk) to and preference was given to those customers offering higher milk prices and paying in cash. Table 5.4 shows the marketing channel based on dairy farmers' decision making in selecting appropriate customer for their produce. The majority (almost 75%) of the respondents sold milk to the milk collectors. Among the remaining, 18 % of the selected farmers delivered fresh milk to the milk

shops. The respondents reported an increasing trend of backward integration (a type of vertical integration in which a business entity takes control over its suppliers) by the milk shops to assure product quality.

Table 5.4   Marketing Chain of Selected Dairy Farmers in Pakistan

Supply Chain Partners	Milk Sold Daily (litres)	Percentage
Milk collector	19,878	74.7
Neighbourhood	124	0.5
Milk shop	4,896	18.4
Urban household	1,522	5.7
Others	188	0.7
Total	26,608	100

The dairy farmers preferred to supply milk to the milk collectors mainly due to following reasons. First, milk collectors collect milk from the farm gate and dairy farmers do not have to deliver milk to customer's place. This option saves dairy farmers' precious time which they spend on their routine farming activities. Second, milk collectors pay weekly, fortnightly, or monthly as per dairy farmer's convenience. Third, in some cases milk collectors pay a certain amount to the dairy farmers in advance to ensure uninterrupted milk supply during off-peak season.

B   Analysis of SCOR Metrics for Selected Dairy Farmers in Pakistan

The selected SCOR metrics and the criteria for selection have been discussed in methodology chapter. However, the caveats in calculating individual metrics for different SC operators are discussed in this chapter as required. The individual SCOR metrics and their interpretation for Pakistani dairy farmers are discussed as follows.

RL.1.1 Perfect Order Fulfilment (POF)

For the calculation of POF for dairy farmers, two level-2 metrics were found relevant. These are:

➢ *RL.2.1 Percentage orders delivered in full*
➢ *RL.2.4 Perfect condition*

RL.2.1 Percentage Orders Delivered in Full

To calculate this metric for dairy farmers in Pakistan, one level-3 SCOR metric namely delivery quantity accuracy was found relevant. The percentage orders delivered in full for the selected farmers in Pakistan are shown in table 5.5.

Table 5.5   The Percentage Orders Delivered in Full by Selected Dairy Farmers

Percentage Orders Delivered in Full	Frequency	Percent
Less than 80%	3	1.4
80 – 90%	12	5.7
Above 90%	195	92.9
Total	210	100

The mean value was 97.8%. The vast majority (almost 93%) of the respondents fulfilled over 90% of the total orders received from customers. The reasons for not fulfilling all the orders included occasional excess calving and excess demand from neighbourhood or household on special events.

RL.2.4 Perfect Condition

To calculate perfect condition for the Pakistani dairy farmers, two level-3 metrics were applicable. These are:

> ➢ *RL3.60 Percentage quantities delivered with product quality compliance*
> ➢ *RL3.61 Presence of quality assurance system (QAS)*

The product quality incorporates the mutually acceptable level of freshness, sensory properties and the presence of inhibitory substances, product safety, and fat contents by both the parties. To measure the percentage orders of milk delivered to the customers with product quality compliance, the respondents were asked what percentage of their sales orders were rejected by the customer or received complaints for above mentioned quality criteria? Table 5.6 represents the quality of milk sold by the respondents. The mean value of product quality was 90.9%.

Table 5.6   Percentage Quantities Delivered with Product Quality Compliance

Product Quality *(%)*	Frequency	Percent
Less than 80%	11	5.2
80 – 90%	93	44.3
Above 90%	106	50.5
Total	210	100

The quality assurance of the agri-food products starts at farm production stage. The presence and enforcement of a quality assurance system is necessary to ensure the product quality compliance at all the processes of farm production. In broader perspective, the process quality under a quality assurance system includes the adherence of its production system, product handling and transportation, and environmental aspects to standard quality compliance. In dairy production these processes include animal health and quarantine, effluent management, feed and fodder management, water facilities, vaccination and breeding program, chemicals and fertilizer application, and milking and milk handling facilities. The process quality is measured in terms of presence or absence of a QAS. To investigate the presence of a quality assurance system in dairy farming system of Pakistan, the selected farmers were asked whether any public or private agency performs quality assurance audit of their farm. All the respondents replied negatively, which represents the absence of quality assurance system at Pakistani dairy farms.

RS.1.1 Order Fulfilment Cycle Time (OFCT)

For the calculation of OFCT for dairy farmers in Pakistan two level-2 metrics were applicable. These are:

- ➢ *RS.2.2 Make cycle time*
- ➢ *RS.2.3 Deliver cycle time*

The OFCT is not always equal to the sum of cycle times for five processes Plan, Source, Make, Deliver, and Return. The calculation of order fulfilment cycle time varies across the three process configurations namely make-to-stock, make-to-order, and engineer-to-order. For example make-to-stock processes are continuous in nature and more than one activity can be performed simultaneously, therefore, the order fulfilment cycle time for

such process is usually the time between order placement and order received by the customer. There were some caveats in calculating order fulfilment cycle time for the dairy farming activities. Unlike manufactured goods, milk production involved a certain dwell time to fulfil customer orders. The dwell time for dairy farmers was the time between two milking times or two milk order supplies. Thus, the major portion of order fulfilment cycle time for dairy farmers was dwell time.

> *Order Fulfilment Cycle Time = Order Fulfilment Process Time + Order Fulfilment Dwell Time*

For once a day milking, the dwell time is 24 hours whereas for twice a day milking it is 12 hours. In this case all the respondent dairy farmers reported that they used to milk dairy animals twice a day. Therefore, the make cycle time was 12 hours. However, deliver cycle time was not necessarily the same as make cycle time because some of the dairy farmers deliver once a day. Table 5.7 represents deliver cycle time for selected dairy farmers in Pakistan. The mean value of deliver cycle time was 14.32 hours.

Table 5.7 Deliver Cycle Time of Selected Dairy Farmers in Pakistan

Deliver Cycle Time (hours)	Frequency	Percent
Up to 12 hours	169	80.5
Above 12 hours	41	19.5
Total	210	100

The overall order fulfilment cycle time of dairy farmers in Pakistan was the same as of their deliver cycle time. The justification is that all milk production took place between two consecutive milk supplies.

AG.1.1 Upside Supply Chain Flexibility

To measure the upside SC flexibility for dairy farmers in Pakistan, one level-2 SCOR metric was applicable. This is:

> ➢ *AG.2.3 Upside flexibility (Deliver)*

The selected dairy farmers were asked whether they used to respond to any unusual increase in demand of fresh milk by their customers. The majority (almost 67 %) of the respondents reported that they didn't respond to any change in demand. However, the

remaining 33% reported that they did respond and had the ability to fulfil an extra demand within 24 hours. In case the unusual increase in demand persisted longer (which is unrealistic in the milk SC), they would have bought more animals in the long run. The respondents reported that they usually sell dried animals and purchase more high yielding animals in order to optimise operational cost and to cope with increase in demand in the long run.

AG.1.4 Overall Value at Risk (VAR)

The SCOR model measures the effect of risk in terms of overall value at risk (VAR) which represents the aggregate of VAR for individual supply chain processes (e.g. Plan, Source, Make, Deliver, and Return). Table 5.8 represents VAR for the selected dairy farmers in Pakistan. Five respondents reported that they did not face any type of risk. Over half (51%) of the respondents reported that the overall value of their business at risk was in the range of 5 – 10%. The mean value was 9.25%.

Table 5.8   Overall Value at Risk of Selected Dairy Farms in Pakistan

Value at Risk	Frequency	Percentage
Less than 5	47	22.9
5 – 10	105	51.2
Above 10	53	25.9
Total	205	100
Missing value	5	2.4

Among various forms of risk reported by the respondents, absence of quality assurance system at the dairy farm was the biggest issue and root cause of majority of the problems. On the ground, there was no government agency responsible to ensure milk quality at dairy farm level. The existing food safety legislation was inadequate in coping with the present and future market demands as well as opportunities in the areas of product and process quality compliance.

The veterinary services provided by the government were also not satisfactory. There was one veterinary health centre at each union council level with one veterinary doctor and one assistant/technician. Farmers had to bring their sick animals to the centre and pay for the publically subsidized veterinary services including medicines. The

respondent dairy farmers reported that the medicines and vaccinations available at the veterinary health centres were of poor quality. Some of the respondents also reported few traditional methods commonly used by the dairy farmers to diagnose animal health and disease. Some other respondent farmers preferred to call a private practicing doctor instead of transporting the sick animal(s) to the government veterinary hospital. They were of the view that paying some extra money to buy quality medicines and ease up with the difficulty in transporting animals to the health centre.

A number of respondent farmers reported that seasonal fluctuation of demand and supply of milk seriously affected their dairy farms' income. This phenomenon has been reported by the previous researchers as well. Figure 5.6 shows the average availability of green fodder per animal per day in Pakistan. The decrease in fodder production in the months of peak summer (May-July) and peak winter (November-January) results in decreased milk supply. Moreover, being a sub-tropical country Pakistan is characterised by extreme seasonal variations. Peak summers are as hot as 52°C which has direct effect on animal health and productivity.

Figure 5.6   Seasonal Availability of Green Fodder in Pakistan
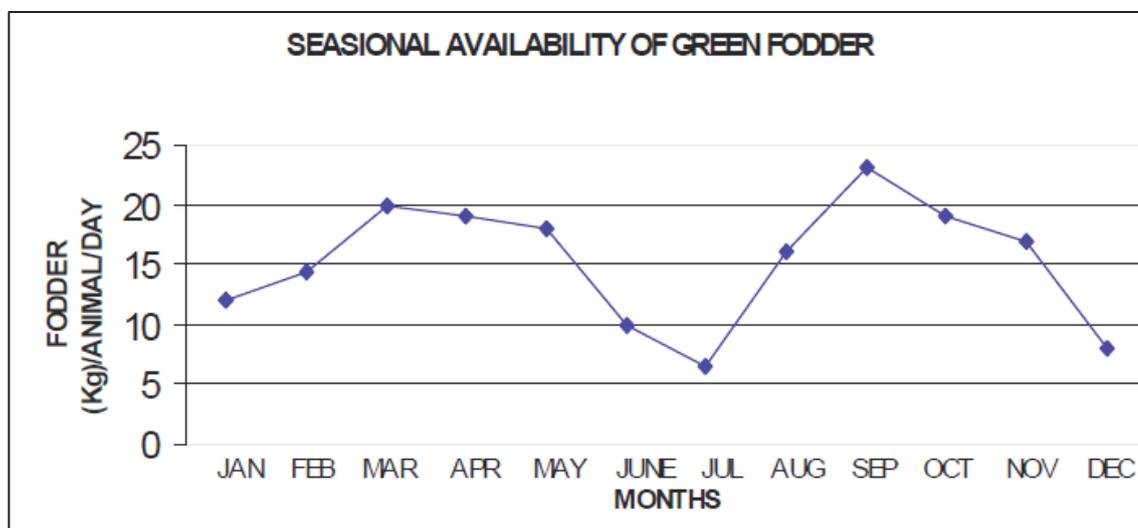
Source: (Sarwar, et al., 2002; Wynn et al., 2006)

The variation in fodder production had a direct effect on milk production. Figure 5.7 shows the seasonal fluctuation in demand and supply of milk in Pakistan. The other risk factors reported by the selected dairy farmers included higher prices and inferior quality of the farm inputs. Farm inputs such as fertilizers, feed, farm machinery, power, labour, etc. make up the overall cost of production. The presence of big cartels and mafias in the fertilizer and feed industry used to exploit farmers through black marketing,

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hoarding, and adulteration. These mafias artificially raise input prices at the time when the crop is at critical growth stage. Moreover, the ongoing power cuts for as long as 18 hours a day had adverse effects on routine dairy farming activities such as chopping fodder for the animals, providing drinking water, air conditioning the shed/paddock. This problem of power shortage increased the direct labour cost significantly, as other sources of power generation are highly expensive.

Figure 5.7 Seasonal Demand and Supply of Milk in Pakistan Dairy Industry
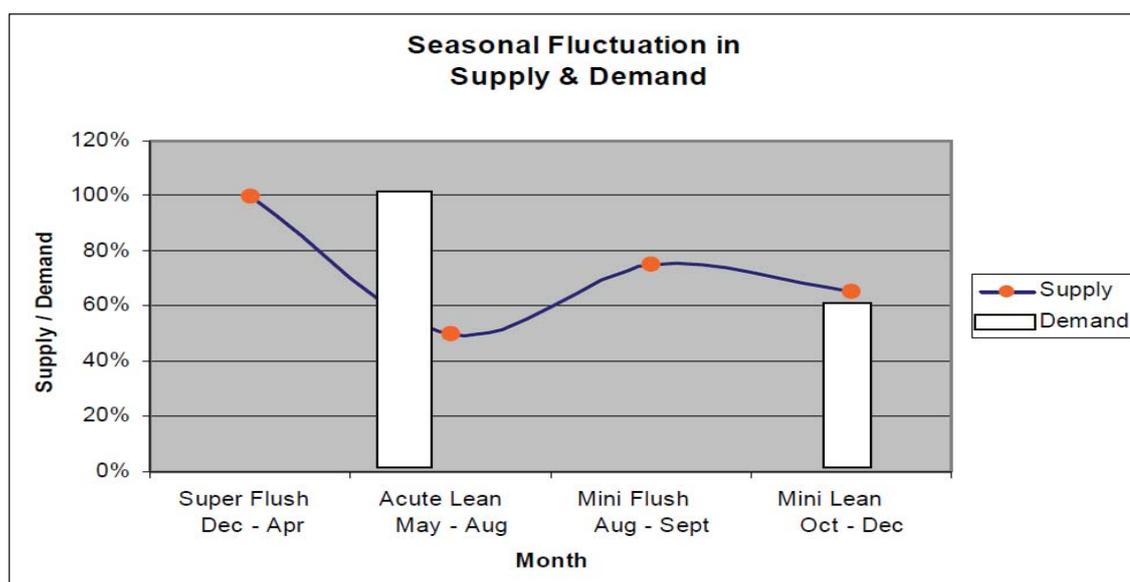
Source: (Zia, 2006)

The farmers reported some individual level issues as risk to their income from dairy activities. These were:

➢ Milk collectors run away with farmers account receivables
➢ Occasionally excess calving
➢ Some animals had prolonged dry period
➢ Animal theft

The selected dairy farmers reported some best practices used to mitigate the effects of risk. For example, dairy farmers operating at commercial level had contracted with private veterinary doctors in order to vaccinate dairy animal. Some others used oxytocin injections to boost milk production. To optimise operational costs dairy farmers used to sell dried animals and purchase high yielding animals. Buying farm inputs in bulk and store them was another best practice to cope with the price fluctuations, particularly, in the peak demand season. Bulk buying allowed them to negotiate on the prices.

Moreover, the dairy farmers mentioned to use feed mixtures of least cost and of high productivity. To deal with the customers (the milk collectors in most cases), the farmers preferred advance payments for their milk as a security.

Supply Chain Costs

The SCOR model divided supply chain costs into SCM cost and cost of goods sold (COGS). Calculating the supply chain costs for Pakistani dairy farmers was different from the New Zealand dairy farmers. In New Zealand, 100% of the milk produced on a dairy farm was supplied to the dairy cooperative, whereas, in Pakistan, the major proportion of the milk produced was consumed at farm (by the farmer and other farm workers). The majority of the respondents reported that they rear dairy animals primarily to fulfil their household consumption needs and the milk excess to their needs was sold. This highlights a possible caveat in calculating supply chain costs as percentage of supply chain revenue (SCR). For this study, the value of total milk produced at dairy farm (it includes milk consumed by farm household plus milk sold in the market) was considered as supply chain revenue, instead of just sales revenue.

CO.1.1 Supply Chain Management Cost

The SCM cost is the sum of all the costs associated with processes Plan, Source, Make, Deliver, and Return. The information required to calculate SCM cost was retrieved from following level-2 metrics:

- ➤ *CO.2.1 Cost to Plan*
- ➤ *CO.2.2 Cost to Source*
- ➤ *CO.2.3 Cost to Make*
- ➤ *CO.2.4 Cost to Deliver (if applicable)*
- ➤ *CO.2.7 Mitigation Cost*

The "Cost-to-Plan" for Pakistani dairy farmers accounted for all the administrative expenses such as managers' salary. Majority of the small farmers worked as manager-cum-worker and their salaries were estimated in terms of the opportunity cost based on the comparative wage rates in the labour market. For manager-cum-worker dairy farmers, half the opportunity cost was accounted for administrative expenses and the remaining half accounted for in the Cost-to-Make as direct labour. Having known that the majority of the smallholder and rural farmers used to rear dairy animals as a side business to crop farming, their opportunity cost for the dairy farming was allocated as half for dairy farming and half for crop farming.

The Cost-to-Source included all those expenses incurred to source farm inputs exclusive of the product price such as, material acquisition cost and supplier management cost.

The 'Cost-to-Make' (also referred as COGS) includes direct labour, direct material, and indirect production related costs. The 'Mitigation Cost' included all those expenses incurred on minimising risks such as animal diseases, animal and building insurance and all other types of risks mentioned earlier in the value at risk metric. Among the selected farmers, none of them used animal and building insurance. In fact there was no livestock insurance service available. The 'Cost to Deliver' was applicable only to those dairy farmers who used to deliver milk to the customer's place. This includes transportation cost and customer management cost. The 'Cost to Return' did not apply to the dairy farmers. Table 5.9 shows the SCM cost of selected dairy farmers in Pakistan. The SCM cost of almost 47% of the selected farmers was less than 5% of SCR. The mean value of SCM cost of dairy farmers was 7.55%.

Table 5.9   Supply Chain Management Cost of Pakistani Dairy Farmers

SCM Cost *(as % of SCR)*	Frequency	Percentage
Less than 5%	99	47.1
5 – 10%	39	18.6
Above 10%	72	34.3
Total	210	100

CO.1.2 Cost of Goods Sold (COGS)

The COGS for dairy farms may also be termed as cost of production. The cost of production of dairy farmers includes direct labour, direct material, and indirect production related costs. The direct material for the selected dairy farmers in Pakistan included the dairy animals, feed cost, veterinary expenses, and vaccination and breeding expenses. The indirect production related costs include fuel and electricity expenses, depreciation of fixed and semi-fixed assets. Table 5.10 shows that cost of production as percentage of SCR for majority (75%) of the respondents was in the range of 50.1% - 80%. However, the mean value for cost of production as percentage of SCR of selected dairy farmers in Pakistan was 59.11%.

Table 5.10 Cost of Production of Selected Dairy Farmers in Pakistan

Cost of Production (as percentage of SCR)	Frequency	Percentage
Less than 50%	41	19.5
50 – 80%	158	75.3
Above 80%	11	5.2
Total	210	100

AM.1.2 Return on Supply Chain Fixed Assets

Return on SC fixed assets measures the return an organization receives on its invested capital in supply chain fixed assets. The SC fixed assets of dairy farms in Pakistan included land, building, and farm machinery and equipment. The respondents were asked to value the fixed assets of their farms according to average market prices of the similar assets in that geography. Table 5.11 shows the fixed assets of the selected farms in Pakistan in detail. The mean value of supply chain fixed assets was 31,292 NZD. To calculate SC revenue for the selected dairy farmers in Pakistan, total milk product (TMP) was used instead of sales revenue.

Table 5.11 Supply Chain Fixed Assets of Selected Dairy Farmers in Pakistan

Fixed Assets (in NZD)	Frequency	Percentage
Less than 10,000 NZD	38	18.1
10,000 – 20,000 NZD	71	33.8
Above 20,000 NZD	101	48.1
Total	210	100

NB: NZForex 2013 yearly average exchange rate of PKR to NZD (0.013138) was used for currency conversion.

Table 5.12 shows the return on fixed assets of selected farmers in milk supply chain in Pakistan. Almost 58% of the selected farmers had less than 0.5, followed by 29.5% (in the range of 0.51 – 1.0) and 15% (above 1.0) return on SC fixed assets.

Table 5.12 Return on Fixed Assets of Selected Dairy Farmers in Pakistan

Return on Supply Chain Fixed Assets	Frequency	Percentage
Less than .50	117	55.7
0.51 – 1.0	62	29.5
Above 1.0	31	14.8
Total	210	100

AM.1.3 Return on Working Capital

Return on working capital is a measure of revenue generated from the working capital investment by a company. To calculate working capital for dairy farms in Pakistan, three level-2 metrics inventory, accounts receivable, and accounts payable were used. The major components of dairy farm inventory were livestock, feed inventory, and farm machinery and equipment. The mean value of inventory was 27,979 NZD. The volume of accounts receivable of the selected farmers was determined by the mode payment mutually agreed with the customers. Table 5.13 shows the mode of payment opted by the dairy farmers in Pakistan. The cash-to-cash cycle time for cash payments was 1 day and for credit payments in the range of 1 week to 1 month.

Table 5.13 Mode of Sales Transaction of Dairy Farmers in Pakistan

Mode of sales	Frequency	Percentage
Cash (or cheque)	33	15.7
Cash (or cheque) and credit	93	44.3
Credit	84	40.0
Total	210	100

The respondents reported that mode of payment for transaction was largely determined by two factors. First, "who is the customer?" if the customer is a milk collector or a milk shop, then second option (a combination of cash and credit) was their preferred mode of payment. A proportion of the total payment was received as cash which was needed by the farmer for operating expenses whereas the remaining amount was received on weekly, fortnightly, or monthly basis as mutually agreed by both parties.

However, if the customer was a neighbour or urban household then payment was received on monthly basis.

Second, the milk supply volume is used a tool to bargain on price settlement. The farmers with higher milk supply volume have higher degree of bargaining power and vice versa. The large scale milk collectors often advance payment to the farmers at the rate of approximately NZD 1300 per 40 litres of daily milk supply to retain suppliers permanently. The milk collectors use this as a risk management strategy to deal with seasonality of demand and supply. Dairy farmers on the other hand demand advance payment to avoid losing accounts receivable, as there were many stories of milk collectors running away with farmers' accounts receivable. The large dairy farmers with higher value at risk usually prefer to transact through banks (and not in cash) and be paid daily or weekly as per mutual agreement. Small farmers, on the other hand, were at the disposal of their customers (particularly the milk collectors and the milk shops) regarding price settlement and mode of payment. The mean value of accounts receivable outstanding was 975 NZD.

Accounts payables of a dairy farm business included all the outstanding payments to the suppliers of farm inputs such as feed, fertilizer, vaccination and veterinary services, animal husbandry, power and energy, livestock purchases, wages and salaries, farm machinery, and advance payment from the buyers. The mean value of accounts payable outstanding was 1394 NZD. Table 5.14 represents the working capital of selected dairy farmers in Pakistan. The mean value of working capital was 28,049 NZD.

Table 5.14 Working Capital of Selected Dairy Farmers in Pakistan

Fixed Assets (in NZD)	Frequency	Percentage
Less than 10,000 NZD	94	44.8
10,000 – 20,000 NZD	41	19.5
Above 20,000 NZD	75	35.7
Total	210	100

NB: NZForex 2013 yearly average exchange rate of PKR to NZD (0.013138) was used for currency conversion.

Return on working capital is a supply chain profitability ratio which helps the management team to prioritize the critical activities in the business and thus reallocate the resources accordingly. Table 5.15 quantifies return on working capital and shows

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that the majority (58.6%) of the selected farmers had less than 0.5 ratio of return on working capital.

Table 5.15 Return on Working Capital of Selected Dairy Farmers in Pakistan

Return on Working Capital	Frequency	Percentage
Less than .50	123	58.6
0.51 – 1.0	67	31.9
Above 1.0	20	9.5
Total	210	100

Overall, dairy farming in Pakistan is predominantly a smallholder enterprise and practiced as a side business of crop farming. Milking of dairy animals is done manually and there is no installed capacity of milk storage at controlled temperature at farm level. Dairy farmers operate at diseconomies of the scale due to which they cannot afford modern farming technologies.

5.3.2 Dairy Farming in New Zealand

The dairy farming in New Zealand is predominantly a cooperative based business. The low cost pasture based production system is highly dependent on weather conditions. The trends in herd size and prevalent dairy production systems are mentioned in the background chapter. This section expands on demographic characteristics and SCOR metrics of the respondent dairy farmers in New Zealand.

A. Demographic Characteristics of Respondent Dairy Farmers in New Zealand

The demographic characteristic of the respondent dairy farmers are related to overall business performance. The respondents were asked for their role at the farm. Table 5.16 represents the respondents' position at dairy farm. The majority of the respondents were farm owners.

Table 5.16 Position of Respondent Dairy Farmers in New Zealand

Respondents' Position	Frequency	Percent
Farm Owner	32	64.0
Share Milker	7	14.0
Farm Manager	11	22.0
Total	50	100.0

Dairy farming experience was an important factor in enhancing their managerial skills which affect the overall productivity of the business. Table 5.17 shows the farming experience of the repondent dairy farmers in New Zealand. Nearly half (46%) of the respondents had more than 20 years of dairy farming experience.

Table 5.17 Farming Experience of NZ Dairy farmers

Farming Experience	Frequency	Percent
0 – 5 years	4	8.0
6 – 10 years	7	14.0
11 – 20 years	16	32.0
Above 20 years	23	46.0
Total	50	100

The formal education is one of the important demographic characteristics which can be used to assess managerial as well as technical skills of the person running the business. Table 5.18 shows the formal education of the respondent dairy farmers in New Zealand. The highest number (38%) of the respondents had bachelor degree, followed by 26% with diploma (in most cases in dairy).

Table 5.18 Education Level of NZ Dairy Farmers

Education Level	Frequency	Percent
No Formal Education	4	8.0
School Certificate	8	16.0
University Entrance/Diploma	13	26.0
Degree	19	38.0
Postgraduate Degree/Diploma	6	12.0
Total	50	100.0

The geographical location of the farms is an important demographic feature which may have an impact on the overall productivity of that farm in terms of ground water quality and soil type. Table 5.19 shows the geographical location of the respondent dairy farmers in New Zealand. The highest number (30%) of respondents dairy farmers was from Waikato region which has the highest (24%) share in national milk production (DairyNZ 2014).

Table 5.19 Location of Respondent NZ Dairy Farms

Region	Frequency	Percent
Bay of Plenty	6	12.0
Canterbury	3	6.0
Hawkes Bay	2	4.0
Manawatu	15	30.0
Marlborough	2	4.0
Northland	1	2.0
Southland	1	2.0
Taranaki	4	8.0
Waikato	13	26.0
Wellington	3	6.0
Total	50	100

B. Analysis of SCOR Metrics for NZ Dairy Farmers

The SCOR metrics and their interpretation for respondent dairy farmer in New Zealand are discussed as following.

RL.1.1 Perfect Order Fulfilment (POF)

Milk production, transportation, and processing in New Zealand is practiced under strict regulation by Ministry of Primary Industries (MPI). The dairy companies are required under dairy industry regulatory act (DIRA) 2001 to collect all the milk produced by their member farmers. Keeping this in mind, the level-2 SCOR metric namely 'percentage orders delivered in full' was not applicable to NZ dairy farmers. To calculate POF for dairy farmers in New Zealand, only one level-2 SCOR metric "perfect condition" was appropriate.

RL.2.4 Perfect Condition

To calculate perfect condition for agri-food supply chains, particularly the milk, two metrics were added to SCOR model at level-3 under perfect condition. These are:

- ➤ *RL3.60 Percentage quantities delivered with product quality compliance*
- ➤ *RL3.62 Presence of quality assurance system (QAS)*

In New Zealand, under the dairy industry regulatory act (DIRA) 2001, all the dairy companies are required to perform regular quality assurance audit of the dairy farm premises supplying raw milk in addition to the standard operating procedures (SOPs) for milk quality testing. Milk quality testing includes all quality attributes such as sensory properties, bactoscan, temperature, somatic cell count. Moreover, regional councils conduct environmental audit for the effluence management of every dairy farm once a year. For low quality or hazardous milk, the dairy companies penalize dairy farmers to a variable extent ranging from demerit points to the cost of all the effected milk or loss to the company. The respondent dairy farmers were asked for penalty from the dairy company or cooperative for milk quality and the penalty amount in NZD. All the respondent dairy farmers reported that more than 90% of the total milk quantity supplied was in compliance with quality standards. However, the mean value for perfect condition was 99.87% which makes perfect order fulfilment.

RS.1.1 Order Fulfilment Cycle Time (OFCT)

To calculate OFCT for NZ dairy farmers, two level-2 metrics were selected.

- ➤ *RS.2.2 Make cycle time*
- ➤ *RS.2.3 Deliver cycle time*

The make cycle time refers to milking frequency, whereas deliver cycle time represents milk collection (by dairy company or cooperative) frequency. Among the respondent dairy farmers in New Zealand, 86% used to milk dairy animals twice a day. The best practice of once a day (OAD) milking was being adopted by a growing number of dairy farmers due to the higher decrease in logistics cost than milk production. The dairy companies used to collect milk once a day or after two days depending upon the milk supply volume, location of the dairy farm, and month of the dairy season. The OFCT of the respondent dairy farmers was the same as deliver cycle time. The mean value of deliver cycle time (order fulfilment cycle time in this case) of the respondent dairy farmers was 33.7 hours. Table 5.20 shows that the majority (72%) of the respondents had order fulfilment cycle time in the range of 25 – 48 hours.

Table 5.20 Order Fulfilment Cycle Time of NZ Dairy Farmers

Order Fulfilment Cycle Time (hours)	Frequency	Percent
Up to 24 hours	14	28.0
25 – 48 hours	36	72.0
Total	50	100.0

AG.1.1 Upside Supply Chain Flexibility

The metrics of upside supply chain flexibility refers to the ability of a business to fulfil unusual increase in demand on sustainable basis. It has already been mentioned that New Zealand dairy companies are required under law to collect all the milk produced by its member dairy farmers. Therefore, the nature of dairy production system does not allow dairy farmers to increase milk supply in short run. Hence, the metric of upside supply chain flexibility does not apply to dairy farmers in New Zealand.

AG.1.4 Overall Value at Risk (VAR)

Value at risk represents the monetary impact of probable risk events. The respondent dairy farmers were asked whether their dairy farms' income was negatively affected by risk factors, 20% reported "no". Those 80% who answered "yes" were asked the number of events they underperformed to the set targets times the monetary impact on their overall business value. Table 5.21 shows overall value at risk for respondent dairy farmers in New Zealand. About 45% of the dairy farmers reporting "yes" had more than

10% value of the dairy farm at risk. The mean value of the respondent dairy farmers at risk was 13.22%.

Table 5.21 Overall Value of NZ Dairy Farms at Risk

Value at Risk (% of total value)	Frequency	Percentage
Less than 5%	13	32.5
5% – 10%	9	22.5
Above 10%	18	45.0
Total	40	100
Missing Values	10	20.0

The respondent dairy farmers reported two main types of risks affecting their farm's income: market risks and physical risk. The market risk includes government and dairy company compliance costs, milk price variability, feed price variability, share price variability, exchange rate variability, and higher interest rates. Whereas, the physical risks include drought, floods, animal diseases, and employee diseases such as eczema. Among the physical risks drought was the biggest risk reported by almost all of the farmers facing risk as it affects grass production resulting low productivity per animal or higher supplement feed cost. The risk management strategies reported by the selected dairy farmers are:

- ➢ Early culling
- ➢ Good feed management so yield per animal does not go down
- ➢ Maintain buffer stock of imported/brought-in supplement feed such as palm kernel
- ➢ Maize silage
- ➢ Fertilize and irrigate during drought
- ➢ Stick to operational plan/regularity in feeding cows
- ➢ Split calving to reduce exposure to weather conditions
- ➢ Efficient farm management especially during calving and mating seasons.

CO.1.1 Supply Chain Management (SCM) Cost

The SCM cost of NZ dairy farmers included cost to plan (administrative expenses, consultation cost), cost to source (transportation costs), risk mitigation cost, and other

overhead costs (such as cooperative membership fees and compliance cost). Table 5.22 shows SCM cost of NZ dairy farmers as percentage of SC revenue. The SCM cost of majority (74%) of the respondents was in the range of above 10%. The mean value was 14.4%.

Table 5.22 SCM Cost of NZ Dairy Farmers as Percentage of SCR

SCM Cost *(as percentage of SC Revenue)*	Frequency	Percentage
Less than 5%	1	2.0
5 – 10%	12	24.0
Above 10%	37	74.0
Total	50	100.0

CO.1.2 Cost of Goods Sold

The cost of goods sold metrics refers to the cost of production in dairy farming business. The cost of production represents all the operating expenses such as direct labour, direct material, and indirect production related costs. Table 5.23 shows the cost of production of respondent dairy farmers as percentage of their SCR. The majority of the respondents had cost of milk production in the range of 50% – 80%. The mean value was 51.14%.

Table 5.23 Cost of Production of NZ Dairy Farmers as Percentage of SCR

Cost of Production *(as percentage of SC Revenue)*	Frequency	Percentage
Less than 50%	23	46.0
50 – 80%	27	54.0
Above 80%	0	0
Total	50	100.0

AM.1.2 Return on Supply Chain Fixed Assets

Return on SC fixed assets measures the return an organization receives on its invested capital in supply chain fixed assets used in Plan, Source, Make, Deliver, and Return. The respondent dairy farmers in New Zealand had relatively higher investments in fixed

assets as compared to selected dairy farmers in Pakistan. The investment on land at NZ dairy farms was higher for self-contained milk production system. The return on SC fixed assets of all the respondent dairy farmers was in the range less than 0.50. The mean value was 0.11 which show 11% return on fixed assets. The major fixed assets of NZ dairy farmers are in the form of share capital, land and building, and equipment. Table 5.24**Error! Reference source not found.** represents the fixed assets of the respondent dairy farms in New Zealand. The mean value was 12,640,860 NZD.

Table 5.24 Fixed Assets of NZ Dairy Farmers

Supply Chain Fixed Assets (million NZD)	Frequency	Percentage
Less than 5 million	17	34.0
5 – 10 million	21	42.0
Above 10 million	12	24.0
Total	50	100

AM.1.3 Return on Working Capital

Return on working capital is a measurement which assesses the revenue generated from the investment by a company in working capital. Table 5.25 shows the return on working capital of the selected New Zealand dairy farms. The majority (64%) had return on working capital ratio higher than 1.0. The mean value was 1.29.

Table 5.25 Return on Working Capital of NZ Dairy Farmers

Return on Working Capital	Frequency	Percentage
Less than .50	9	18.0
0.51 – 1.0	9	18.0
Above 1.0	32	64.0
Total	50	100.0

The working capital of the respondent dairy farmers represents net current assets (current assets minus current liabilities). The major current assets reported by NZ dairy farms were cash in hand, stock inventories, and dairy animals. Table 5.26 shows the working capital of selected NZ dairy farms. The mean value of working capital was 820,163 NZD.

Table 5.26 Working Capital of NZ Dairy Farmers

Working Capital (million NZD)	Frequency	Percentage
Less than 0.5 million	18	36.0
0.5 – 1.0 million	20	40.0
Above 1.0 million	12	24.0
Total	50	100

Overall, respondent dairy farmers reported automatic milking of dairy animals and installed capacity to store milk at controlled temperature at their farms. Moreover, all the milk produced was supplied to the cooperative which shows that all the milk was formally processed into finished dairy products. Cost of milk production was relatively low due to pasture-based dairy production system, however, a number of respondents reported overall high compliance costs from New Zealand Government in accordance with its highest food safety standards.

5.4 SCOR Metrics For Informal Chain of Milk in Pakistan

Milk marketing system in Pakistan has been discussed in detail in chapter 2. The vast majority (almost 95%) of marketable surplus reaches consumers through informal chain, whereas the remaining (almost 5%) through formal chain. The informal chain represents unprocessed milk or locally processed into traditional products, whereas formal chain represents the standard processed and packaged dairy products. The key players in the informal chain of milk in Pakistan are: dairy farmers, milk collectors and milk shops. However, dairy companies solely are the key players of formal chain of milk in Pakistan. The SCOR metrics for dairy farmers in Pakistan have already been discussed in the previous section. This section provides SCOR metrics for milk collectors and milk shops in Pakistan.

5.4.1 Milk Collectors in Pakistan

After dairy farmers, the milk collectors are the second key players in the informal chain of milk in Pakistan. A detailed encounter on the role of milk collectors in overall supply chain, their functions and scale of operation has been given in the chapter 2. Demographic characteristics and SCOR metrics of selected milk collectors in Pakistan are described as follows.

A. Demographic Characteristics of the Milk Collectors

Demographic characteristics such as size of business, experience of doing business, level of education, and type of suppliers and customers represent the overall level of skills which are deemed necessary for performing business operations effectively. Table 5.27 represents the business volume of the selected milk collectors on the bases of their size of operation. Over half (59%) of the selected milk collectors were operating at small scale followed by (almost 32%) medium scale milk collectors. Whereas, the large scale milk collectors (also known as milk contractors) were only 9%. Generally, the large scale operators did not collect milk from individual dairy farms; rather they had outsourced milk collection to the small or medium scale milk collectors through supply contracts and advance payment. Some milk collectors used to sell to or buy milk from other milk collectors to fulfil the instant change in demand.

Table 5.27 Business Volume of Milk Collectors in Pakistan

Business Volume	Frequency	Percent
Small scale milk collectors (< 200 litres)	71	59.2
Medium scale milk collectors (201 – 1000 litres)	38	31.7
Large scale milk collectors (>1000 litres)	11	9.2
Total	120	100

The experience of doing business is an important demographic feature of the milk collectors. Table 5.28 describes the level of business experience of the selected milk collectors. The majority (62.5%) of the milk collectors had less than ten years of experience.

Table 5.28 Milk Collector's Experience of Doing Business

Business Experience	Frequency	Percent
0-5 Years	44	36.7
6-10 Years	31	25.8
11-20 Years	25	20.8
21 Years and above	20	16.7
Total	120	100

Table 5.29 shows the education level of the selected milk collectors. Over half (57.5%) of the milk collectors abandoned their formal education just after school whereas the remaining 30% had no formal education at all. However, 10% of the selected milk collectors had bachelor degree.

Table 5.29 Formal Education Level of Milk Collectors in Pakistan

Formal Education Level	Frequency	Percent
No Formal Education	36	30.0
School Certificate (10 years of schooling)	69	57.5
Intermediate or Diploma level	3	2.5
Degree	12	10.0
Total	120	100.0

The milk collectors reported that they source milk from: individual dairy farmers; other milk collectors; or from both. The source of milk supply largely depended on the milk collectors' size of business volume and seasonal fluctuating demand and supply. Table 5.30 represents the milk collector's source of milk supply. Almost 15% of the respondents reported that they work in an integrated way. They sourced milk from own dairy farm and supplied to the own milk shop(s) in the city. This vertical integration was undertaken mainly to ensure milk quality along the entire chain. Among the others nearly 47% of milk collectors sourced milk from individual dairy farms, followed by nearly 32% sourced milk from other milk collectors. The remaining (almost 7%) sourced milk from a combination of above three sources of supply.

Table 5.30 Sources of Milk Supply of Milk Collectors in Pakistan

Sources of Milk Supply	Frequency	Percentage
Own Dairy Farm	18	15
Dairy Farmers	56	46.7
Milk Collectors	38	31.7
Others	8	6.7
Total	120	100

The milk collectors' marketing decision making was dependent on various factors such as milk prices, the demand and supply situation, and the mode and security of payment. Table 5.31 represents the milk collectors choice of customers.

Table 5.31 Marketing channels of the Milk Collectors in Pakistan

Supply Chain Partners	Milk Sold Daily (Ltrs.)	Percentage
Milk Collectors	4,595	9.72
Milk Shops	32,517	68.79
Urban Household	8,780	18.57
Other	1,380	2.92
Total	47,272	100

The selected milk collectors reported that almost 69% of the milk volume was sold to the milk shops followed by 18% to the urban household. Whereas, almost 10% of the milk was sold to the other milk collectors especially the large scale operators. Almost 3% of the respondents sold milk to the private contractors supplying milk to the dairy companies.

B. SCOR Metrics for Selected Milk Collectors in Pakistan

The SCOR metrics and their interpretation for selected milk collectors in Pakistan are discussed in this section.

RL.1.1 Perfect Order Fulfilment (POF)

To calculate POF for milk collectors in Pakistan two level-2 metrics were applicable. These are:

➤ *RL.2.1 Percentage orders delivered in full*
➤ *RL.2.4 Perfect condition*

RL.2.1 Percentage Orders Delivered in Full

The information required to calculate this metric comes from a level-3 metric called delivery quantity accuracy. Table 5.32 shows the delivery quantity accuracy of selected milk collectors. The mean value for percentage orders delivered in full for selected milk collectors in Pakistan was 93.76%. The majority (69%) of the respondents replied that

their customers' satisfaction level regarding quantity of milk supplied was in the range $90\% - 100\%$.

Table 5.32 Percentage Orders Delivered in Full by Milk Collectors in Pakistan

Percentage Orders Delivered in Full	Frequency	Percent
Less than 80%	0	0
80 – 90%	37	30.8
Above 90%	83	69.2
Total	120	100

RL.2.4 Perfect Condition

To calculate perfect condition for milk collectors, three level-3 metrics were selected. These are:

> ➤ *RL3.24 Percentage quantities received with product quality compliance*
> ➤ *RL3.60 Percentage quantities delivered with product quality compliance*
> ➤ *RL3.61 Presence of quality assurance system (QAS)*

The quality of milk sourced by the milk collectors was measured in terms of their level of satisfaction for quality criteria namely freshness, presence of inhibitory substance, and sensory properties of the milk, product safety and fat contents. Table 5.33 shows the results for percentage of milk quantities received by the milk collectors with product quality compliance.

Table 5.33 Product Quality of Milk Sourced by Milk Collectors in Pakistan

Percentage Orders Received with Product Quality Compliance	Frequency	Percent
Less than 80%	1	0.8
80 – 90%	92	76.7
Above 90%	27	22.5
Total	120	100

The overall quality of milk received by the majority (almost 77%) of milk collectors was in the range of 80 – 90% with the mean value 88.64%. The milk collectors were

asked about their satisfaction level regarding the quantity of milk supplied to them. The product quality of the milk sourced by the respondent milk collectors was measured in terms of number of complaints per 100 orders received. Majority of the respondents complained that the farmers dilute milk with water to increase volume. The reasons for low order fill rate included: fluctuation in milk supply due to seasonality factor, supply chain disruptions, and occasional increase in demand on special events such as Eid and Ramadan.

The overall product quality incorporates the mutually acceptable level of freshness, inhibitory substances, sensory properties, product safety, and fat contents by both the parties. The product quality of orders delivered by the selected milk collectors to their customers was measured in terms of number of complaints per 100 orders delivered. The calculation of this metric was subjected to the existant level of milk quality awareness of both parties (the farmers and milk collectors in this case). The mean value of orders delivered with mutually agreed product quality was 77.5%. Table 5.34 represents the perfect condition of the milk sold by the selected milk collectors.

Table 5.34 Pakistani Milk Collector's Deliver Product Quality Compliance

Percentage Orders Delivereded with Product Quality Compliance	Frequency	Percent
Less than 80%	48	40.0
80 – 90%	72	60.0
Above 90%	0	0
Total	120	100

The process quality is equally important to ensure quality of the agri-food products throughout the supply chain. The process quality for the milk collection and transportation implies specialized handling, storage, and transport of milk that ensures non-human touch and temperature maintenance until it is delivered to the customer. The milk collectors were asked whether any government authority performs quality assurance audit of the milk handling and transportation operations. Over half (55.8%) of the respondents replied that the veterinary officer from the provincial food safety authority collected random samples for milk quality check. Moreover, it was observed by the interviewer that the milk collectors were using unhygienic and inappropriate milk

handling equipment for transporting milk. This shows the outdated quality assurance system with poor implementation as compared to the developed countries such as New Zealand. The mean value of overall perfect order fulfilment was 72.34%. Table 5.35 provides further insight into the perfect order fulfilment of selected milk collectors.

Table 5.35 Perfect Order Fulfilment of the Milk Collectors in Pakistan

Perfect Order Fulfilment *(%)*	Frequency	Percent
Less than 80%	96	80.0
80 – 90%	24	20.0
Above 90%	0	0
Total	120	100

RS.1.1 Order Fulfilment Cycle Time

The Order fulfilment cycle time for the milk collectors represents the cycle time for all the five processes Plan, Source, Make, Deliver, and Return plus any dwell time. The plan cycle time for the milk collectors would be nearly zero as it is a continuous process and overlaps with other processes. In other words it is hard to segregate the plan cycle time from other processes as it is going side by side as a continuous process. The source cycle time of the milk collectors was dependent to the number of milk collection trips per day. The majority (67.5%) of the selected milk collectors had source cycle time of 24 hours which means once a day milk collection and delivery. However, 32.5% of the selected milk collectors had source cycle time of 12 hours which means twice a day milk collection and delivery. The mean value for the source cycle time was almost 21 hours.

The make cycle time on the other hand is the time taken to process milk. Among the respondents, only 13% reported that they used to de-cream the milk before selling it to the customers, especially the milk shops. The milk collectors used to de-cream milk in order to maximise their profit margin by selling the cream separately. The respondents reported that every 10 litres of milk yield 1 kilogram of cream of value approximately 3 NZD per kilogram. The price of de-creamed milk was therefore less than that of whole milk. Table 5.36**Error! Reference source not found.** shows the make cycle time of the 16 out of 120 selected milk collectors. The overall mean value was 22.5 hours.

Table 5.36 Make Cycle Time of the Milk Collectors in Pakistan

Make Cycle Time	Frequency	Percent
12 hours	2	12.5
24 hours	14	87.5
Total	16	100
Milk collectors not processing milk	104	86.7

The respondent milk collectors were undertaking dual role as a supplier to the milk shops and as retailer to the urban household consumers. Therefore, the SCOR metrics 'deliver cycle time' and 'delivery retail cycle time' both were calculated. Table 5.37 shows the delivery cycle time of 85 out of the 120 selected milk collectors who used to deliver milk to the retail shops of fresh milk and milk products. The majority (68.2%) of the milk collectors supplied milk to the milk shops once a day. The overall mean value was 20.10 hours.

Table 5.37 Deliver Cycle Time of the Milk Collectors in Pakistan

Deliver Cycle Time	Frequency	Percent
12 hours	27	31.8
24 hours	58	68.2
Total	85	100
Milk collectors supplying only to the urban household consumers.	35	29.2

Less than half (42.5%) of the selected milk collectors used to supply milk to the milk shops as well as to the urban household consumers. Table 5.38 shows that the vast majority (89.3%) of the milk collectors selling milk to the urban household consumers completed the task in less than one hour with the mean value of 0.5 hour.

Table 5.38 Delivery Retail Cycle Time of Milk Collectors in Pakistan

Delivery Retail Cycle Time	Frequency	Percent
Less than 1 hour	50	89.3
1 – 2 hours	6	10.7
Above 2 hours	0	0
Total	56	100
Milk collectors supplying only to the milk shops.	64	53.3

The order fulfilment cycle time may or may not be equal to the sum of all the cycle times depending upon the process configuration. The order fulfilment cycle time for milk collectors was equal to deliver cycle time which is 20.10 hours.

AG.1.1 Upside Supply Chain Flexibility

To measure the upside SC flexibility of the milk collection, distribution and retail business in the informal sector of the Pakistan dairy industry, the selected milk collectors were asked whether they respond to any unusual increase in demand due to some special event or decrease in supply due to SC disruption. Table 5.39 shows that majority (80.8%) of the respondents replied positively that they did respond to the change in demand and could sustain it. However, the remaining 19.2% replied that they did not respond to the increase in demand at all.

Table 5.39 Upside Supply Chain Flexibility of Milk Collectors in Pakistan

Response to a Change in Demand	Frequency	Percentage
Less than 12 hours	41	42.3
12 – 24 hours	51	52.5
Above 24 hours	5	5.2
Total	97	100
Milk collectors not responding to the change in demand	23	19.2

Among those who did respond to the change in demand, over half (52.5%) had the flexibility to fulfil the extra demand within 12 – 24 hours, followed by 42.3% who

could fulfil that extra demand within less than 12 hours. The mean value was 16.53 hours.

AG.1.4 Supply Chain Value at Risk

The value of milk collection and distribution businesses at risk indicates the monetary impact of all the events with performance below the targets. The overall value (VAR) at risk is equal to sum of VAR for source, make, and deliver processes. The respondent milk collectors reported a number of risk factors affecting their business performance. Seasonality of demand and supply is one of them and affects the milk collection and distribution business directly. The milk production reduces during peak summer and peak winter seasons due to limited fodder availability and high cost of production on alternative feed mix. The nearly perfect competition in the market restricted the milk collectors to increase milk prices in the months of low milk supply. On the other hand, the milk collectors were bound to buy milk from the suppliers during the period of high milk supply and low demand in order to retain them for the time of low supply. The milk collectors used to advance payment and pay higher prices for milk to the dairy farmers in order to ensure smooth milk supply in the months of low milk production. In the months of high milk supply, the milk collectors used to pay competitive rates which discourage the farmers to sell milk in the market and they prefer to consume at home or convert it to other products such as *Lassi* (butter milk), butter, or *Desi Ghee*. Moreover, the milk collectors find more customers, particularly the urban households.

Among other risk types include: spoilage of milk, high transportation losses due to extreme temperature during summer, poor roads infrastructure, and non-specialised transportation. Pakistan is a tropical country with extreme weather conditions ranging from hallucinating hot summer (as high as $50^{o}C$) to cold chilly winter. Summer season is usually prolonged than winter. The prolonged power cuts increased the probability of milk spoilage. The milk collectors used to add ice to the milk as a remedial measure as well as to increase the milk volume simultaneously. The other risk factors reported by the selected milk collectors are: financial insecurity due to verbal/informal nature of agreements, being looted at gun point, and *Kaat (*milk shops pay less for substandard, diluted, or low fat milk). The mean value of supply chain value at risk as percentage of supply chain revenue was 10.17%. Table 5.40 describes the supply chain value of milk collection and distribution business in Pakistan at risk.

Table 5.40 Value at Risk for Selected Milk Collectors in Pakistan

Value at Risk *(as percentage of SCR)*	Frequency	Percentage
Less than 5	6	5.0
5 – 10	65	54.2
Above 10	49	40.8
Total	120	100

The supply chain costs of milk collectors represent the SCM cost and the cost of goods sold (COGS). The cost of goods sold for milk collectors may also be termed as cost of milk sold.

CO.1.1 Supply Chain Management Cost

The supply chain management cost for milk collection and distribution would account for cost to source and deliver. For non-cash family businesses such as the milk collectors and milk shops, the business processes were not well defined. Therefore, a redundant overlap was observed between the cost to plan and cost to source. Moreover, the cost to plan for such subsistence level businesses was nominal as compared to the total cost. Table 5.41 illustrates that the majority (64%) of the selected milk collectors had supply chain management cost as percentage of supply chain revenue in the range of 1 – 5% which shows the least value added activities performed by the milk collectors. Direct labour and transportation costs are all of their expenses. The mean value of supply chain management cost as percentage of supply chain revenue for the selected milk collectors was 1.77%.

Table 5.41 The SCM Cost of Selected Milk Collectors in Pakistan

SCM Cost *(as percentage of SCR)*	Frequency	Percentage
Less than 1	41	34.2
1 – 5	77	64.1
Above 5	2	1.7
Total	120	100

CO.1.2 Cost of Goods Sold (COGS)

The Cost of goods sold may also be termed as cost of milk sold for the milk collectors, to relate it to the collection and distribution of fresh (unprocessed) milk. The cost of milk sold for milk collection and distribution businesses in Pakistan included direct labour, direct material, and indirect production related costs. Direct labour was mainly in the form of non-cash family labor, whereas, the direct material refers to the cost of milk purchased. Table 5.42 explains that the majority (almost 62%) of the respondents had cost of milk sold as percentage of supply chain revenue above 80%, whereas, the remaining 37.5% had cost of milk sold in the range of 50 – 80%. The mean value of cost of milk sold as percentage of annual total revenue of selected milk collectors was 80.73%.

Table 5.42 Cost of Milk Sold of Selected Milk Collectors in Pakistan

Cost of Milk Sold *(as percentage of SCR)*	Frequency	Percentage
Less than 50	1	0.8
50 – 80	45	37.5
Above 80	74	61.7
Total	120	100

AM.1.2 Return on Supply Chain Fixed Assets

Return on supply chain fixed assets measures the milk collectors' ability to generate profit from the investment in fixed assets. The fixed assets of milk collectors included milk transportation vehicle, and milk handling utensils. The small scale operators (<200 litres) usually used motorcycle whereas the medium and large scale operators used mini trucks and carry vans to transport milk from dairy farm to milk shops in the nearby town. The milk handling utensils used were either large plastic drums (drum capacity 100 litres) or metal coated small silver drums (capacity 10 – 40 litres). The respondents were asked to assess the value the fixed assets used for milk collection and distribution according to the current market value. The milk collectors were debriefed to calculate average market value using a combination of liquidation and substantial valuation methods. The mean value of supply chain fixed assets of milk collectors was almost

3,536 NZD. Table 5.43 categories the fixed assets of the selected milk collectors in milk supply chain of Pakistan.

Table 5.43 The SC Fixed Assets of the Milk Collectors in Pakistan

Supply Chain Fixed Assets (in NZD)	Frequency	Percentage
Less than 1,000	61	50.8
1,000 – 10,000	52	43.4
Above 10,000	7	5.8
Total	210	100

NB: NZForex 2013 yearly average exchange rate of PKR to NZD (0.013138) was used for currency conversion.

The mean value of return on supply chain fixed assets for the selected milk collectors was 7.82. Table 5.44 shows the rate of return on fixed assets for the selected milk collectors in milk supply chain in Pakistan. The highest percentage (42.5%) of the selected milk collectors had return on fixed assets less than 5 which means every dollar invested in fixed assets is earning less than 5 dollars.

Table 5.44 Return on SC Fixed Assets of the Milk Collectors in Pakistan

Return on Supply Chain Fixed Assets	Frequency	Percentage
Less than 5	51	42.5
5 – 10	36	30.0
Above 10	33	27.5
Total	120	100

AM.1.3 Return on Working Capital

Return on working capital assesses the revenue generated from the investment in working capital. The SCOR model uses accounts payable outstanding, inventory, and accounts receivable outstanding to calculate supply chain working capital. The accounts payables of the milk collectors include all the short term liabilities which include outstanding payments to suppliers. The mean value of accounts payable outstanding of the selected milk collectors was 1,237 NZD. The inventory in a milk collection and distribution business is mainly in the form of milk, cash in hand, and milk handling

equipment. The mean value of inventory of milk collectors was almost 2,056 NZD. The accounts receivable outstanding represent current assets in the form of outstanding payments the customers owe to the milk collectors. The mean value of accounts receivable outstanding was 4,180 NZD.

The respondents reported that their cash to cash cycle time depends upon the mode of payment by their customers. Table 5.45 shows that majority of the respondents were getting paid partially in cash and partially in credit. This payment method was more common because of its suitability to the milk collectors financial needs. The cash payment was a method preferred by the milk collectors to keep the business running smoothly and with minimum working capital.

Table 5.45 Mode of Payment of Selected Milk Collectors in Pakistan

Mode of sales	Frequency	Percentage
Cash (or cheque)	22	18.3
Cash (or cheque) and credit	85	70.8
Credit	13	10.8
Total	210	100

The above information shows that major portion of the working capital of milk collectors was in the form of outstanding accounts receivable rather than inventory or cash in hand. Table 5.46 represents working capital of the selected milk collectors in Pakistan. The working capital of majority (63%) of the milk collectors was in the range of 1,000 – 10,000 NZ dollars. The mean value was 4,877 NZ dollars.

Table 5.46 Working Capital of Selected Milk Collectors in Pakistan

Accounts Receivable Outstanding (in NZD)	Frequency	Percentage
Less than 1,000	38	31.7
1,000 – 10,000	76	63.3
Above 10,000	6	5.0
Total	120	100

NB: NZForex 2013 yearly average exchange rate of PKR to NZD (0.013138) was used for currency conversion.

The return on working capital is a supply chain profitability ratio and calculated by dividing the supply chain profit by working capital. The mean value of return on working capital for the selected milk collection and distribution businesses in Pakistan was 10.16. Table 5.47 quantifies the return on working capital for the selected milk collectors.

Table 5.47 Return on Working Capital of the Milk Collectors in Pakistan

Return on Working Capital	Frequency	Percentage
Less than 5	53	44.2
5 – 10	24	20.0
Above 10	43	35.8
Total	120	100

It was observed that the return on working capital ratio was higher for the milk collectors receiving cash payments for the milk sales as compared to those receiving payment through mixed (cash and credit) or credit (after 7 days, 15 days, 30 days) methods. The cash-to-cash cycle time of the selected milk collectors was as short as 2 days (for cash payments) and as long as 30 days. The rate of return on working capital ratio was higher for cash payments and lower for credit payments.

5.4.2 Milk Shops in Pakistan

The third key player in the informal chain of milk in Pakistan is the milk shop. The milk shops represent a wide range of retailers of unprocessed fresh milk and/or locally processed milk products. A brief on various types of milk shops and the dairy products they offer to the consumers is given in chapter 2. This section expands on demographic characteristics and SCOR metrics for selected milk shops in Pakistan.

A. Demographic Characteristics of Selected Milk Shops in Pakistan

A total of 90 milk shops were selected from Faisalabad, Lahore, and Gujrat districts. A sample size of 30 milk shops from each district was selected conveniently. Demographic characteristics of the respondents include business volume, business experience, level of education, and food service type/nature of products offered for sale. Table 5.48 shows the business experience of the milk shop keepers. Among the respondents, 41% had less than five years of milk shop experience, followed by 20%

with 6 – 10 years of experience, 20% with 11 – 20 years of experience, and 19% with more than 20 years of experience.

Table 5.48 Business Experience of Respondents at Pakistani Milk Shops

Business Experience	Frequency	Percent
0-5 Years	37	41.1
6-10 Years	17	18.9
11-20 Years	18	20.0
Above 20 Years	18	20.0
Total	90	100

Respondent's education level is another important demographic characteristic which may have an impact on the business performance. Table 5.49 shows that over half (57.5%) of the milk collectors had abandoned their formal education just after school whereas 30% of them were illiterate with a very basic knowledge of counting and performing routine business activities.

Table 5.49 Education Level of the Respondents at Pakistani Milk Shops

Education Level	Frequency	Percent
No Formal Education	25	27.8
School Certificate	52	57.8
Intermediate or Diploma level	0	0
Degree	13	14.4
Total	120	100

The milk shops were categorised on the same criteria as for the milk collectors, the business volume. Table 5.50 represents the selected milk shops organized into three categories on the bases of their size of operation. The milk shops essentially fall in the ambit of micro enterprises of the small and medium enterprise development authority (SMEDA) of Pakistan. However, their business volume very much depends upon type of products offered for sale as well as the geographical location such as city centre or peri-urban area. Nearly half (47.7%) of the respondents were medium scale operators whereas, the remaining half (46.7%) were small scale operators.

Table 5.50 Business Volume of Selected Milk Shops in Pakistan

Business Volume	Frequency	Percent
Small scale milk shops (< 200 litres per day)	42	46.7
Medium scale milk shops (200 – 1000 litres per day)	43	47.7
Large scale milk shops (>1000 litres per day)	5	5.6
Total	90	100

The milk shops were also categorised on the basis of dairy products they offer. Table 5.51 represents the selected milk shops according to this categorization. The majority (63.3%) of the respondents were fresh milk shops. The fifth category 'any combination of the above' represents those milk shops which in addition to selling fresh milk were also selling traditional sweets in order to diversify the product line as a risk management strategy against uncertain demand. Moreover, there are sweets shops in the market selling traditional sweets only, but they are not called milk shops.

Table 5.51 Type of Selected Milk Shops in Pakistan

Type of Milk Shop	Frequency	Percent
Fresh milk shop	57	63.3
De-creamer	4	4.4
Canteen/cafe	11	12.2
Sweets and bakers shop	0	0
Any combination of the above	18	20.0
Total	90	100

The sources of milk supply to the milk shops are the determinants of milk supply chain structure. Table 5.52 shows that milk collectors were the biggest (almost 58%) milk suppliers to the milk shops. On the other hand, a number of milk shops (almost 18%) had their own source of supply which shows the level of vertical integration within the milk supply chain in Pakistan.

Table 5.52 Source of Milk Supply to Selected Milk Shops in Pakistan

Sources of Milk Supply	Frequency	Percentage
Own dairy farm	16	17.8
Dairy farmers	10	11.1
Milk collectors	52	57.8
Any combination of the above	12	13.8
Total	90	100

Milk shops are the end point of informal chain of milk in Pakistan directly selling milk and milk products to the consumers.

B. Analysis of SCOR Metrics for the Milk Shops in Pakistan

The SCOR metrics and their detailed interpretation for selected milk shops in Pakistan are:

RL.1.1 Perfect order fulfilment (POF)

Perfect order fulfilment is the strategic level SCOR metrics for supply chain reliability. The information required to measure POF comes from two level-2 metrics and relevant level-3 metrics. These are:

> ➢ *RL.2.1 Percentage orders delivered in full*
> ➢ *RL.2.4 Perfect condition*

RL.2.1 Percentage Orders Delivered in Full

Table 5.53 describes the order fill rate of the selected milk shopsin Pakistan.

Table 5.53 Orders Delivered in Full by Selected Milk Shops in Pakistan

Percentage Orders Delivered in Full	Frequency	Percent
Less than 80%	0	0
80 – 90%	7	7.8
Above 90%	83	92.2
Total	90	100

The mean value of orders delivered in full was 98.42%. The majority (almost 78%) of the respondents fulfilled more than 95% of the customer's orders. The reasons for not being able to fulfil all of the customers' orders include fluctuations in milk supply and demand due to seasonality factor, supply chain disruptions, and excess demand on special events such as Ramadan and Eid.

RL.2.4 Perfect Condition

To calculate perfect condition for milk collectors, three metrics were added to SCOR model at level-3. These are:

> ➤ *RL3.24 Percentage orders received with product quality compliance*
> ➤ *RL3.60 Percentage orders delivered with product quality compliance*
> ➤ *RL.3.61 Presence of quality assurance system (QAS)*

The respondents were asked to estimate the level of their satisfaction for the milk supply for quality parameters namely freshness, presence of inhibitory substance, sensory properties of the milk, product safety and fat contents. The mean value of product quality level of the milk supply was 88.43%. Table 5.54 describes the percentage of milk quantities received with mutually agreed product quality level. The majority (62%) of the respondents' satisfaction level over the product quality of received milk quantities was in the range of 80 - 90%.

Table 5.54 Source Product Quality of Selected Milk Shops in Pakistan

Percentage Quantities Received with Product Quality Compliance *(%)*	Frequency	Percent
Less than 80%	8	8.9
80 – 90%	56	62.2
Above 90%	26	28.9
Total	90	100

The product quality was measured by two criteria; presence of quality assurance system and the level of satisfaction for quality parameters namely freshness, presence of inhibitory substance, sensory properties of the milk, product safety and fat contents. The first criterion is the measure of product quality as well as process quality. The second criterion provides the perceived level of satisfaction of customers after consuming the product. The respondents were asked to estimate their customers' satisfaction level for

product quality in terms of freshness, presence of inhibitory substance, sensory properties of the milk, product safety and fat contents. The minimum value of all the quality parameters was considered as the product quality level in percentage.

The milk shop keepers after receiving the milk divides it into two: the milk to be sold as *Kaccha*, and the milk to be boiled and processed into milk products such as yoghurt, *Lassi*, and *Khoya*. The milk is boiled in a big pan, after which it is transferred to various other pans for different products such as for drinking, tea, yoghurt, *Lassi*, and *Khoya*. Table 5.55 represents the product quality of the milk and milk products sold by the selected milk shops. The mean value was 95.7% which is higher than the mean value of product quality for milk quantities received which is quite logical because after processing milk quality is improved. However, a limitation in the measurement of product quality of the milk shops was that mostly the customers do not complain rather they buy from other shops. Therefore the above results may be slightly exaggerated.

Table 5.55 Deliver Product Quality of Selected Milk Shops in Pakistan

Percentage Quantities Delivered with Product Quality Compliance *(%)*	Frequency	Percent
Less than 80%	1	1.1
80 – 90%	15	16.7
Above 90%	74	82.2
Total	90	100

The process quality is equally important to ensure quality of the agri-food products throughout the supply chain. The process quality for milk shops implies the presence of standard operating procedures for handling, storage, and processing and hygiene of the situation and equipment used. In response to the question 'does any government authority performed quality assurance audit of the milk shop' almost 49% of the respondents replied that food safety officers from provincial Food Safety Authority pay random visits occasionally. The respondents reported the major concern of these visits was price control. These visits may not replace a quality assurance system but a bureaucratic way of price. One of the purposes of conducting face-to-face interviews was to actually visit and evaluate the process quality, which in fact, was not witnessed. This also shows the poor implementation of the existing laws. The mean value for

perfect order fulfilment was 94.19%. Table 5.56 shows perfect order fulfilment of the selected milk shops.

Table 5.56 Perfect Order Fulfilment of Selected Milk Shops in Pakistan

Perfect Order Fulfilment *(%)*	Frequency	Percent
Less than 80%	1	1.1
80 – 90%	19	21.1
Above 90%	70	77.8
Total	90	100

RS.1.1 Order Fulfilment Cycle Time

The Order fulfilment cycle time for the milk shops spans the sum of all the cycle times for the SC processes Plan, Source, Make, Deliver, and Return plus any dwell time. The milk shops manage the dwell time between two milk supplies according to the demand pattern. The milk shop processes are continuous in nature and the shopkeeper performs planning activities along with other activities simultaneously. Therefore, no need to measure the plan cycle time as it overlaps with other processes. The source cycle time of the milk shop represents to the average time between two milk supplies and includes the inherent dwell time as well. The mean value of source cycle time of the selected milk shops was 15.8 hours. The prevalent milk supply patterns are once a day and twice a day. Table 5.57 describes the source cycle time of the selected milk shops in a bit detail.

Table 5.57 Source Cycle Time of the Milk Shops in Pakistan

Source Cycle Time	Frequency	Percent
Less than 10 hours	13	14.4
10 – 20 hours	44	48.9
Above 20 hours	33	36.7
Total	90	100

The make cycle time of the milk shops depends on the source cycle time. The raw milk, after receiving, is transferred to a big pan for boiling which takes 1.33 hours on an

average. This boiled milk is then sold as it is or converted to other products such as yoghurt, *Khoya, Falooda, Lassi*, butter, milk shakes, traditional sweets, and bakery products. The processing lead time for each product is different from the other. The time between two production processes is the same as between two milk supplies. Therefore, the processing or make cycle time is equal to source cycle time. It is noteworthy here that make cycle time includes non-value added lead time in addition to processing lead time. The delivery retail cycle time is the time between two sales orders fulfilled. The mean value of delivery retail cycle time of the selected milk shops was 0.22 hour. The detailed information is shown in table 5.58. The four missing values are the de-creamers' shops supplying cream to the wholesalers only.

Table 5.58 Delivery Retail Cycle Time of the Milk Shops in Pakistan

Delivery Retail Cycle Time (hours)	Frequency	Percent
Less than 0.5 hour	77	89.5
0.5 – 1.0 hour	8	9.3
Above 1.0 hour	1	1.2
Total	86	100
Missing values	4	4.4

The order fulfilment cycle time may or may not be equal to the sum of cycle times for source, make, and retail. For example, the order fulfilment cycle time for milk shops was equal to source cycle time (15.8 hours), whereas delivery retail and make activities were performed between two consecutive milk supplies.

AG.1.1 Upside Supply Chain Flexibility

The upside SC flexibility of the retail businesses like milk shops is a measure of their ability to respond to increase in demand or decrease in supply on sustainable basis. The respondents were asked whether they respond to any unusual increase in demand or decrease in supply due to SC disruption. The mean value of upside flexibility of the selected milk shops was 10.94 hours. Table 5.59 represents that one third of the respondents said that they don't respond to any change in demand or supply in the short run whereas the remaining two third did respond to the change in demand and could sustain it. The majority (almost 62%) of the later ones had ability to fulfil the extra

demand in less than 12 hours' time. However, the remaining 38% had the flexibility to fulfil the extra demand within 12 – 24 hours.

Table 5.59 Supply Chain Flexibility of Selected Milk Shops in Pakistan

Response to a Change in Demand	Frequency	Percentage
Less than 12 hours	37	61.7
12 – 24 hours	23	38.3
Above 24 hours	0	0
Total	60	100
Missing values	30	33.3

A number of milk shops reported that they have more than one milk shops under single ownerships which is an indicator of horizontal integration in the milk supply chain in Pakistan. It is also helpful in improving the flexibility of milk shop.

AG.1.4 Supply Chain Value at Risk

The milk shop businesses in Pakistani are characterised as small enterprises. There are a number of risk factors affecting the income of these milk shops. In addition to measure value at risk, identification of those risk factors and risk management strategies practiced by the milk shops is necessary. The mean value of VAR of the selected milk shops was 7.9%. Table 5.60 represents the supply chain value of the selected Pakistani milk shops at risk.

Table 5.60 Value at Risk of Selected Milk Shops in Pakistan

Value at Risk *(as percentage of SCR)*	Frequency	Percentage
Less than 5	11	13.1
5 – 10	60	71.4
Above 10	13	15.5
Total	84	100
Missing values	6	6.7

The risk factors reported by the selected milk shops risk include all those issues negatively related to the income generation directly or indirectly. Milk spoilage is perhaps the biggest issue of the milk shops, especially during hot summers. In addition to this power cut (both electricity and gas) for as long as 16 hours a day make it from bad to worst. To avoid milk spoilage, milk shop keepers process milk immediately after receipt. Alternative sources of energy such as gas cylinders are used. Ice cubes are used to save milk from spoilage.

Seasonal fluctuation of demand and supply affect the milk shops directly. The milk supply reduces during peak summer and peak winter seasons due to the limited fodder availability and high cost of production on alternative feed mix. To deal with the fluctuating demand and supply the retailers of fresh milk produce a number of dairy products such as yoghurt, *Khoya*, and traditional sweets from the processed milk. This diversification strategy is helpful when supply is greater than demand. Vertical and horizontal integration strategy is helpful when demand is greater than the supply. If not vertically integrated, the milk shops advance pay to the suppliers of milk in order to retain them. The customer base of the milk shop is highly localised to its proximity. There is a nearly perfect competition situation in central areas of the city which restricts milk shops to increase milk prices in the period of low milk supply. Moreover, it asserts pressure for product quality to stay in the market place.

Supply Chain Costs

The supply chain cost of the milk shops was calculated in terms of SCM cost and cost of milk and milk products sold. The major cost heads are transportation, cost of milk purchased, processing cost, direct labour, depreciation, rent, and utility bills. Direct labour is usually in the form of non-cash family labour whereas the transportation cost covers cost to source and cost to deliver. The mean value of supply chain costs as percentage of SCR was 82.51%. The higher supply chain costs and nominal operating profits show a typical dilemma of diseconomies of the scale at subsistence level micro enterprises in Pakistan. Other reasons include perfect competition situation in the market, poor collaboration, and lack of value addition across the entire supply chain network. In nutshell, it is the opportunity cost of the non-cash family labour which keeps them in the business.

CO.1.1 Supply Chain Management Cost

The supply chain management cost for retails shops of fresh milk and locally processed milk products would account for cost to plan, source, and retail/deliver. The mean value of supply chain management cost as percentage of supply chain revenue for the selected milk shops was 1.97%. Table 5.61 explains that the majority (74.5%) of the selected milk shops had SCM cost in the range of 1 – 5% of the supply chain revenue.

Table 5.61 SCM Cost of Selected Milk Shops in Pakistan

SCM Cost *(as percentage of SCR)*	Frequency	Percentage
Less than 1	21	23.3
1 – 5	67	74.5
Above 5	2	2.2
Total	90	100

CO.1.2 Cost of Goods Sold (COGS)

The Cost of goods sold for retail sale of fresh milk and milk products may also be termed as cost of products sold, to relate it to the retail of fresh (unprocessed) milk and locally processed milk products. The cost of products sold retail shops in Pakistan includes direct labour, direct material, and indirect production related costs. Direct labour is non-cash family labour as well as hired labour, whereas, direct material refers to the cost of milk purchased. The indirect product related costs include power bills and depreciation cost. The mean value of cost of product sold as percentage of supply chain revenue of selected milk shops was 91.29%. Table 5.62 explains that the vast majority (93%) of the respondents had cost of product sold above 80% of supply chain revenue.

Table 5.62 Cost of Products Sold of Selected Milk Shops in Pakistan

Cost of Milk Sold *(as percentage of SCR)*	Frequency	Percentage
Less than 50%	0	0
50% – 80%	6	6.7
Above 80%	84	93.3
Total	90	100

AM.1.2 Return on Supply Chain Fixed Assets

Return on supply chain fixed assets measures the milk shops' ability to generate profit from the investment in fixed assets. The fixed assets of retail milk shops vary according to the type of milk products sold. The fresh milk shops have least value of fixed assets which include milk handling and processing utensils, fixed investments in structuring the shop floor, furniture, and some milk processing appliances. The other types of milk shops such as cafes/canteens, de-creamers, and sweets and bakery shops have relatively higher value of fixed assets. The mean value of supply chain fixed assets of milk shops of all type was almost 2385 NZD. Table 5.63 organises the fixed assets of the selected milk shops in three categories. The majority (71%) of the selected milk shops had fixed assets in the range of 1,000 – 10,000 NZD.

Table 5.63 Fixed Assets of Selected Milk Shops in Pakistan

Supply Chain Fixed Assets (in NZD)	Frequency	Percentage
Less than 1,000	23	25.6
1,000 – 10,000	64	71.1
Above 10,000	3	3.3
Total	90	100

NB: NZForex 2013 yearly average exchange rate of PKR to NZD (0.013138) was used for currency conversion.

The mean value of return on supply chain fixed assets for the selected milk shops was 4.22. Table 5.64 shows the rate of return on fixed assets for the selected milk shops in the milk supply chain in Pakistan. The vast majority (71%) of the selected retailers had return on fixed assets less than 5 which means every dollar invested in fixed assets earned less than 5 dollars.

Table 5.64 Return on Fixed Assets of Selected Milk Shops in Pakistan

Return on Supply Chain Fixed Assets	Frequency	Percentage
Less than 5	64	71.1
5 – 10	12	13.3
Above 10	14	15.6
Total	90	100

AM.1.3 Return on Working Capital

The working capital of the milk shops directly depends upon the accounts payable outstanding, accounts receivable outstanding, and inventory which are indirectly affected by the mode of payment to the suppliers of milk and by the customers. Table 5.65 represents mode of payment of the selected milk shops in Pakistan.

Table 5.65 Mode of Payment of Selected Milk Shops in Pakistan

Mode of Payment	Raw Milk Procurement		Milk and Milk Products Sold	
	Frequency	Percentage	Frequency	Percentage
Cash (or Cheque)	45	50.0	49	54.4
Cash and Credit	40	44.4	41	45.6
Credit	5	5.6	0	0
Total	90	100	90	100

Cash payments to the suppliers of milk generated frequent cash flows whereas credit payments generate more accounts payable. It shows that the milk shop keepers preffered cash payments for smooth running of their business. However, a nearly equal number of them undertook combination of cash and credit payments to the suppliers as well as by the customers. The credit payments to the suppliers were made on weekly, fortnightly, or monthly basis depending upon the volume of milk supplied. However, the credit payments by the customers were usually made on monthly basis.

The accounts payable indicate cash outflows to the suppliers of milk whereas the accounts receivable indicate cash inflows from the customers. The more the cash payments for purchases and sales, the least the working capital employed. The inventory was mainly in the form of cash in hand, milk, furniture and equipment. Table 5.66 shows the working capital of the selected milk shops in Pakistan. The mean value was 2151 NZD.

Table 5.66 Working Capital of Selected Milk Shops in Pakistan

Working Capital (NZD)	Frequency	Percentage
Less than 1,000	44	48.9
1,000 – 10,000	43	47.8
Above 10,000	3	3.3
Total	90	100

NB: NZForex 2013 yearly average exchange rate of PKR to NZD (0.013138) was used for currency conversion.

The return on working capital is a supply chain profitability ratio and calculated by dividing the supply chain profit by working capital. The mean value of return on working capital for the selected milk shops was 4.09. Table 5.67 quantifies the return on working capital for the selected milk shops.

Table 5.67 Return on Working Capital of Selected Milk Shops in Pakistan

Return on Working Capital	Frequency	Percentage
Less than 5	59	65.6
5 – 10	21	23.3
Above 10	10	11.1
Total	90	100

The results show that return on working capital ratio was higher for the milk shops receiving cash payments (shorter cash-to-cash cycle time) for the sales as compared to those receiving through mixed (cash and credit) or credit (after 7 days, 15 days, 30 days) modes of payment.

5.5 SCOR Metrics for Dairy Companies in Pakistan and New Zealand

Dairy products manufacturing companies are the key players of the formal chain of milk in Pakistan. The formal chain of milk occupies a very small share of overall milk marketing system in Pakistan. However, in New Zealand almost all the milk produced is marketed through the formal chain which represents standard processed and packaged dairy products. This section deals with the SCOR metrics of dairy products manufacturing companies in Pakistan and New Zealand.

5.5.1 SCOR Metrics for Dairy Products Manufacturing Companies in Pakistan

The dairy companies in Pakistan collect milk through their own milk collection network. Punjab and Sindh are the major milk producing provinces in Pakistan. Currently, there are more than 25 milk processing plants producing UHT milk, butter and cream. The majority of milk processing plants are located around milk production pocket areas in Punjab and Sindh provinces. The leading milk processing companies are Nestlé Pakistan Limited, Engro Foods Limited, Haleeb Foods Limited, Shakarganj Food Products Limited, Nirala Dairy (Pvt.) Limited, Noon Group of Companies, Idara-e-Kisaan (Halla), Royal Dairy and Gourmet Foods. With exception to Engro Foods, almost all the dairy processing plants are located in Punjab province.

RL.1.1 Perfect Order Fulfilment

The perfect order fulfilment represents the reliability of products and services offered by the dairy companies. It represents the orders received by the customers in perfect condition (at right time, at right place, and in right condition) which incorporates product as well as process quality which is ensured by the quality assurance system. The respondent dairy companies reported that their operations were performed under the quality assurance system that ensures the product as well as process quality. The quality assurance system of dairy companies comes into effect once the fresh milk is received at village level milk collection centres (VMCC) or at milk collection centres (MCC). However, the overall milk quality still depends upon the quality compliance at the dairy farm level which is the primary point of production. The POF metrics was calculated with the information from three level-2 metrics. These are:

➢ *RL.2.1 Percentage orders delivered in full*
➢ *RL.2.2Delivery performance to customer commit date*
➢ *RL.2.4 Perfect condition*

Table 5.68 shows mean values and standard deviation of perfect order fulfilment metric and its relevant level-2 and level-3 metrics. The perfect condition of a product depends on the quality level of raw milk and production process.

Table 5.68 Perfect Order Fulfillment of Dairy Companies in Pakistan

SCOR Metrics	Mean Value	Standard Deviation
RL1.1 Perfect Order Fulfilment	92.69%	3.97%
RL2.1 % Orders Delivered in Full	97.39%	1.93%
RL3.34 Delivery Quantity Accuracy	97.39%	1.93%
RL2.2 Delivery Performance to Customer Commit Date	96.20%	1.93%
RL3.32 Delivery Time Accuracy	96.20%	1.93%
RL2.4 Perfect Condition	98.89%	0.56%
RL3.24 Percentage Orders Received with Product Quality Compliance	93.00%	4.06%
RL3.60 Percentage Orders Delivered with Product Quality Compliance	98.89%	0.56%
RL3.61 Presence of Quality Assurance System	Yes	

n=10

It is noteworthy that value of metrics for quality of raw milk received was less than the products manufactured from it.

RS.1.1 Order Fulfilment Cycle Time

The order fulfilment cycle time of the dairy companies measures the responsiveness in fulfilling customer's orders and may or may not be equal to the sum of source, make, and deliver cycle times. The basic reason behind this is that dairy products manufacturing companies follow make-to-stock process configuration where more than one process operates simultaneously. To calculate order fulfilment cycle time for dairy companies in Pakistan, data from three level-2 SCOR metrics was used. These metrics are:

➢ *RS.2.1 Source cycle time*
➢ *RS.2.2 Make cycle time*
➢ *RS.2.3 Deliver cycle time*

The source cycle time depends on the mode of milk collection. The source cycle time depends upon two factors: the geographic distance between the point of milk production and processing plant, and the number of milk collections per day. The respondents were

asked for average time from farm to the company's plant. The source cycle time for 'once a day' milk collection was recorded as 24 hours and 12 hours for 'twice a day' milk collection. The make cycle time was variable for each product line depending upon the length of production lead time. The deliver cycle time for chilled dairy products was less than ambient dairy products. Generally, the OFCT of the make-to-stock processes is equal to the delivery cycle time because the activities related to source, make, and deliver processes are performed simultaneously. Table 5.69 presents order fulfilment cycle time and its relevant level-2 SCOR metrics for respondent dairy companies in Pakistan.

Table 5.69 Order Fulfilment Cycle Time of Dairy Companies in Pakistan

SCOR Metrics	Mean Value	Standard Deviation
RS1.1 Order Fulfilment Cycle Time	33.60 hours	9.47 hours
RS2.1 Source Cycle Time	20.40 hours	5.80 hours
RS2.2 Make Cycle Time		
Fresh Milk	2.78 hours	0.36 hours
Milk Powders	24.00 hours	-
Butter and Fats	24.00 hours	-
Cheese	30.00 days	-
Others	48.00 hours	48.00 hours
RS2.3 Deliver Cycle Time		
Ambient Dairy	33.60 hours	9.47 hours
Chilled Dairy	34.67 hours	9.38 hours

n=10

AG.1.1 Upside Supply Chain Flexibility

The supply chain agility is measured by upside SC flexibility and value at risk. The upside SC flexibility of a business is measured by its capability in terms of maximum number of days required to fulfil an unusual increase in demand on recurring and without any cost penalty. For Pakistan, upside SC flexibility refers to an unusual increase in demand or decrease in supply due to the effect of seasonality, special events and festivities, natural disasters such as floods, prolonged power cuts, machinery breakdown, and security situation. The upside flexibility of the selected dairy companies for an unusual increase in demand was in the range of 10 – 15 days. Dairy

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companies use an optimal combination of various options including the substitution with imported milk powder to fulfil additional demand. Apart from the natural disasters, an unusual increase in demand is unrealistic in dairy sector.

AG.1.4 Overall Value at Risk

Dairy companies in Pakistan deal with various types of risk in their routine operations. The respondents were asked whether their business performance was effected by any type of risk. They reported various types of risks such as market risk (including currency risk, price risk and interest rate risk, credit risk, market competition) financial and liquidity risk, outstanding letters of credit, and seasonal fluctuations in milk supply and raw milk prices. To mitigate these risk types dairy companies employ a combination of various strategies including relocating target markets, substitute with imported milk powder, and effective cash management. The overall value of the respondent dairy companies at risk was 25.30%.

CO.1.1 Supply Chain Management Cost

Supply chain management cost refers to the sum of costs to plan, source, make, deliver, return and mitigate risk. The mean value of SCM cost of the respondent dairy companies in Pakistan as percentage of their supply chain revenue was 14.45%.

CO.1.2 Cost of Goods Sold

The cost of goods sold (COGS) of respondent dairy companies in Pakistan included the cost associated with buying raw materials (such as milk, food additives etc.) and producing finished goods (including packaging). This includes all direct costs (such as labour, materials) and indirect production related overhead costs. The COGS of respondent dairy companies as percentage of their supply chain revenue was 81.45%.

AM.1.2 Return on Supply Chain Fixed Assets

To calculate return on fixed assets (also called non-current assets), one level-2 metric was used.

 ➢ *AM.2.5 Supply chain fixed assets*

The mean value of fixed assets of respondent dairy companies in Pakistan was 89.3 million New Zealand dollars, whereas, the mean value of return on fixed assets ratio was 0.12.

AM.1.3 Return on Working Capital

To calculate working capital, three level-2 metric were used.

- ➤ *AM.2.6 Accounts payable*
- ➤ *AM.2.7 Accounts receivable*
- ➤ *AM.2.8 Inventory*

The mean value of working capital of respondent dairy companies in Pakistan was 9.2 million New Zealand dollars, whereas, the mean value of return on fixed assets ratio was 0.29. Table 5.70 shows selected SCOR metrics to evaluate asset management of respondent dairy companies in Pakistan.

Table 5.70 Asset Management of Dairy Companies in Pakistan

SCOR Metrics	Mean Value	Standard Deviation
AM1.2 Return on SC Fixed Assets	0.12	0.22
AM2.5 SC Fixed Assets	89.31 million NZD	14.17 million NZD
AM1.3 Return on Working Capital	0.29	0.39
AM2.9 Working Capital	9.22 million NZD	1.85 million NZD

n=10

Overall, respondent dairy companies in Pakistan reported quality constraints in sourcing raw milk mainly due to non-existing cool chain infrastructure at dairy farm level. Moreover, among other risk factors seasonality of milk production was the major one, leading them to substitute their product mix with imported dairy products in order to meet market demand.

5.5.2 SCOR Metrics for Dairy Companies in New Zealand

The role of dairy products manufacturing companies in New Zealand dairy industry has been discussed in detail in the background chapter. The milk from individual dairy farms is mainly collected by a large dairy cooperative in order to be cost effective and

optimise economies of the scale. The company profiles and contact details of 52 dairy products manufacturing companies were retrieved from KOMPASS database. With a response rate of 26%, only 13 questionnaires were returned by the respondents with 5 of them incomplete or simply not qualified for data analysis. Moreover, two dairy companies were surveyed through face-to-face interviews.

RL.1.1 Perfect Order Fulfilment

The mean value for perfect order fulfilment of NZ dairy companies was 96.15%. To calculate perfect order fulfilment information from three level-2 metrics and relevant level-3 metrics was used. Table 5.71 shows perfect order fulfilment of selected dairy companies in New Zealand.

Table 5.71 Perfect Order Fulfilment of Dairy Companies in New Zealand

SCOR Metrics	Mean Value	Standard Deviation
RL1.1 Perfect Order Fulfilment	96.15%	1.65%
RL2.1 % Orders Delivered in Full	98.55%	0.80%
RL3.34 Delivery Quantity Accuracy	98.55%	0.80%
RL2.2 Delivery Performance to Customer Commit Date	98.85%	0.58%
RL3.32 Delivery Time Accuracy	98.85%	0.58%
RL2.4 Perfect Condition	98.70%	0.89%
RL3.24 Percentage Orders Received with Product Quality Compliance	99.15%	0.62%
RL3.60 Percentage Orders Delivered with Product Quality Compliance	98.70%	0.89%
RL3.61 Presence of Quality Assurance System	Yes	

n=10

RS.1.1 Order Fulfilment Cycle Time

To calculate order fulfilment cycle time for dairy companies in New Zealand, data from three level-2 SCOR metrics was used. These metrics are:

➢ *RS.2.1 Source cycle time*
➢ *RS.2.2 Make cycle time*
➢ *RS.2.3 Deliver cycle time*

The source cycle time of dairy companies depends on geographic distance between the point of milk production and processing plant, and the number of milk collections per day. The respondents were asked for average time from farm to the company's plant. The milk collection frequency of the respondent dairy companies was variable along the dairy season and for milk volume of the individual dairy farms. During the peak season, milk is collected 'twice a day' from large dairy farms and 'once a day' from small dairy farms whereas during the off-peak season 'once a day' from large dairy farms and once in two days from small dairy farms. The source cycle time for 'once a day' milk collection was recorded as 24 hours and 48 hours for 'once in two days' milk collection.

The make cycle time was variable for each product line depending upon the length of production lead time. The deliver cycle time for chilled dairy products was less than that for ambient dairy products. Generally, the OFCT of the make-to-stock processes is equal to the delivery cycle time because the activities related to source, make, and deliver processes are performed simultaneously. Table 5.72 presents order fulfilment cycle time and its relevant level-2 SCOR metrics for respondent dairy companies in Pakistan.

Table 5.72 Order Fulfilment Cycle Time of Dairy Companies in New Zealand

SCOR Metrics	Mean Value	Standard Deviation
RS1.1 Order Fulfilment Cycle Time	24.00 hours	20.91 hours
RS2.1 Source Cycle Time	8.8 hours	6.25 hours
RS2.2 Make Cycle Time		
Fresh Milk	2.33 hours	0.58 hours
Milk Powders	12.00 hours	-
Butters and Fats	10.00 hours	-
Cheese	14.20 days	12.30 days
Others	16.83 hours	15.52 hours
RS2.3 Deliver Cycle Time		
Ambient Dairy	11.20 hours	22.69 hours
Chilled Dairy	14.40 hours	14.39 hours

n=10

AG.1.1 Upside Supply Chain Flexibility

The NZ dairy companies were quite flexible to any increase in demand of dairy products. However, the respondentds reported that an unusual increase in demand is unrealistic in dairy sector except during natural disasters. With the logistics function outsourced to 4PL providers NZ companies truly benefit from SC collaboration. All of the respondents reported that they do respond to a change in demand for dairy products. The upside supply chain flexibility of the respondent dairy companies for an unusual increase in demand was 4.5 days.

AG.1.4 Overall Value at Risk

All of the respondents reported that their business performance is being affected by various risk factors. These risk factros and relevant risk management strategies are briefly described as:

➢ Fluctuation in milk production with direct effect of weather.

➢ Foreign exchange risk affects sales, purchases, investments and borrowings made in foreign currencies – maintain financial assets in hard currencies such as USD and AUD.

➢ Interest rate risk affects company's borrowing and funds in deposit – actively hedge re-pricing against volatile interest rates

➢ Credit risk arises from company's receivables when customers fail to meet contractual obligations – secure trading according to importing country's trade regulations.

➢ Liquidity risk refers to the company's inability to meet its financial obligations when due – effectively manage operating cash flows.

➢ Capital risk poses non-optimal use of shareholders equity – maximise shareholder's value by optimal allocation of funds.

➢ Dairy products price risk posed by price volatility in global dairy trade – diversify product mix.

The mean value of VAR for respondent dairy companies in New Zealand was 23.6%.

CO.1.1 Supply Chain Management Cost

Supply chain management cost refers to the sum of costs to plan, source, make, deliver, return and mitigate risks. The mean value of SCM cost of the respondent NZ dairy companies as percentage of their supply chain revenue was 16.5%.

CO.1.2 Cost of Goods Sold

The cost of goods sold (COGS) of respondent NZ dairy companies refers to the cost associated with buying raw materials (such as milk, food additives etc.) and producing finished goods (including packaging). This includes all direct costs (such as labour, materials) and indirect production related overhead costs. The mean value of COGS of the respondent dairy companies as percentage of their supply chain revenue was 72.7%.

AM.1.2 Return on Supply Chain Fixed Assets

To calculate return on fixed assets ratio, one level-2 metric was used.

> ➤ *AM.2.5 Supply chain fixed assets*

The mean value of fixed assets of respondent NZ dairy companies was 1,100 million New Zealand dollars, whereas, the mean value of return on fixed assets ratio was 0.11.

AM.1.3 Return on Working Capital

To calculate working capital, three level-2 metric were used.

> ➤ *AM.2.6 Accounts payable*
> ➤ *AM.2.7 Accounts receivable*
> ➤ *AM.2.8 Inventory*

The mean value of working capital of respondent NZ dairy companies was 153 million New Zealand dollars, whereas, the mean value of return on fixed assets ratio was 0.36. Table 5.73 shows selected SCOR metrics to evaluate asset management of respondent dairy companies in New Zealand.

Table 5.73 Asset Management of Dairy Companies in New Zealand

SCOR Metrics	Mean Value	Standard Deviation
AM1.2 Return on SC Fixed Assets	0.11	0.05
AM2.5 SC Fixed Assets	1,100 million NZD	2,710 million NZD
AM1.3 Return on Working Capital	0.36	0.28
AM2.9 Working Capital	153 million NZD	512 million NZD

n=10

Overall, dairy products manufacturing in New Zealand was predominantly a cooperative business with private companies performing secondary processing for value addition to the dairy export mix. The respondent dairy companies reported a number of challenges to their performance. Milk supply from New Zealand dairy farms is highly unstable due to variable weather conditions. In addition to this, major share of NZ dairy exports is destined to few overseas markets with variable demand and ever changing exchange rates.

CHAPTER 6

6. DISCUSSION

6.1 Introduction

This chapter is about interpretation of the results presented in chapter 5. The discussion includes performance gap analysis between the key players in Pakistan and New Zealand milk supply chains. Independent sample t-test was used to compare mean values of individual SCOR metrics of key operators in the milk supply chains of Pakistan and New Zealand. The null hypothesis [H_0: $\mu_1 = \mu_2$] was that mean values of samples from two groups were equal to each other, whereas alternate hypothesis [H_1: $\mu_1 \neq \mu_2$] was that mean values of samples from two groups were not equal to each other. For p-value less than .05 for the two tailed t-test null hypothesis was rejected and alternate hypothesis was accepted, that means the mean value of samples from one group is significantly different from the mean value of samples from the other group. Following the introduction, this chapter is organized into four sections.

➢ Section 6.2 includes statistical comparison of mean SCOR metrics for dairy farmers in both the milk supply chains.

➢ Section 6.3 includes statistical comparison of mean SCOR metrics between informal milk supply chain in Pakistan and dairy companies in New Zealand.

➢ Section 6.4 includes statistical comparison of mean SCOR metrics for dairy companies in Pakistan and New Zealand.

➢ Section 6.5 summarises the discussion chapter.

6.2 Gap Analysis of Dairy Farmers

Dairy farming is the first interface of milk supply chain. To statistically compare SCOR means for dairy farmers from Pakistan and New Zealand, independent-sample two-tailed t-tests were performed for individual SCOR metrics. Table 6.1 illustrates that almost all SCOR metrics for NZ dairy farmers are significantly different from Pakistani dairy farmers. As discussed earlier in the results chapter that SCOR metrics are either upward or downward directed. The upward directed metrics are those for which higher value refers to the higher performance and vice versa, for example, perfect order fulfilment. Oppositely, for downward metrics lower value refers to higher performance and vice versa, for example, order fulfilment cycle time.

Table 6.1   Gap Analysis of Dairy Farmers

SCOR Metrics	Respondents	n	Mean	Std. Dev.	Gap	t-stat
Perfect order fulfilment (%) ↑	NZ dairy farmers	50	99.8710	.39617	10.78	.000*
	PK dairy farmers	210	89.0929	10.13163		
Order fulfilment cycle time (hours) ↓	NZ dairy farmers	50	33.7000	8.70433	19.3	.000*
	PK dairy farmers	210	14.3238	4.78533		
Upside supply chain flexibility (hours) ↓	NZ dairy farmers	NA	NA	NA	-	NA
	PK dairy farmers	70	24.0286	5.65934		
Overall value at risk (%) ↓	NZ dairy farmers	40	13.2228	14.34750	4.19	.009*
	PK dairy farmers	205**	9.2488	7.09263		
SCM cost (as % of SCR) ↓	NZ dairy farmers	50	14.4016	5.17025	6.85	.000*
	PK dairy farmers	210	7.5525	5.75886		
Cost of production (as % of SCR) ↓	NZ dairy farmers	50	51.1338	7.42204	7.97	.000*
	PK dairy farmers	210	59.1110	10.76393		
Return on fixed assets (Ratio) ↑	NZ dairy farmers	50	.1082	.08436	0.38	.000*
	PK dairy farmers	210	.4880	.41717		
Return on working capital (Ratio) ↑	NZ dairy farmers	50	1.2870	.73570	0.78	.000*
	PK dairy farmers	210	.5084	.32671		

* Significant at α = .05 and equal variances assumed
** Missing values refer to "No" value at risk

The perfect order fulfilment (POF) is an upward metric which measures SC reliability. The POF value for NZ farmers is higher than Pakistani farmers by almost 11%. Among others, two major reasons reported by the respondents for this performance gap are: First, the product as well as process quality at New Zealand dairy farms is ensured by an integrated quality assurance system in place. The milk quality at NZ dairy farms as well as the entire dairy chain is a collaborative responsibility of all the stakeholders including dairy farmers, dairy companies, regional councils, consultancy firms and regional councils, whereas no such quality assurance system is in practice at Pakistani dairy farms. Second, due to large average herd size (402 dairy cows (DairyNZ, 2014)) New Zealand dairy farmers can afford modern technologies such as automatic milk and cool chain infrastructure which ensures milk quality and safety during storage and transportation, whereas Pakistani dairy farmers are largely (92%) smallholder with 1-6 dairy animals which is why they cannot afford modern farming technologies such as automatic milk and coll chain infrastructure at dairy farm. The automatic milking of the dairy animals, chilling plants to store milk at dairy farm level, and refrigerated transport system to and from milk processing plant are the necessary components of a dairy

chain. Whether it is informal of formal chain of milk in Pakistan, the very first stage 'farm production' is critical for quality assurance. The issues of food safety, sanitary and hygienic conditions at milk production, handling and transport stages in Pakistan dairy chain have also been reported by earlier researchers (Anjum, et al., 1989; Khan et al., 2008; Sarwar, et al., 2002; Tariq, et al., 2008; Teufel, 2007; Wynn, et al., 2006). For example, Tariq et al. (2008) pointed out that farming community is unorganized and smallholder which is why they cannot afford farm infrastructure such as cold chain equipment. The Figure 6.1 shows a subsistence level farmer manually milk water buffalo in rural Pakistan.

Figure 6.1 A Rural Farmer in Pakistan

Source: Author

The order fulfilment cycle time (OFCT) is a downward metric which measures the SC responsiveness. Now-a-days the responsiveness has become the basis for competition among the supply chains. However, some processes in agri-food supply chains are not continuous, such as milk production, and they inherit a certain non-productive dwell time. Twice a day milking has 12 hours throughput time whereas once a day milking has 24 hours throughput time. The New Zealand dairy farmers reported that the dairy company collected milk in three formats: once a day, once in two days, and any

combination of the both in order to minimise milk transportation cost. The appropriate milk collection format depends on the time of year (as milk production varies with seasonality and lactation), herd size, and distance between dairy farm and factory. All the respondent dairy farmers in Pakistan reported twice a day milking of dairy animals. Therefore, the vast majority (80.5%) reported to supply milk twice a day to their customers. However, the remaining (19.5%) used to supply milk once a day mainly due to small volume of sales. The overall OFCT of Pakistani dairy farmers was almost 19 hours less than NZ dairy farmers.

Supply chain agility is measured as upside SC flexibility and value at risk. The upside SC flexibility is a downward metric which measures the ability of a business to response to any unusual increase in demand. The mean value for Pakistani dairy farmers was 24 hours whereas this does not apply to NZ dairy farmers because they already supply all the milk produced to the dairy cooperative or company. The overall value at risk (VAR) is a downward metric and was calculated as VAR as percentage of SC revenue. The VAR for NZ dairy farmers was higher than Pakistani dairy farmers by 4.19%. This performance gap is primarily due to the inherent differences in both the milk supply chains such as the dairy farming in New Zealand is pasture-based, exposed to highly fluctuating weather and employing huge capital investment in land resources whereas in Pakistan is fodder-based where animals are kept in barns and therefore, relatively less investment required for land.

The SC costs are divided into SCM cost and cost of milk production, both downward metrics. The SCM cost of Pakistani dairy farmers as percentage of their supply chain revenue (SCR) was 6.85% less than NZ dairy farmers. The prime reason behind this performance gap is the fundamental difference of scale of operation of the benchmarking partners. Majority (almost 63%) of the selected dairy farmers in Pakistan were smallholders (having less than 10 dairy animals). Moreover, milk transportation cost which is the largest contributor to SCM cost is not applicable to majority of the Pakistani farmers whereas this cost is deducted from farm gate milk pay out of all NZ dairy farmers. The cost of milk production as percentage of SCR of selected dairy farmers in Pakistan was almost 8% higher than NZ dairy farmers. Tariq et al. (2008) report a bunch of reasons for higher cost of milk production at Pakistani dairy farms. These are small scale of production, poor farm management practices, poor productivity per dairy animal, and seasonal variation in fodder availability. On the other side, dairy

farming in New Zealand is least cost due to its pasture-based milk production system whereas, Pakistani dairy farming is mainly fodder based which is a labour intensive milk production system.

The efficiency and effectiveness of doing business is gauged as return on investment. Asset management varies across geographical locations, cultural norms, regulatory structure, and managerial expertise. The SCOR model measures return on investment in terms of return on fixed (non-current) assets and return on working capital, both upward directed metrics. The value of return on fixed assets ratio for NZ dairy farmers was less than Pakistani dairy farmers with a performance gap of 0.38. This performance gap is mainly due to different structure of capital investment in both dairy industries. This relatively higher level of investment in fixed assets in NZ dairy farms is due to three factors. First, it is predominantly a pasture-based production system where huge capital investments are attached to land. Second, higher compliance cost which means investment in farm infrastructure including automatic milking parlour, chilling plant, effluent management. Third, is the investment in the form of share capital (wet shares) of cooperative which is a pre-requisite to become a cooperative member and to supply milk. On the other hand, Pakistani farmers utilize fixed assets such as land and machinery predominantly for crop farming and relatively less fixed invetment is required for stall-fed dairy production system. The value of return on working capital ratio for NZ dairy farmers was higher than Pakistani dairy farmers by 0.78. Despite of higher investment in the fixed assets at NZ dairy farms, farm working expenses were comparatively less due to the least cost pasture-based production system and economies of the large scale production. On the other hand, Pakistani smallholder farms were operating at diseconomies of the scale and at comparatively higher working expenses.

The above gap analysis can be summarised as the Pakistani dairy farmers under performed in supply chain reliability, cost of production, and return on working capital as compare to NZ dairy farmers. The majority of the Pakistani dairy farmers were smallholders and due to diseconomies of the scale of their operation they could not afford modern dairy farming technologies such automatic milking, milk storage at controlled temperature, and other precision dairy farming (PDF) technologies.

6.3 Gap Analysis of Informal Chain of Milk in Pakistan

As discussed in chapter 5 that the milk supply chain in Pakistan is a complex multi-echelon network. Milk and milk products reach ultimate consumers in two ways, the informal and the formal chain of milk. This section discusses the gap analysis between key players of informal chain of milk in Pakistan and dairy companies in New Zealand. The informal chain of milk in Pakistan is responsible for almost 95% of milk supply to the market. The informal chain represents the set of processes and activities involved in the flow of fresh/unprocessed milk and traditionally processed milk products from farm to ultimate consumer. The key players of informal chain are dairy farmers, milk collectors, and milk shops. As gap analysis of SCOR metrics for dairy farmers has already been covered in previous section, this section expands on milk collectors and milk shops. On the other hand, milk supply chain in New Zealand is completely formal, which means that all the milk produced at dairy farms is collected, transported, and processed by dairy companies according to the standard operating procedures set by New Zealand Ministry of Primary Industries. Table 6.2 represents the statistical comparison of mean SCOR metric values of NZ dairy companies with PK milk collectors and PK milk shops.

The milk collector is second key player of informal chain of milk in Pakistan. The functions and activities performed by milk collectors have been discussed in detail in results chapter. The mean value for perfect order fulfilment (POF) of milk collectors in Pakistan was 72.35% which shows statistically significant difference of 23.4% from mean value of POF for NZ dairy companies. Respondents reported two reasons for this performance gap. First, lack of cool chain storage and specialized transportation facilities. Similar to dairy farmers, milk collectors operate at diseconomies of the scale due to which they cannot afford modern technologies. Similar findings have been reported by a number of researchers in the past (Anjum, et al., 1989; Khan et al., 2013; Khan, et al., 2008; Sarwar, et al., 2002; Shahid et al., 2012; Tariq, et al., 2008; Teufel, 2007; Wynn, et al., 2006). Wynn et al. (2006) indicated that poor milk distribution infrastructure in Pakistan is a major constraint to milk supply chain. According to Khan et al. (2013) lack of infrastructure facilities and value addition are the major constraints in milk marketing system in Pakistan.

Table 6.2   Gap Analysis of Informal Chain of Milk in Pakistan

SCOR Metrics	Respondents	n	Mean	Std. Dev.	Gap	t-stat
Perfect order fulfilment (%)↑	NZ dairy companies	10	96.1510	1.63529		
	PK milk collectors	120	72.3571	10.02037	23.80	.000*
	PK milk shops	90	94.1917	6.80497	1.96	.368
Order fulfilment cycle time (hours) ↓	NZ dairy companies	10	24.00	20.913		
	PK milk collectors	120	20.10	5.644	3.81	.130
	PK milk shops	90	15.79	6.449	8.21	.006*
Upside supply chain flexibility (days) ↓	NZ dairy companies	10	4.5000	3.83695		
	PK milk collectors	97**	.6882	.64692	3.81	.000*
	PK milk shops	58**	.4714	.43686	4.03	.000*
Overall value at risk (%)↓	NZ dairy companies	10	23.6080	12.47055		
	PK milk collectors	120	10.1684	4.14875	13.44	.000*
	PK milk shops	84**	7.8845	3.15937	15.69	.000*
SCM cost (as % of SCR) ↓	NZ dairy companies	10	16.4900	8.15293		
	PK milk collectors	120	1.7723	1.25557	14.72	.000*
	PK milk shops	90	1.9708	1.23536	14.52	.000*
Cost of goods sold (as % of SCR) ↓	NZ dairy companies	10	72.7010	16.37208		
	PK milk collectors	120	80.7300	10.15256	7.64	.024*
	PK milk shops	90	91.2853	6.68001	18.59	.000*
Return on fixed assets (Ratio) ↑	NZ dairy companies	10	.1060	.04600		
	PK milk collectors	120	7.8240	7.07820	7.71	.001*
	PK milk shops	90	4.2232	5.65989	4.11	.024*
Return on working capital (Ratio) ↑	NZ dairy companies	10	.3610	.28006		
	PK milk collectors	120	10.1583	11.46376	9.80	.008*
	PK milk shops	90	4.0906	4.70340	3.73	.014*

* Significant at α = .05 and equal variances assumed
** Missing values refer to the response "No" for flexibility and/or value at risk

Second, majority of the respondents admitted that they perform a number of malpractices to increase milk volume such as by adding ice or decrease nutritional value such as de-creaming. Some of the respondents reported addition of urea fertilizer, ammonia, caustic soda, and some weeds like water caltrop powder to enhance viscosity of de-creamed or diluted milk. All these malpractices deteriorate milk quality to variable extent and are food safety hazards for consumers. This problem has also been reported by numerous researchers in the past (Akhtar, 2015; Aziz & Khan, 2014; Khan,

et al., 2013; Sarwar, et al., 2002). Sarwar et al. (2002) mentioned that the suppliers of milk in Pakistan practice one of the three ways of adulteration.

a) Dilution – mainly by adding water or ice.

b) De-creaming the milk before selling to customer

c) A combination of both (a) and (b)

According to Akhtar (2015) almost 80% of the total milk sold in tetrapacks or in the loose form in Pakistan is adulterated. Hydrogen peroxide, carbonates, bicarbonates, antibiotics, caustic soda, and formalin have been confirmed in the milk as adulterants.

The mean value of POF for respondent milk shops in Pakistan was not significantly different from NZ dairy companies. It is noteworthy here that respondent milk shops claimed a higher POF (94.2%) for the same milk they sourced from milk collectors with POF (72.4%). The respondent milk shops reported that they process raw milk for any impurities such as added water thus improving milk quality back to standard. Figure 6.2 shows (a) a milk collector on his way to collect milk from rural smallholder farms (b) a milk collector unloading milk at a local de-creamer shop before delivering to urban customers (c) a local de-creamer de-creaming milk (d) a corner milk shop processing milk in a large open pan after receiving from milk collector. The un-hygienic containers (noticeable in the figure 6.2) used for milk handling and transportation represent the state of process quality in the informal chain of milk in Pakistan.

The order fulfilment cycle time (OFCT) of respondent milk collectors and milk shops in Pakistan is shorter than dairy companies in New Zealand. However, the statistical comparison of the means shows that OFCT of milk collectors was not significantly different from NZ dairy companies. The reason is that more or less both collect and transport milk from dairy farms to milk shops (in case of Pakistan) or to processing plant (in case of NZ) once a day. However, the milk shops in Pakistan receive milk supply more than once a day. Figure 6.3 portrays milk flow in informal chain of milk in Pakistan.

Figure 6.2 Key Players of Informal Chain on Milk in Pakistan

A. A milk collector go to collect milk from dairy farmers in rural Punjab

C. A milk collector unloading milk for de-creaming before delivering to customers

B. A de-creamer skimming milk
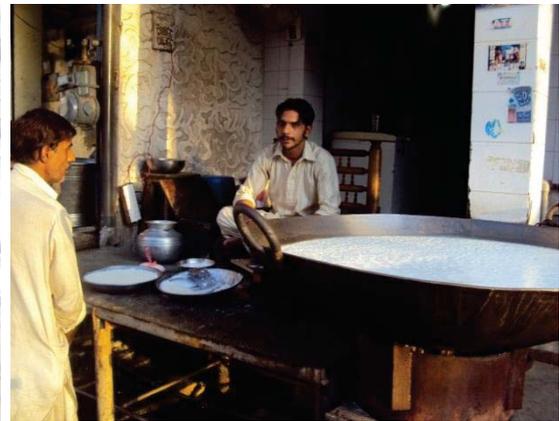
D. A corner milk shop in city

Source: Author

Figure 6.3 Order Fulfilment in the Informal Chain of Milk in Pakistan

Dairy Farmer	Milk Collector	Milk Shop
•Milk supply •Morning (5-7am) •Evening (3-5pm)	•Milk collection and transportation •Morning (6-9am) •Evening (4-6pm)	•Milk reception, processing, and retailing

Source: Author

The supply chain flexibility to respond to an unusual increase in demand of milk and milk products was significantly higher for respondent milk collectors and milk shops in Pakistan as compared to NZ dairy companies. The basic reason for this difference is the short order fulfilment cycle time in the informal chain of milk in Pakistan, as shown in

figure 6.3. The milk shop's process configuration was make-to-order with raw milk supply at fixed intervals. Moreover, small scale of operation allows milk collectors and milk shops in Pakistan to respond quickly to change in demand and manage accordingly. Similarly, value at risk for milk collectors as well as milk shops was significantly less than NZ dairy companies. The major reason is the structural advantage of small scale businesses over large businesses in managing risk efficiently.

The total cost as percentage of supply chain revenue of milk collectors and milk shops in Pakistan were less than NZ dairy companies. However, SCOR model divides supply chain costs into SCM cost and cost of goods sold (COGS). The gap analysis of SCOR metrics given in table 6.2 shows that the mean value of SCM cost as percentage of supply chain revenue for milk collectors (1.8%) and milk shops (1.9%) in Pakistan are significantly less than NZ dairy companies (16.5%). However, COGS as percentage of supply chain revenue for milk collectors (80.7%) and milk shops (91.3%) in Pakistan are significantly higher than NZ dairy companies (72.7%). Table 6.2 represents that major cost for both milk collectors and milk shops in Pakistan is the price of milk itself. All the overheads contribute a quite small proportion of the total cost, whereas, this is not the case with NZ dairy companies. Moreover, lower total costs for NZ dairy companies are a result of economies of the large scale.

The SCOR metrics used to gauge efficiency and effectiveness of doing business in terms of return on return on fixed assets and return on working capital, both upward directed metrics. The return on fixed assets ratios of selected milk collectors (7.8) and milk shops (4.2) in Pakistan were significantly higher than respondent dairy companies (0.1) in New Zealand. The major reasons behind this include very short cash-to-cash cycle time and least level of investment required to run such small level businesses in Pakistan. Due to pasture-based dairy production system in New Zealand, major share of investment in fixed assets goes to land. Moreover, compliance cost of New Zealand dairy farms is very high as compared to Pakistan where it is trivial. Similar to return on fixed assets ratio, return on working capital ratio of the selected milk collectors (10.15) and milk shops (4.09) in Pakistan were significantly higher than respondent dairy companies (0.36) in New Zealand.

The above gap analysis can be summarised in two steps. First, the key players (milk collectors and milk shops) of informal chain of milk are responsible for major share (almost 95%) of total milk marketed in Pakistan. Milk collectors collect fresh milk from

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smallholder farms and transport it to the milk shops (and/or urban household) without processing it. The retail milk shops sell as unprocessed milk or traditional dairy products. Whereas, in New Zealand all the milk produced is collected and processed formally by dairy companies. Second, the milk collectors and milk shops in Pakistan require a nominal investment to start such micro level businesses which operate at diseconomies of the scale.

6.4 Gap Analysis of Dairy Companies in Pakistan and New Zealand

The performance gaps between SCOR metrics of respondent dairy companies in Pakistan and New Zealand are shown in table 6.3.

Table 6.3   Gap Analysis of SCOR Metrics for Dairy Companies

SCOR Metrics	Respondents	n	Mean	Std. Dev.	Gap	t-stat
Perfect order fulfilment (%) ↑	NZ dairy companies	10	96.1510	1.63529		
	PK dairy companies	10	92.6920	3.97181	3.46	.020*
Order fulfilment cycle time (hours) ↓	NZ dairy companies	10	24.00	20.913		
	PK dairy companies	10	33.60	9.466	9.6	.203
Upside supply chain flexibility (days) ↓	NZ dairy companies	10	4.5000	3.83695		
	PK dairy companies	10	11.3000	1.63639	6.8	.000*
Overall value at risk (%) ↓	NZ dairy companies	10	23.6080	12.47055		
	PK dairy companies	10	25.3000	12.86727	1.69	.769
SCM cost (as % of SCR) ↓	NZ dairy companies	10	16.4900	8.15293		
	PK dairy companies	10	14.4495	1.68281	2.04	.448
Cost of Goods Sold (% of SCR) ↓	NZ dairy companies	10	72.7010	16.37208		
	PK dairy companies	10	81.4490	6.51758	8.75	.134
Return on fixed assets (Ratio) ↑	NZ dairy companies	10	.1060	.04600		
	PK dairy companies	10	.1240	.22102	0.01	.804
Return on working capital (Ratio) ↑	NZ dairy companies	10	.3610	.28006		
	PK dairy companies	9**	.3067	.40056	0.07	.734

* Significant at α = .05 and equal variances assumed

** one missing value corresponds to the outlier

Dairy products manufacturing companies in Pakistan as well as New Zealand represent standard processing of milk into various dairy products. The mean value of perfect order fulfilment of respondent dairy companies in Pakistan was significantly lower than those of New Zealand with a performance gap of 3.46%. The overall product quality is determined by the quality compliance along the entire supply chain, particulary at the dairy farm level. The milk production and handling at Pakistani dairy farms is typified as with poor quality compliance and lack of temperature control facilities. Therefore, chances for malpractices and adulteration are higher due to manual milking and handling of raw milk at dairy farms.

The mean value of order fulfilment cycle time of the respondent dairy companies in Pakistan was not significantly different from NZ dairy companies primarily because of similar processes involved in milk collection, transport, processing, and dirstibution. Figure 6.4 describes order fulfilment process in formal chain of milk in Pakistan. As dairy companies follow make-to-stock process configuration, therefore the orderfulfilment cycle time of the respondent dairy companies is the average time between order received from distributors and shipment actually received by the distributors.

Figure 6.4 Order Fulfilment in formal Chain of Milk in Pakistan
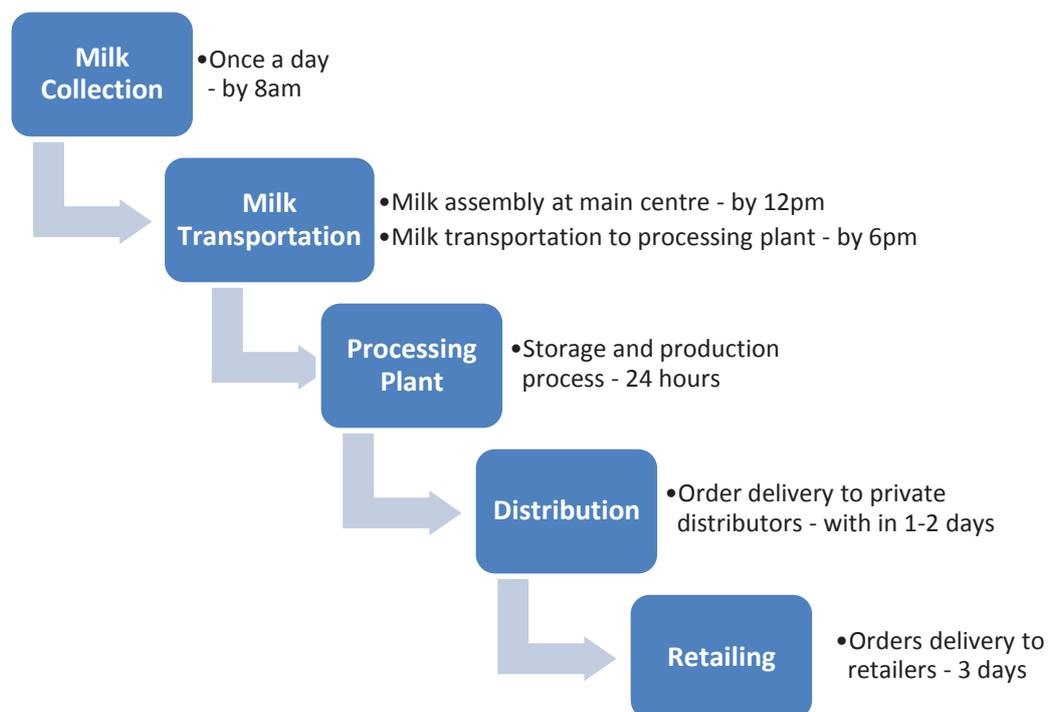
Source: Author

The mean value of flexibility of respondent dairy companies in Pakistan to an unusual increase in demand was significantly less than New Zealand dairy companies. The overall value at risk of respondent dairy companies in Pakistan was not significantly different from that of New Zealand dairy companies. apart from various risk factors affecting overall business value, macro economic indicators in Pakistan are not favourable in providing enabling environment to the businesses.

The overall cost of doing business for respondent dairy companies in Pakistan was not significantly different from NZ companies. Table 6.3 shows that among SC costs, the mean value of SCM cost as percentage of SCR of respondent dairy companies in Pakistan was not significantly lower than that of NZ dairy companies. The major contributing factor in the SCM cost of NZ dairy companies was their export orientation in addition to the domestic market. On the other hand, Pakistan dairy ompanies used to import milk powders to substitute their product mix during the months of low domestic supply, which increased their SCM cost. Table 6.3 also shows that the COGS of Pakistani companies was apparently higher than NZ ones by almost 9%, but t-stat computes it a non-significant difference provided the large standard deviation of NZ dairy campanies as compared to that of Pakistan. The respondent dairy companies in Pakistan reported significant losses of raw milk due to poor and unhygienic milk production and handling processes from farm to milk collection centre are the major contributors to the COGS.

The level of return on investment of respondent dairy companies in both countries was not significantly different from each other. Table 6.3 shows that return on fixed assets ratio of Pakistani companies was slightly higher than that of NZ by .01 showing negative gap, whereas, the return on working capital ratio was lower by .07 showing positive gap.

Overall, the gap analysis between the SCOR metrics of both benchmarking partners concludes that respondent dairy companies in Pakistani comparatively underperformed in reliability attribute and outperformed in flexibility attribute, whereas the mean values of remaining performance attributes were not significantly different from each other. The major reason behind positive performance gap in reliability attribute was the poor milk quality control in Pakistan from farm to milk collection centres of the dairy companies.

6.5 Key Findings and Recommendations

Since benchmarking is the process of looking at best practices leading to superior performance, the performance gaps identified in the dairy supply chain of Pakistan prove that there is an ample room for improvement. This section aims to look at possible corrective measures and best practices in context of Pakistan dairy industry. Salient findings of the gap analysis performed in this chapter can be summarised as:

➢ By and large dairy farmers in Pakistan are smallholders and dairy farming complementary to crop farming

➢ Majority of the dairy farmers, milk collectors, and milk shops in Pakistan operate at diseconomies of the scale.

➢ Due to diseconomies of the scale dairy farmers cannot afford modern technologies such as automatic milking, infrastructure to store milk at controlled temperature, and other precision dairy farming (PDF) technologies.

➢ There is no system of quality assurance in place (at least in practice) from the government.

These findings reveal that key players in the milk supply chain in Pakistan operate at subsistence level. Diseconomies of the scale is the root cause of all the issues undermining the overall performance of milk supply chain in Pakistan. Nonetheless, increasing competition in global agricultural markets incite agricultural producers to achieve scale economies in production, processing and marketing, and to coordinate along the supply chain to provide better channels of communication between producers and consumers. Agricultural cooperatives are one means of achieving scale economies and coordination along the entire food chain. Evans and Meade (2006) claim that modern cooperative form of enterprise has found successful application in farm production and processing and marketing of agricultural products. The critical success factor is homogeneity of interest among cooperative members which is further facilitated by product homogeneity (i.e. milk). Cooperative form of business can be defined as,

"A cooperative is an organisation in which those who transact with (i.e. "patronise") the organisation also own and formally control the organisation, and derive significant benefits from those transactions over and above any

financial returns they derive from their investment in the organisation" (Evans & Meade, 2006).

New Zealand dairy industry is the best example of successful agricultural cooperatives. Cooperative farming is part of a long and proud agricultural tradition in New Zealand. In dairy industry, farm production, dairy products manufacturing, distribution and retail sale is predominantly carried out by an amalgamation of producer and consumer cooperatives. This amalgamation benefits society in a number of ways. First, the cooperative form of business has ease of capital accumulation from its members in the form of pooling up resources to achieve economies of the scale as well as create wealth in comparatively less time. Second, the wealth created by the cooperatives is distributed among its members in the form of dividend per share which helps to decrease income inequality in the society. Third, the cooperatives enable small enterprises to gain bargaining power.

A number of reseachers found cooperative form of business performing better compared to independently owned firms (IOFs) (Painter, 2007; Parliament et al., 1989; Sabir et al., 2012). For example, Parliament et al. (1989) analyse relative performance of a sample of cooperatives and IOFs in the US dairy industry over 1971 – 1987. They found that the cooperatives performed significantly better than the IOFs in terms of leverage, liquidity and asset efficiency. In a comparison of dairy industries in Canada and New Zealand Painter (2007) conclude that due to cooperative farming New Zealand dairy farmers out performed in average farm size, cost and production efficiencies and prices paid to dairy farmers for their milk. Similarly, Sabir et al. (2012) compare production efficiency of cooperative and non-cooperative farming in Pakistan and identify that productivity of cooperative farmers was 38% higher than non-cooperative farmers.

Agriculture sector contributes 20.9% (Ministry of Finance, 2015) to Pakistan's GDP which highlights that any minor improvement implies significant impact. At the same time any policy recommendation must consider its good or bad impact on those 40.3% of the total population employed by this sector. Moreover, dairy farming in Pakistan is predominantly practiced as complementary to crop framing. Therefore, the recommendation must be equally applicable to other areas of agriculture. In Pakistan, agricultural cooperatives have not been very successful form of business in the past.

Khan (2008) views that the absence of external and internal pre-requisits of cooperative development are the major reasons of this failure. In a similar context, Garnevska et al. (2011) reported that a stable legal environment; a dedicated initiator and leader; government financial and technical support; farmer understanding and participation of cooperative activities and appropriate external support from professional NGOs were the key factors for the successful development of farmer cooperatives in Northwest of China.

To overcome the issue identified in this study responsible for undermining the overall performance of milk supply chain in Pakistan, promotion of agricultural cooperatives through policy intervention is recommended. To provide a cost benefit analysis and feasibility report for this recommendation is beyond the scope of this study due to time and resource constraints which are inherent part of academic research. However, a phased-out medium to long term strategy can better serve the needs of smallholder and subsistence level dairy farms in Pakistan enabling them to pool up resources, increase productivity and profitability and eventually to break the vicious cycle of poverty. The attainment and use of capital intensive farming technologies such as farming machinery, automatic milking, infrastructure to store milk at controlled temperature, and other precision dairy farming (PDF) technologies can be made possible for the subsistence level farmers who otherwise cannot afford due to diseconomies of the scale.

6.6 Summary

This chapter discusses the performance gaps between the key operators of milk supply chains of benchmarking partners. Independent sample t-test was used to compare mean values of individual SCOR metrics of key operators in the milk supply chains of Pakistan and New Zealand. The null hypothesis [H_0: $\mu_1 = \mu_2$] was that mean values of samples from two groups were equal to each other, whereas alternate hypothesis [H_1: $\mu_1 \neq \mu_2$] was that mean values of samples from two groups were not equal to each other. For p-value less than .05 for the two tailed t-test null hypothesis was rejected and alternate hypothesis was accepted, that means the mean value of samples from one group is significantly different from the mean value of samples from other group. The key findings of gap analysis of SCOR metrics are outlined as:

> ➤ By and large dairy farmers in Pakistan are smallholders and dairy farming is complementary to crop farming.

➢ Majority of the dairy farmers, milk collectors, and milk shops in Pakistan operate at diseconomies of the scale.

➢ Due to diseconomies of the scale dairy farmers cannot afford modern technologies such as automatic milking, infrastructure to store milk at controlled temperature, and other precision dairy farming (PDF) technologies.

➢ There is no system of quality assurance in place (at least in practice) from the government.

The key findings reveal that key players in the milk supply chain in Pakistan operate at subsistance level. Diseconomies of the scale is root cause of all the issues undermining the overall performance of milk supply chain in Pakistan. To overcome the issue identified in this study, promotion of agricultural cooperatives policy intervention is recommended. A phased-out medium to long term strategy to promote agricultural cooperatives can better serve the needs of smallholder and subsistence level dairy farms in Pakistan enabling them to pool up resources, increase productivity and profitability and eventually to break the vicious cycle of poverty. Cooperatives are the best way to introduce competitive prices for consumers and maximise returns for producers at the same time.

CHAPTER 7

7. CONCLUSION

7.1 Introduction

This chapter concludes the overall thesis under following sections.

> ➢ Section 7.2 reiterates the research objectives
> ➢ Section 7.3 links the results with research objectives of this study.
> ➢ Section 7.4 presents limitations of the research methodology used and the overall study.
> ➢ Section 7.5 is about the contribution of this study and future research.

7.2 Research Objectives

This study aims to examine the causes of poor performance of milk supply chain in Pakistan. For this purpose the milk supply chain in Pakistan was benchmarked against that of New Zealand with following research objectives.

Objective 1: to overview dairy industries of Pakistan and New Zealand.

Objective 2: to measure the performance of key players of milk supply chains in Pakistan and New Zealand.

Objective 3: to identify and analyse performance gaps between milk supply chains in Pakistan and New Zealand.

Objective 4: to suggest policy measures for the improvement of milk supply chain in Pakistan.

7.3 Linking Results with Objectives

The results from value chain analysis, SCOR analysis and gap analysis are discussed in detail in previous chapter. The key findings of these results are linked with the study objectives in the subsequest section.

Objectives 1: to overview dairy industries of Pakistan and New Zealand.

Chapter 2 provides a detailed description on the dairy industry from global as well as national perspectives which provides exploratory information about the milk supply

chains in Pakistan and New Zealand. Moreover, the pilot survey (in chapter 4) and value chain analysis (in chapter 5) were performed to develop a deeper understanding of the supply chain functions, activities, key operators, facilitators, and enablers in the milk supply chains of Pakistan and New Zealand.

The value chain analysis was performed to explore the benchmarking milk supply chains as well as to gauge the level of vale addition. The analysis of value distribution along the entire chain indicated:

➢ The informal chain of milk (unprocessed milk) in Pakistan had 22.39% ex-farmgate value addition, with the largest (almost 82%) share of the value captured by the dairy farmers.

➢ The formal chain of milk (processed milk) in Pakistan had 104.23% ex-farmgate value addition, with the largest (51%) share of the value captured by the dairy farmers.

➢ The milk supply chain in New Zealand had 216.83% ex-farmgate value addition, with the largest (55.6%) share of value captured by the retailers.

Objective 2: to measure the performance of key players of milk supply chains in Pakistan and New Zealand.

A framework based on SCOR model version 10 was developed (in chapter 4) and used to measure performance of key players in milk supply chains of Pakistan and New Zealand. The selected SCOR metrics for dairy farmers, milk collectors, milk shops and dairy companies in milk supply chain in Pakistan and for dairy farmers and dairy companies in New Zealand are presented in chapter 5. Moreover, these metrics were used to compare performance of both the benchmarking partners in the form of gap analysis (in chapter 6). The SCOR metrics are organised under five performance attributes: reliability, responsiveness, agility, cost, and asset. The SCOR metrics were computed according to the guidelines of SCOR model version 10. These was collected from the SC operators of both the benchmarking partners was presented in previous chapter supported with phenomenological discussion.

Objective 3: to identify and analyse performance gaps between milk supply chains in Pakistan and New Zealand.

The gap analysis of SCOR metrics was organised into three sentions: the dairy farming, the informal chain, and the formal chain. In first section the mean values of strategic level SCOR metrics for dairy farmers from Pakistan and New Zealand were compared. In second section the mean values of strategic level SCOR metrics for milk collectors and milk shops from Pakistan were compared with dairy companies in New Zealand. Whereas, in third section the mean values of strategic level SCOR metrics for dairy companies from Pakistan and New Zealand were compared The key findings are:

➢ Pakistani dairy farmers under performed in supply chain reliability, cost of production, and return on working capital as compare to NZ dairy farmers. The majority of the Pakistani dairy farmers were smallholders and due to diseconomies of the scale of their operation they could not afford modern dairy farming technologies such automatic milking, milk storage at controlled temperature, and other precision dairy farming (PDF) technologies.

➢ The Pakistani milk collectors underperformed in perfect order fulfilment, flexibility and cost of milk sold and outperformed in value at risk, SCM cost and return on assets as compared to NZ dairy companies.

➢ The Pakistani milk shops underperformed in cost of milk sold and outperformed in order fulfilment cycle time, flexibility, value at risk, SCM cost and return on assets as compared to NZ dairy companies.

➢ The Pakistani dairy companies underperformed in perfect order fulfilment and flexibility as compared to NZ dairy companies.

Objective 4: to suggest policy measures for the improvement of milk supply chain in Pakistan.

The ultimate objective of every business is to maximise the shareholder value. Appendix-E shows the linkage between SCOR metrics and shareholder value. The key findings of this study conclude that dairy farmers, milk collectors and milk shops in Pakistan operate as micro enterprises and small scale diseconomies is the root cause to many other issues such as mentioned in chapter 1. This study suggests to promote agricultural cooperatives as a phased-out medium to long term policy intervention. Agricultural cooperatives are one means of achieving scale economies and coordination along the entire food chain. Evans and Meade (2006) claim that modern cooperative form of enterprise has found successful application in farm production and processing

and marketing of agricultural products. Some earlier studies conducted in settings similar to this study, claim that cooperative farming is more profitable than non-cooperative farming (Riaz, 2008; Sabir, et al., 2012). However, the reasons of failure of cooperatives in developing countries must also be considered while formulating policies (Khan, 2008).

Farmer cooperatives are started mainly to source farm inputs (such as agricultural machinery, fertilizer, seed, and finance), farm services (such as consultancy and veterinary), market farm produce, and process agricultural commodities. For small holder farmers in Pakistan with fragmented landholdings cooperative farming is the most effective way to pool up resources, adopt advanced farming technologies such as automatic milking and cool chain infrastructure, and resultantly create more value of their farm produce through economies of the large scale. Once established, these cooperatives can extend their operations to processing as well and ultimately contribute to the expansion of the formal chain of milk in Pakistan.

7.4 Major Limitations of This Study

This study was largely descriptive in nature and focused on performance measurement and benchmarking in agri-food supply chain networks. However, it implies few limitations.

➢ This study included only key operators rather than all the stakeholders of the milk supply chain networks of Pakistan and New Zealand, mainly due to the time and cost constraints, which are usually attached with most of the academic research projects.

➢ The samples drawn from both the benchmarking populations were not statistically representative of their respective populations. The reasons were: time and cost contraints; and unavailability of the sampling frame for key SC operators such as milk collectors and milk shops in the milk supply chain in Pakistan. Lack of institutional support in distributing questionnaires to the New Zealand dairy farmers was another constraint.

➢ The SCOR performance measurement and benchmarking framework assumes that the participant companies use SCOR model to manage and measure performance and researcher's full access to the company's IT systems to retrieve the required information. It was a challenging task for the researchers to acquire

such information particularly from those companies or individuals not using IT systems or in worse case not maintaining accounting record of their business transaction. The respondents from the informal chain of milk in Pakistan were such examples. Utmost care was taken in preparing interview sheets and collecting data required to construct SCOR metrics for such respondents. The accounting principles for preparing financial statements were taken care of to the extent possible. However, the validity and reliability of such data may not be as higher as of the one retrieved from the company's financial statements and IT systems.

➢ The best practices reported by the respondents in the milk supply chain in New Zealand were not statistically tested for their positive impact on the business performance, however, they were discussed with the experts on dairy in New Zealand before recommending for the improvement of milk supply chain in Pakistan.

7.5 Contribution of This Study

This study contributes in two ways.

7.5.1   Contribution to Body of Knowledge

The literature on supply chain performance measurement is too large and multi-dimensional to develop a clear understanding from all aspects. The performance measurement frameworks found in the literature were reviewed against five criteria characterising agri-food supply chains. These criteria are balance between financial and non-financial performance measures, holistic to entire supply chain, food quality focus, risk assessment, and environmental sustainability. A number of past researchers have used criteria approach to evaluate existing performance measurement frameworks against a set of criteria and select an appropriate one (Beamon, 1999; Gunasekaran, et al., 2001; Neely, et al., 1995; Van der Spiegel, et al., 2004; Varma & Deshmukh, 2009). The review of literature revealed that no such performance measurement framework exists which satifies all five criteria characterising agri-food supply chains. This study abridged this research gap by developing a performance measurment and benchmarking framework for agri-food supply chains. The framework is based on SCOR model version 10 and incorporates food quality metrics relevant to milk supply chain. The

food quality metrics include product as well as process quality at all interfaces of a supply chain.

7.5.2 Contribution to Milk Supply Chains in Pakistan and New Zealand

The role of stakeholders of milk supply chains in Pakistan and New Zealand has been described in value chain analysis (in chapter 5). This research is helpful for milk supply chain stakeholders in Pakistan in a number of ways.

a) The past research on Pakistan dairy industry highlights a number of issues responsible for poor performance, such as those mentioned in chapter 1. This study concludes that small scale diseconomies is the key issue of farmers, milk collectors, and milk shops in Pakistan. Almost all of the other issues such as those mentioned in chapter 1 are somehow dependent on this issue. Moreover, this study suggests policy makers to promote agricultural cooperatives as a phased-out medium to long term policy intervention.

b) This document is helpful for key players of milk supply chain in Pakistan in improving output of their routine activities. For instance, it highlights various risk factors affecting their business value and best practices to effective risk management.

c) This study is helpful for relevant researchers in updating their understanding of the subject as well as for exploratory research. Moreover, the research work of this thesis presented at international conferences and published in scientific journals added to the literature on performance measurement and benchmarking in agri-food supply chains.

For milk supply chain in New Zealand, the performance measurement framework developed and used in this study documents performance benchmarks for dairy farmers and dairy products manufacturing companies. These benchmarks provide novel and unique SCOR metrics for New Zealand dairy industry.

7.6 Future Research

This study suggests future research in following areas:

➢ The food safety regulations in Pakistan are inadequate and outdated in global perspective. A benchmarking study of the food safety regulations of Pakistan against a benchmark with particular focus on the milk supply chain is needed.

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➢ The analytical framework developed in this study is scalable and can be replicated to other agri-food supply chains such as fruits, vegetables, and sea food.

➢ Further research is required on successful development of sustainable agricultural cooperatives in developing countries such as Pakistan.

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Appendix-A Definitions of Supply Chain

Author(s)	Definitions	Focus
Cavinato (1992, p. 285)	The supply concept consists of actively managed channels of procurement and distribution. It is the group of firms that add value along product flow from original raw materials to final customer. It concentrates upon relational factors rather than transactional ones.	Flow of goods, value addition, and relationship management.
La Londe and Masters (1994, p. 38)	A set of firms which pass materials forward.	Flow of goods.
Quinn (1997, p. 43)	All of those activities associated with moving goods from the raw-materials stage through to the end user. This includes sourcing and procurement, production scheduling, order processing, inventory management, transportation, warehousing, and customer service. Importantly, it also embodies the information systems so necessary to monitor all of those activities.	Flow of goods, IT monitoring and holistic approach.
Beamon (1998, p. 282)	An integrated manufacturing process wherein raw materials are converted into final products, then delivered to customers.	Integration, flow of goods, and manufacturing perspective
Christopher (1998, p. 15)	The network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer.	Integration, flow of goods and services, and customer value
Lambert, Stock and Ellram (1998, p. 504)	The alignment of firms that brings products or services to the market.	Flow of goods and services.
Swaminathan, Smith, and Sadeh (1998, p. 607)	A network of autonomous or semiautonomous business entities collectively responsible for procurement, manufacturing and distribution activities associated with one or more families of related products.	Flow of goods, integration, and manufacturing perspective
Lummus and Vokurka (1999, p. 11)	All the activities involved in delivering a product from raw material through to the customer including sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, delivery to the customer, and the information systems necessary to monitor all of these activities.	Flow of goods, IT monitoring, information sharing, and holistic approach.
Van der Vorst (2000b, p. 22)	A supply chain is a network of (physical and decision making) activities connected by material and information flows that cross organizational boundaries.	Flow of goods and information, integration, and holistic approach
Mentzer, et al. (2001, p. 4)	A set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer.	Flow of goods, services, finances, and information.

Appendix-B Definitions of Supply Chain Management

Author(s)	Definitions	Focus
Cooper and Ellram (1993, p. 13)	SCM is an integrating philosophy to manage the total flow of a distribution channel from supplier to ultimate customer.	Integration and flow of goods.
Berry, Towill, and Wadsley (1994, p. 20)	SCM aims at building trust, exchanging information on market needs, developing new products, and reducing the supplier base to a particular Original Equipment Manufacturer (OEM) so as to release management resources for developing meaningful, long-term relationship.	Relationship management and information sharing.
Christopher (1998, p. 18)	The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole.	Relationship management, efficiency, and effectiveness.
Lambert, et al. (1998, p. 504)	SCM is the integration of business processes from end user through organizational suppliers that provides products, services, and information that add value for customers.	Integration, value addition, and system approach.
Tan, Kannan, Hanfield and Ghosh (1999, p. 1035)	The simultaneous integration of customer requirements, internal processes, and upstream supplier performance is commonly referred to as supply chain management.	Integration, efficiency, and effectiveness.
Van der Vorst (2000b, p. 26)	SCM is the integrated planning, coordination and control of all logistical business processes and activities in the SC to deliver superior consumer value at less cost to the SC as a whole whilst satisfying the requirements of other stakeholders in the SC.	Integration, coordination, efficiency, consumer value, and system approach
Mentzer, et al. (2001, p. 18)	The systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long term performance of the individual companies and the supply chain as a whole.	Coordination, efficiency, effectiveness, and system approach.
Simchi-Levi, Kaminsky, and Simchi-Levi (2003, p. 1)	SCM is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandize is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements.	Integration, efficiency, responsiveness, and customer value.
Ellram, Tate, and Billington (2004, p. 17).	SCM is the management of information, processes, goods and funds from the earliest supplier to the ultimate customer, including disposal.	Flow of goods and funds, reverse logistics
Council of Supply Chain Management Professionals cited in Ballou (2007, p. 338)	Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies.	Planning, relationship management, integration, and system approach.

Appendix-C Supply Chain Performance Measurement Frameworks

Performance Measurement Systems	Balanced Approach	Holistic Approach	Food Quality Focus	Risk Assessment	Environmental Sustainability	Overall Focus
A. Function based measurement systems						
Christopher (1995)	×	√	×	×	×	Sourcing decisions based on average cost model
B. Dimension based measurement systems						
Neely et al. (1995)	√	×	√*	×	×	Quality, time, flexibility, and cost
Beamon (1999)	√	√	√*	×	×	Resource, output, and flexibility
Van der Vorst et al. (2000)	×	√	√	×	×	Simulate multi-echelon Dutch food systems in terms of cost and service.
Aramyan et al. (2007)	√	√	√	×	√*	Develop and validate PM framework for agri-food supply chain focusing efficiency, flexibility, responsiveness, and quality.
Ho (2007)	×	√	×	×	×	Use total related cost approach to evaluate ERP-base supply chains
Cai et al. (2009)	√	√	×	×	×	Resource, output, flexibility, innovativeness, information.
Hofmann and Locker (2009)	×	√	×	×	×	Value-based PMS aimed at maximising shareholder value
Joshi et al. (2012)	√	√	√	×	×	Evaluating cold chains in terms of cost, quality and safety, traceability, service level, return on assets, innovativeness, and relationship.

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C. Supply chain balanced scorecard

Author					Description
Kaplan and Norton (1992)	√	×	×	×	Develop balanced scorecard (BSC) to measure performance of an individual firm.
Brewer and Speh (2000)	√	×	×	×	Link BSC to supply chain performance measurement
Bhagwat and Sharma (2007b)	√	√*	×	×	Link BSC to supply chain performance measurement
Varma and Deshmukh (2009)	√	√*	√	×	Overcome shortcomings of BSC in evaluating supply chain performance
Bigliardi and Bottani (2010)	√	√	×	×	Evaluate food supply chains with BSC

D. Supply chain operations reference (SCOR) model

Author					Description
Stewart (1997)	√	√*	×	×	SCOR version 1 overview for operation excellence at cross-industry level.
Huang et al. (2005)	√	√*	×	×	Configuration of computer-assisted supply chains using SCOR version 5.
Hwang et al. (2008)	√	√*	×	×	Use SCOR version 7 to evaluate sourcing processes of Taiwan's TFT-LCD industry
Irfan et al. (2008)	√	√*	×	×	Present SCOR version 7 based computer-assisted SCM system in Pakistan Tobacco Company.
Liu (2009)	√	√*	×	×	Examine the effect of implementing ISO/TS-16949 on SC performance of SCOR using companies in Taiwan
Millet et al. (2009)	√	√*	×	×	Develop SCOR version 7 based approach for the alignment of information system and business processes

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Reference					Description
Li et al. (2011)	√	√	√*	×	Integrate SCOR version 9 and ISO 9000 series to analyse the impact of SC decisions on SC performance in China.
E. Hierarchical based measurement system					
Rangone (1996)	√	×	√*	×	Use analytical hierarchical process to compare performance of manufacturing units.
Li and O'Brien (1999)	√	√	×	×	Measure performance at SC and operation levels in terms of profit, lead time, delivery flexibility, and waste elimination.
Chan and Qi (**2003a**)	√	√	√*	×	Quantitative: cost, resource utilization. Qualitative: quality, flexibility, visibility, trust, and innovativeness.
Gunasekaran et al. (2004)	√	√	√*	×	Strategic, tactical, and operational focus.
Bhagwat and Sharma (2007a)	√	√	√*	×	Use analytical hierarchical process to evaluate SCM decisions
Li et al. (2007)	×	√	×	×	Structural and operational level performance in SC measured as productivity, cost, lead time, place, and service level
Fattahi et al. (2013)	√	√	√	√	A PMS for meat supply chain to evaluate financial indicators, quality and safety, customer service, efficiency, flexibility, and chain coordination.
F. Interface based measurement system					
Lambert and Pohlen (2001)	×	√	×	×	Managing performance at individual interfaces of a supply chain.
G. Perspective based measurement system					
Otto and Kotzab (2003)	×	√	×	×	To identify problems, their possible solutions, and to optimize the trade-off of measures among each perspective.

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Reference						Aim
Gerbens-Leenes et al. (2003)	×	√	×	×	√	Develop a measuring method for environmental sustainability in food production systems
Li et al (2005)	×	√	×	×	×	Strategic supplier partnership, customer relationship, information sharing, information quality, internal lean practices, and postponement.
La Forme et al. (2007)	√	√	√	×	×	Measure collaborative performance in supply chains
Yakovleva (2007)	×	√	√	×	√	Measuring sustainability of food supply chains
Papakiriakopoulos and Pramatari (2010)	√	√	×	×	×	Assess collaborative performance of a supply chain
Van der Vorst et al. (2013)	×	√	×	×	√	Measuring sustainability of food supply chains
Leat and Revoredo-Giha (2013)	×	√	√	√	×	A case study of risk assessment in Scotland's pork supply chain.
Zubair and Mufti (2015)	×	√	×	√	×	Risk assessment in dairy chains
Wiengarten and Longoni (2015)	×	√	√	×	√	Impact assessment of supply chain integration on sustainability

The symbols used are: × for NO, √ for YES, and √* for YES, BUT NOT SUFFICIENT.

Appendix-D Selected SCOR Metrics for Milk Supply Chain

Attribute	Level-1 Metric	Level-2 Metric	Level-3 Metric
Reliability	RL1.1 perfect order fulfilment	RL2.1 % orders delivered in full	RL3.33 delivery item accuracy RL3.35 delivery quantity accuracy
		RL2.2 delivery performance to customer commit date	RL3.31 customer commit date achievement time customer received RL3.34 delivery location accuracy
		RL2.4 perfect condition	RL3.14 percent orders meeting environmental performance RL3.24 % supplies received with product quality compliance RL3.60 % orders fulfilled free of health hazards RL3.61 % orders fulfilled with expiry date compliance RL3.62 % orders fulfilled with sensory properties compliance RL3.63 % orders fulfilled with convenience compliance RL3.64 % orders fulfilled with product composition compliance RL3.65 presence of quality assurance system
Responsive-ness	RS1.1 order fulfilment cycle time	RS2.1 source cycle time RS2.2 make cycle time RS2.3 deliver cycle time RS2.4 delivery retail cycle time	
Agility	AG1.1 upside SC flexibility AG1.4 value at risk		
Costs	CO1.1 SCM cost	CO2.1 cost to plan CO2.2 cost to source CO2.3 cost to make CO2.4 cost to deliver CO2.5 cost to return CO2.7 cost to mitigate	
	CO1.2 cost of goods sold		CO3.140 direct labour cost CO3.141 direct material cost CO3.155 indirect cost related to production
Assets	AM1.2 return on fixed assets	AM2.5 fixed assets	
	AM1.3 return on working capital	AM2.9 working capital	

Source: Adapted from (Supply Chain Council, 2012)

Grey area highlights food quality metrics added to SCOR model for performance measurement in milk supply chains in Pakistan and New Zealand.

Appendix-E Linking SCOR Metrics with the Business Performance

```
Shareholder Value
├── Increase SC Revenue
│   ├── ↑ Perfect Order Fulfilment
│   │   ├── ↑ Order Fill Rate
│   │   ├── ↑ Product Quality
│   │   └── ↑ Process Quality
│   ├── ↓ Order Fulfilment Cycle Time
│   │   ├── ↓ Source Cycle Time
│   │   ├── ↓ Make Cycle Time
│   │   └── ↓ Deliver Cycle Time
│   └── ↑ Upside SC Flexibility — ↓ Order Fulfilment Cycle Time
├── Reduce SC Costs
│   ├── ↓ SCM Cost — ↓ Procurement and distribution costs
│   └── ↓ COGS — ↑ yield and ↓ waste of production process
└── Improve ROI
    ├── ↓ Non-Current Assets
    ├── ↓ Working Capital
    │   ├── ↓ Cash-to-cash cycle time
    │   └── Optimise inventory management
    └── ↓ Overall Value at Risk
        ├── Comply with food regulations
        └── Implement SOPs for SC processes
```

Appendix-F Approval Letter from Massey University Human Ethics Committee

MASSEY UNIVERSITY

4 August 2011

Muhammad Moazzam
2/85 Linton Street
West End
PALMERSTON NORTH 4410

Dear Muhammad

Re: **Benchmarking Pakistan and New Zealand Milk Industry Supply Chains**

Thank you for your Low Risk Notification which was received on 3 August 2011.

Your project has been recorded on the Low Risk Database which is reported in the Annual Report of the Massey University Human Ethics Committees.

The low risk notification for this project is valid for a maximum of three years.

Please notify me if situations subsequently occur which cause you to reconsider your initial ethical analysis that it is safe to proceed without approval by one of the University's Human Ethics Committees.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor John O'Neill, Director (Research Ethics), telephone 06 350 5249, e-mail humanethics@massey.ac.nz".

Please note that if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to provide a full application to one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

John G O'Neill (Professor)
Chair, Human Ethics Chairs' Committee and
Director (Research Ethics)

cc   Dr Norman Marr   Dr Elena Garnevska
        Institute of Food, Nutrition and Human Health   Institute of Food, Nutrition and Human Health
        PN452   **PN452**

        Prof Richard Archer, HoI
        Institute of Food, Nutrition and Human Health
        PN452

Appendix-G Cover Letter for Survey Debriefing

Dear Sir/Madam,

My name is Muhammad Moazzam and I am undertaking PhD degree under the supervision of Professor Norman E. Marr, N.E.Marr@massey.ac.nz Co-Director of Logistics and Supply Chain Management at Massey University, New Zealand. My research entitled "Benchmarking Agri-food Supply Chain Networks" aims to measure and benchmark the performance of milk supply chain networks in the dairy industries of Pakistan and New Zealand. It would be very much appreciated if you could complete the survey questionnaire which is designed to estimate the performance and best practices leading to superior performance in New Zealand Dairy Industry.

We respect your rights to:

1. Not answer any particular question or abandon the survey at any level.
2. Provide information on the understanding that it is completely confidential to the research team only and will be used solely for the academic research purpose. Confidentiality of information will be ensured in a way that it will not be possible to identify you or your company in any reports prepared from this study.
3. Be given the access to the summary of findings, once concluded.

Your cooperation and valuable information will be highly appreciated.

Best Regards,

Muhammad Moazzam
PhD Candidate
Logistics & Supply Chain Management,
School of Engineering & Advanced Technology
Massey University, PN, New Zealand
E: M.Moazzam@massey.ac.nz

Appendix-H Questionnaire for Dairy Farmers in Pakistan

Please answer these questions with information from your dairy farm's 2012-13 accounts

1. What is your current position at this dairy farm? Please specify ------------------------

2. For how long you have been working at this dairy farm? --------------------------- (Years)

3. What is the highest education level you have completed?

   a) No formal edcation   b) School Certificate
   c) University Entrance/Diploma   d) Degree
   e) Postgraduate Degree/Diploma   f) Other (Please specify)

4. What was the total number of dairy animals at your farm?

   a) Buffalos   b) Cows
   c) Other (please specify)

5. What was the total milk production per day at your dairy farm (litres)?

   a) Buffalos   b) Cows
   c) Other (please specify)

6. How often did you milk these dairy animals?

   a) Once a day (How many of total dairy animals ----------)
   b) Twice a day (How many of total dairy animals ----------)
   c) Other (Please specify)

7. What milk volume was sold daily to the following (Ltrs.)?

	Buffalo Milk		Cow Milk		Other	
	Ltrs.	*PKR/Ltr.*	*Ltrs.*	*PKR/Ltr.*	*Ltrs.*	*PKR/Ltr.*
a) Gawala						
b) Neighbourhood						
c) Milk Shop						
d) Urban Households						
e) Other						

8. How often did you sell/deliver milk to your customers?

   a) Once a day (and for how many days of the month? ------------------)
   b) Twice a day (and for how many days of the month? ------------------)
   c) Other (Please specify--)

9. What was your point of milk sale?

   a) At farm gate   b) Deliver at customer's place
   c) Other (please specify)

10. How your customers used to measure quality of milk?

11. What percentage of your customers was satisfied with:

   a) Product shelf life (Freshness) ---------- (%)   b) Sensory properties ------------ (%)
   c) Product safety (hazard free) ----------- (%)   d) Fat contents -------------------- (%)
   e) Right quantity -------------------------- (%)   f) Other (please specify) ------- (%)

12. Did any government or private organization conducted quality assurance audit at your farm?

   a) Yes   b) No

   If Yes, what was the name of that organization?

13. In case of an unusual increase in demand, what is the maximum time you require to fulfil orders on sustainable/recurring basis (hours or days)?

14. Was your dairy farms' income affected by risk?

   a) Yes (go to question-15)   b) No (go to question-18)

15. What types of risk are you facing?

16. What techniques did you employ to manage risk?

17. What was the overall value of your dairy business at risk (Value at Risk) (Rs)?

18. How many full time workers worked at your dairy farm?

19. Please provide the following financial information.

Financial Indicators (Monthly)	Amount in PKR
a) Salaries	
b) Cost to source	
c) Cost to make (cost of production)	
d) Cost to deliver (If any)	
e) Inventory (includes dairy animals, equipment, cash in hand, feed and other inventory)	
f) Account payables	
g) Account receivables	
h) Total value of non-current/fixed assets (includes building, land and machinery)	

20. Did you follow any specific operational plan for your routine dairy farm activities?

   a) Yes   b) No

21. Did you benchmark your annual performance level with best-in-class performance?

   a) Yes   b) No

22. Would you like to mention any best practice(s) you used at your dairy farm?

Appendix-I Questionnaire for Milk Collectors in Pakistan

Please answer these questions with information from your business's 2012-13accounts

1. What is your current position in this business? Please specify ----------------------------------

2. For how long have you been in this business?

   a) 0-5 years

   b) 6-10 years

   c) 11-20 years

   d) 21 years and above

3. What is the highest education level you have completed?

   a) No formal edcation

   b) School Certificate

   c) University Entrance/Diploma

   d) Degree

   e) Postgraduate Degree/Diploma

   f) Other (Please specify)

4. What was your source of milk supply?

   a) Dairy farmer

   b) Milk collector

   c) Your own dairy farm

   d) Other (Please specify)

5. How often did you collect milk per day?

   a) Once a day

   b) Twice a day

   c) Other (Please specify)

6. What milk volume was purchased daily from the following?

Buffalo Milk		Cow Milk		Mixed	
Ltrs.	PKR/Ltr.	Ltrs.	PKR/Ltr.	Ltrs.	PKR/Ltr.

7. From how many suppliers did you source milk?

8. How did you pay to your suppliers?

   a) Cash ------------------------------------ (%)

   b) Credit ------------------------------- (%)

   c) A combination of both

   d) Other (Please specify)

9. How did you measure milk quality?

10. What percentage of total monthly milk supply did not with mutually agreed level of quality for following parameters?

    a) Inhibitory substances --------------------- (%)

    b) Sensory evaluation ---------------- (%)

    c) Fat contents ------------------------------- (%)

    d) Other (Please specify) ------------ (%)

11. Did you process milk?

    a) Yes

    b) No

    If yes, what was the average processing cycle time (Hours)?

12. To whom did you sell milk and/or milk products?

    a) Milk Collector

    b) Milk Shop

    c) Urban Households

    d) Other (Please specify)

13. What was the milk volume sold daily to the following?

Milk Collector		Milk Shop		Urban Households		Other	
Ltrs.	PKR/Ltr.	Ltrs.	PKR/Ltr.	Ltrs.	PKR/Ltr.	Ltrs.	PKR/Ltr.

14. How did your customers pay you?

    a) Cash ------------------------------------ (%)

    b) Credit ------------------------------ (%)

    c) A combination of both

    d) Other (Please specify)

15. What percentage of your customers was satisfied with:

 a) Product shelf life (Freshness) ---------- (%)   b) Sensory properties --------------- (%)
 c) Product safety (hazard free) ----------- (%)   d) Fat contents ----------------------- (%)
 e) Right quantity -------------------------- (%)   f) Other (Please specify) ---------- (%)

16. Were your milk handling and transportation operations regularly audited for quality assurance by any Govt. or a private organization?

 a) Yes   b) No
 If Yes, provide the name(s) of organization(s).

17. In case of an unusual increase in demand or variable weather condition, what is the maximum time you require to resume your business on sustainable/recurring basis (hours or days)?

18. Did your business face any risk?

 a) Yes (go to question-20)   b) No (go to question-24)

19. What types of risk your business faced?

20. What techniques did you employ to manage risk?

21. What was the overall value of your business at risk (Value at Risk) (PKR)

22. How many full time workers worked with you in this business?

23. Please provide the following financial information.

Financial Indicators-Monthly	Amount in PKR
a) Salaries	
b) Transportation Cost	
c) Fixed assets (like Milk drums, vehicle etc.)	
d) Account payables	
e) Account receivables	

24. Would you like to mention any other best practice(s) you used at your business?

Appendix-J Questionnaire for Milk Shops in Pakistan

Please answer these questions with information from your business's 2012-13 accounts

1. What is your current position in this business? Please specify -------------------------------

2. For how long have you been in this business?
   a) 0-5 years
   b) 6-10 years
   c) 11-20 years
   d) 21 years and above

3. What is the highest education level you have completed?
   a) No formal edcation
   b) School Certificate
   c) University Entrance/Diploma
   d) Degree
   e) Postgraduate Degree/Diploma
   f) Other (Please specify)

4. What was your source of milk supply?
   a) Dairy farmer
   b) Milk collector
   c) Your own source
   d) Other (Please specify)

5. How often did you source milk daily?
   a) Once a day
   b) Twice a day
   c) Other (Please specify)

6. What milk volume was purchased daily?

Buffalo Milk		Cow Milk		Others	
Ltrs.	PKR/Ltr.	Ltrs.	PKR/Ltr.	Ltrs.	PKR/Ltr.

7. From how many suppliers did you buy milk?

8. How did you pay to the suppliers of milk?
   a) Cash ------------------------------------ (%)
   b) Credit ---------------------------- (%)
   c) Other (Please specify)

9. How did you measure milk quality?

10. What percentage of total monthly milk supply did not comply with the mutually agreed level of quality for following parameters?
    a) Inhibitory substances ------------------- (%)
    b) Sensory evaluation -------------- (%)
    c) Fat contents ---------------------------- (%)
    d) Other (Please specify) ---------- (%)

11. What milk products did you sell?
    a) Fresh milk
    b) Milk Shake
    c) Yoghurt
    d) Tea
    d) Sweets and Bakery
    e) Other (Please specify)

12. What quantities of milk and/or milk products were sold daily?

Fresh Milk		Milk Shake		Yoghurt		Tea		S & Bakers		Other	
Ltrs.	PKR /Ltr.	Ltrs.	PKR /Ltr.	Ltrs.	PKR /Ltr.	Ltrs.	PKR /Ltr.	Ltrs.	PKR /Ltr.	Ltrs.	PKR /Ltr.

13. How did your customers pay you?
    a) Cash ------------------------------------ (%)
    b) Credit ------------------------------------
    c) Other (Please specify)

14. What percentage of your customers was satisfied with:

    a) Product shelf life (Freshness) ----------- (%)   b) Sensory properties --------------- (%)

    c) Product safety (hazard free) ------------- (%)   d) Fat contents ---------------------- (%)

    e) Right quantity --------------------------- (%)   f) Other (Please specify) ---------- (%)

15. What was the average processing cycle time (time from milk supply received until a product is ready for sale) dairy products (hours)?

    a) Fresh milk --------------------------------------   b) Milkshake --------------------------------------

    c) Yoghurt --------------------------------------   d) Tea --------------------------------------

    e) Sweets and Bakery ----------------------------   f) Other (Please specify)

16. Was your milk shop regularly audited for quality assurance by any Govt. or a private organization?

    a) Yes   b) No

    If Yes, provide the name(s) of organization(s).

17. In case of an unusual increase in demand or variable weather condition, what is the maximum time you require to resume your business on sustainable/recurring basis (hours)?

18. Did your business face any risk?

    a) Yes (go to question-19)   b) No (go to question-22)

19. What types of risk were faced by your business?

20. What techniques did you employ to manage risk?

21. What was the overall value of your business at risk (Value at Risk) (PKR)

22. How many full time workers worked at shop?

23. Please provide the following financial information

Financial Indicators	Amount in PKR
a) Salaries	
b) Bills	
c) Shop Rent	
d) Fixed assets (like shop utilities)	
e) Account payables	
f) Account receivables	

24. From the following best practices select all which were in use at your company and describe briefly the reason/problem they address.

a) Carrier Agreement	
b) Customer relationship management system	
c) Electronic data interchange (EDI)	
d) Full visibility of inventory and demand to all supply chain participants	
e) Performance measurement and reporting system	
f) Outsource non-core activities to third party	
g) Supplier performance assessment system	
h) Benchmark performance level with best-in-class	

25. Would you like to mention any other best practice(s) you are using at your company?

Appendix-K Questionnaire for Dairy Companies in Pakistan

Please answer these questions with information from your company's 2012-13 accounts

1. What is your current position in this company? Please specify -------------------------------

2. For how long have you been in this company?
   - a) 0-5 years
   - b) 6-10 years
   - c) 11-20 years
   - d) 21 years and above

3. What is the highest education level you have completed?
   - a) No formal edcation
   - b) School Certificate
   - c) University Entrance/Diploma
   - d) Degree
   - e) Postgraduate Degree/Diploma
   - f) Other (Please specify)

4. What percentage of total revenue of your company was from dairy products (%)?

5. What was the average source cycle time (from dairy farms to the company's processing plants) of raw milk (hours)?

6. What was the average make cycle time (from start of processing to finished goods including incubation time, if any) (hours).
   - a) Liquid milk
   - b) Milk powders
   - c) Cream and Butter
   - d) Cheese
   - e) Others

7. What was the average customer order delivery cycle time (from order placement to order received by the customer) (hours).
   - a) Chilled dairy
   - b) Ambient dairy

8. Was your company part of a quality assurance system?
   - a) Yes
   - b) No

   If Yes, provide the name(s) of organization(s).

9. Did your company generate any waste?
   - a) Yes
   - b) No

   If yes, provide type of waste generated and percentage treated/recycled before disposing off.
   - a) Liquid waste generated (Tons) ----------------- treated/recycled (%) -----------------
   - b) Solid waste generated (Tons) ------------------ treated/recycled (%) ------------------
   - c) Carbon emissons produced (Tons CO_2 equivalent) -------------------------------------

10. In case of supply chain disruption (due to a natural disaster), what is the maximum number of days required by your company to deliver orders on a sustainable/recurring basis (days)?

11. Did your company face any risk?
    - a) Yes (go to question-11)
    - b) No (go to question-14)

12. What types of risk your company faced?

13. What techniques did your company employ to manage risk?

14. What was the overall value of your dairy business at risk (Value at Risk) (PKR)?

15. What was the total annual milk supply received by your company (in million litres)?

16. What was the source of milk supply of your company?
   a) Dairy farmers   b) Milk collectors
   c) Company's own milk collection network

17. What percentage of total annual milk supply was rejected/underpaid/penalised by your company due to non-adherence to the following quality parameters:
   a) Somatic Cell Count ---------------------- (%)   b) Bactoscan -------------------------- (%)
   c) Inhibitory substances -------------------- (%)   d) Sensory evaluation ---------------- (%)
   e) Right quantity --------------------------- (%)

18. What was the total number of sales orders (or value of ordered quantities in million PKR), received by your company from its Pakistani customers?

19. What was the actual order fill rate of your company for the orders received from Pakistani customers?

20. What percentage of the orders delivered to the NZ customers was rejected or returned?

21. What percentage of total quantities(or value in million PKR) of dairy products delivered to your company's Pakistani customers were received by them:
   a) With right quantity --------------------- (%)   b) At committed date and time ----- (%)

   c) With accurate documentation (i.e. invoice, payment etc.) -------------------------- (%)

22. What was the annual revenue of your company (PKR)?

23. What was the annual cost of goods sold (PKR)?

24. What was the annual supply chain management cost (PKR)?

25. What was the working capital employed (PKR)?

26. What was the total value of non-current/fixed assets (PKR)?

27. From the following best practices please select all which are under use at your company and describe briefly the reason/problem they address.

a) Enterprise Resource Planning (ERP) system	
b) Available-to-promise inventory system	
c) Carrier Agreement	
d) Collaborative Planning, Forecasting & Replenishment	
e) Integrated Sales and Operations Planning	
f) Customer relationship management system	
g) Electronic data interchange (EDI)	
h) Full visibility of inventory and demand to all supply chain participants	
i) Performance measurement and reporting system	
j) Wave picking (to consolidate LTL's into TL's)	
k) Outsource non-core activities to third party	
l) Supplier performance assessment system	
m) Benchmark performance level with best-in-class	

28. Would you like to mention any other best practice(s) you are using at your company?

29. Should you wish to receive a summary of report?
   a) Yes (provide your details below)   b) No
   Full Name: Email Address:

Appendix-L Questionnaire for New Zealand Dairy Farmers

Please answer these questions with information from your dairy farm's 2012-13 accounts

1. What is your current position at this dairy farm? Please specify ----------------------------

2. In what region of New Zealand is your farm(s) located? ---------------------------------------

3. For how long you have been involved in dairy farming?---------------------------- (Years)

4. What is the highest education level you have completed?
    a) No formal edcation   b) School Certificate
    c) University Entrance/Diploma   d) Degree
    e) Postgraduate Degree/Diploma   f) Other (Please specify)

5. What is the total number of dairy cows (peak numbers) at your dairy farm? ---------------

6. How often do you milk these dairy cows?
    a) Once a day (----------------- % of total dairy cows)
    b) Twice a day (--------------- % of total dairy cows)

7. Is the owner of this dairy farm a member of a dairy cooperative?
    a) Yes   b) No (go to question-9)
    If Yes, please provide the name of that dairy cooperative -------------------------------------
    No. of shares held ---

8. How often the milk tanker collects milk from your dairy farm?
    a) Once a day (and for how many days or weeks of the year? ------------------------------)
    b) Once in two days (and for how many days or weeks of the year? -----------------------)

9. Is the owner of this dairy farm a member of any other cooperative (for dairy inputs like feed, fertilizer, farm machinery, animal health etc.)?
    a) Yes   b) No
    If Yes, please provide the name(s) of cooperative(s)

10. Is your dairy farm part of a quality assurance system?
    a) Yes   b) No
    If Yes, which organization(s) conducts quality assurance audit at your dairy farm?

11. Which one of the five dairy production systems you fall in?
    a) System-1 (All grass self-contained)
    b) System-2 (4-14% of total feed is imported, for dry cows or cows grazed off)
    c) System-3 (10-20% of total feed is imported, for dry cows and extended lactation)
    d) System-4 (20-30% of total feed is imported, for dry cows and extended lactation)
    e) System-5 (25-40% of total feed is imported and used all year)

12. What is the number of cows per hectare (or comparative stocking rate) at your dairy farm?

13. Are you practicing Split-Calving at your dairy farm?
    a) Yes   b) No

14. Are you practicing precision dairy farming (PDF) at your dairy farm?
    a) Yes   b) No

15. Is your dairy farms' income being affected by risk?
    a) Yes   b) No (go to question-19)

16. What types of risk are you facing?

17. What techniques do you employ to manage risk?

18. What is the overall value of your dairy business at risk (Value at Risk) (NZD)?

19. What was the total annual milk supply from your dairy farm? ----------------------(KgMS)

20. Did the cooperative penalize you (got a grade/demerit point) for sub-standard milk quality?
    a) Yes   b) No (go to question-23)

21. What was the level of penalty or number of milk solids rejected by the cooperative (value in $ or Kgs. of Milk Solids)?

22. What percentage of the penalised value or the milk solids rejected was due to:
    a) Somatic Cell Count --------------------- (%)   b) Thermoduric plate count ------- (%)
    c) Bactoscan ----------------------------- (%)   d) Inhibitory substances ----------- (%)
    e) Milk temperature ----------------------- (%)   f) Others --------------------------- (%)

23. What was the average cost of production of milk (in NZD/KgMS)?

24. What was the annual supply chain management cost (all overhead costs e.g. admin cost, insurance, cooperative membership)?

25. What was the working capital employed (NZD)?

26. What was the total value of non-current/fixed assets?

27. Do you follow any specific written operational plan for your routine dairy farm activities?
    a) Yes   b) No

28. Do you benchmark your annual performance level with best-in-class performance (e.g. Dairybase or within discussion groups)?
    a) Yes   b) No

29. Would you like to mention any best practice(s) you are using at your dairy farm?

30. Should you wish to receive a summary of report? (Please provide your contact details)
    Full Name: Email Address

Appendix-M Questionnaire for New Zealand Dairy Companies

Please answer these questions with information from your company's 2012-13 accounts

1) What is your current position in this company? Please specify --------------------------------

2) For how long have you been in this company?
   a) 0-5 years
   b) 6-10 years
   c) 11-20 years
   d) 21 years and above

3) What is the highest education level you have completed?
   a) No formal edcation
   b) School Certificate
   c) University Entrance/Diploma
   d) Degree
   e) Postgraduate Degree/Diploma
   f) Other (Please specify)

4) Does your company sell its dairy products in the New Zealand market?
   a) Yes
   b) No (Please abandon the survey)

5) What percentage of total revenue of your company comes from dairy products (%)?

6) What is the average source cycle time (from dairy farms to the company's processing plants) of raw milk (hours)?

7) What is the average storage cycle time (from receiving to start of processing) of raw milk at your company's milk processing plants (hours)?

8) What is the average processing cycle time and average customer order delivery cycle time (hours)?

9) What is the average processing cycle time (from start of processing to finished goods including incubation time, if any) (hours).
   a) Liquid milk
   b) Milk powders
   c) Cream and Butter
   d) Cheese
   e) Others

10) What is the average customer order delivery cycle time (from order placement to order delivery) (hours).
   a) Chilled dairy
   b) Ambient dairy

11) Is your company part of a quality assurance system?
   a) Yes
   b) No
   If Yes, provide the name(s) of organization(s).

12) Did your company generate any waste?
   c) Yes
   d) No
   If yes, provide type of waste generated and percentage treated/recycled before disposing off.
   d) Liquid waste generated (Tons) ---------------- treated/recycled (%) -----------------
   e) Solid waste generated (Tons) ------------------ treated/recycled (%) -----------------
   f) Carbon emissons produced (Tons CO_2 equivalent) -------------------------------------

13) In case of supply chain disruption (due to a natural disaster), what is the maximum number of days required by your company to deliver orders on a sustainable/recurring basis (days)?

14) Is your company facing any risk?
   a) Yes (go to question-14)
   b) No (go to question-17)

15) What types of risk is your company facing?

16) What techniques does your company employ to manage risk?

17) What is the overall value of your dairy business at risk (Value at Risk) ($)?

18) What was the total annual milk supply received by your company (in million KgMS)?

19) What was the source of milk supply of your company?
   a) Dairy farmers   b) Fonterra
   c) Other (Please specify --------------------------)

20) What percentage of total annual milk supply was rejected/underpaid/penalised by your company due to non-adherence to the following quality parameters:
   a) Somatic Cell Count ---------------------- (%)   b) Bactoscan ------------------------- (%)
   c) Inhibitory substances -------------------- (%)   d) Sensory evaluation ----------------- (%)
   e) Other (Please specify -------------------------)

21) What was the total number of sales orders (or value of ordered quantities in million NZD), received by your company from its New Zealand customers?

22) What was the actual order fill rate of your company for the orders received from New Zealand customers?

23) What percentage of the orders delivered to the NZ customers was rejected or returned?

24) What percentage of total quantities(or value in million NZD) of dairy products delivered to your company's NZ customers were received by them:
   a) With right quantity ---------------------- (%)   b) At committed date and time ----- (%)
   c) With accurate documentation (i.e. invoice, payment etc.) ------------------------- (%)

25) What was the annual revenue of your company (NZD)?

26) What was the annual cost of goods sold (NZD)?

27) What was the annual supply chain management cost (NZD)?

28) What was the working capital employed (NZD)?

29) What was the total value of non-current/fixed assets (NZD)?

30) From the following best practices please select all which were under use at your company and describe briefly the reason/problem they address.

a) Enterprise Resource Planning (ERP) system	
b) Available-to-promise inventory system	
c) Carrier Agreement	
d) Collaborative Planning, Forecasting & Replenishment	
e) Integrated Sales and Operations Planning	
f) Customer relationship management system	
g) Electronic data interchange (EDI)	
h) Full visibility of inventory and demand to all supply chain participants	
i) Performance measurement and reporting system	
j) Wave picking (to consolidate LTL's into TL's)	
k) Outsource non-core activities to third party	
l) Supplier performance assessment system	
m) Benchmark performance level with best-in-class	

31) Would you like to mention any other best practice(s) you are using at your company?

32) Should you wish to receive a summary of report?
   a) Yes (provide your details below)   b) No
   Full Name: Email Address: