UNIVERSITY OF HULL

Developing a 'Best Practice' Supply Chain Performance and Operational Framework for Dairy Producers

A multiple case study analysis in Egypt

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Abstract

Supply chain management is based on the global concept, where different companies are connected worldwide. Moreover, supply chain performance management is a growing field of study, especially for perishable products. Egyptian dairy producers have suffered a significant drop in their production since 2011, due to the poor quality and quantity of raw milk, changes in governmental regulations, hazard risks, and volatility in consumer taste. This has threatened meeting the increasing market demand for dairy products. Extant literature highlighted the following gaps: limited research assessing the dairy producers' supply chain performance in a detailed view from an operational perspective, and lack of specific performance measures especially in Egypt as a developing country in this context. Therefore, this thesis introduces a best practice performance framework for dairy producers in Egypt to optimise and assess their performance, in terms of sustainable production of safe and secure dairy products to fulfil the Egyptian market demand. The research adopts three theories to explore and understand the research problem. The resource-based view theory is used to identify the operational capabilities and the critical control points within the production. Network theory is used to explore the risks in the wider dairy supply chain and identify solutions to overcome them. Last, the institutional theory is used to understand the pressures faced by dairy producers, all of which will help to develop a best practice performance framework by following the mimetic approach to contrast and compile the performance measures of the top six large Egyptian dairy producers. That is achieved by referring to the Supply Chain Operation Reference (SCOR) model key attributes as a guide. This research utilises a narrative literature review to consolidate the background knowledge on the dairy sector's operations and supply chain risks. Then, classify the different operational and supply chain performance measures and models to provide future research directions based on the research gaps identified. A multiple case-study methodology is adopted in this study. It follows a qualitative research approach across two phases by using the NVivo12 software to conduct a thematic analysis. Firstly, two observations and seventeen exploratory semi structured interviews with key informants within six case studies were conducted to explore the operational capabilities, critical control points and performance measures and the risks affecting large Egyptian dairy producers. Secondly, two focus groups were held with a diversified sample of practitioners, government officials, and suppliers to validate the results of the first phase. The key findings of the research highlighted that those dairy producers performing on a satisfactory level qualify them to adopt the SCOR model to enhance their performance and imitate the dairy producers' practices in developed countries. The following key areas were addressed: 1) identifying the current operational capabilities needed to produce milk products, defining and classifying new critical control points for the production of UHT milk and pasteurised milk which up until now remains vague and not well determined, 2) each producer has designed their performance measures which has left them exposed to vulnerabilities and limits their optimum utilisation of their capabilities and to be able to continually improve. Thus, standardisation of performance measures and sharing of best practice, with a detailed classification for applicability is key for Egyptian dairy producers. A major contribution of this research is the development of an operational and supply chain performance-based best practice framework, based on SCOR, to guide the dairy producers through optimising and enhancing their production of safe and secure dairy products. Further, the research has identified three new SCOR attributes: a) suppliers' improvement and traceability, b) health and safety environment, and c) employees' morale, also seven new critical control points and capabilities. Besides, utilising the qualitative approach to provide in-depth within and cross-case exploration of six large dairy producers' current state. This research also recommends that the government should leverage the small farmers within a milk hub, with a tracking system, to close the gap of raw milk supply shortage to Egypt. That addresses the shortcomings in the extant literature, which will significantly contribute to enhancing the performance and sustainability of the Egyptian dairy industry as a whole, and consequently will benefit the Egyptian economy. That sets the base for future researchers to utilise the proposed best practice for a wider scope of dairy producers with similar characteristics.

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List of Abbreviations

AE: Active Customer Engagement

AFM1: Aflatoxin M1

AG: Agility

AHP: Analytical Hierarchy Process

AM: Asset Management

BRC: British Retail Consortium

BSC: Balance Score Card

CAGR: Compound Annual Growth Rate

CAPMAS: The Egyptian Central Agency for Public Mobilization and Statistics

CF: Cross-functional Coordination

CP: Constraint Programming

CCP: Critical Control Point

CIP: Clean in Place

CO: Cost

COGS: Cost of Goods Sold

COMESA: The Common Market for Eastern and Southern Africa

CPMU: Complaints Per Million Unit

CS: Creative Solutions

DC: Distribution Centre

DEA: Data Envelopment Analysis

DMP: Drinking Milk Products

DPMU: Defect Per Million Unit

EDA: European Dairy Association

EOS: The Egyptian Organization for Standardisation and Quality Control

EU: European Union

FAO: Food and Agriculture Organization

FG: Focus Group

FBMS: Function-Based Measurement System

FDA: Food and Drug Administration

FIS: Fuzzy Inference System

FLW: Food losses and wastes

FMCG: Fast Moving Consumer Goods

FMEA: Failure Mode Effect Analysis

FSC: Food Supply Chain

FSCM: Food Supply Chain Management

FSMS: Food Security Monitoring System

FSANZ: Food Standards Australia New Zealand

FTR: First Time Release

GAFTA: The Grain and Feed Trade Association

GSCRM: Global Supply Chain Risk Management

GMP: Good Manufacturing Practices

GW: Gross Weight

HACCP: Hazard Analysis and Critical Control Point

HRBS: Hierarchal Risk Breakdown Structure

HSE: Health and Safety Environment

IDSS: Intelligent Decision Support System

IT: Institutional Theory

JIT: Just in Time

KPI: Key Performance Indicator

LDA: Loss Distribution Approach

LE: Large Enterprise

LPD: Loss Distribution Approach

MCC: Milk Collection Centre

MCDM: Multi-criteria Decision Making

MILP: Mixed Integer Linear Programming

MOP: Multi-objective Programming

MPS: Master Production Schedule

MT: Metric Ton

MTO: Make to Order

MTS: Make to Stock

NCR: None-Conformity Report

NFSA: The Egyptian National Food Safety Authority

NSW: New South Wales

NT: Network Theory

NZ: New Zealand

OEE: Overall Equipment Effectiveness

OHSAS: Occupational Health and Safety

OI: Operations Improvement

OM: Operations Management

OT: Organizational Theory

OTIF: On Time and In Full Percentage

PD: Professional Delivery

QA: Quality Assurance

PRA: Probabilistic Risk Assessment

PMS: Performance Measurement System

PRP: Prerequisite Program

QRA: Quantitative Risk Analysis

RAC/CP: Regional Activity Centre for Clear Production

RBV: Resource-based View Theory

R&D: Research & Development

RL: Reliability

RPN: Risk Priority Number

RQ: Research Question

RS: Responsiveness

SC: Supply Chain

SCI: Supply Chain Integration

SCOR: Supply Chain Operation Reference Model

SCM: Supply Chain Management

SCP: supply chain performance

SCRM: Supply Chain Risk Management

SEM: Structural Equation Modelling

SHER: Safety, Health, Environment, and Risk

SIP: Sanitize in Place

SM: Simulation

SME: Small Medium Enterprises

SNF: Solid Non-fat

SP: Stochastic Programming

SSOPs: Sanitation Standard Operating Procedures

TCIR: Total Case Incident Rate

TQM: Total Quality Management

UHT: Ultra Heat Temperature Treatment

UK: United Kingdom

VSM: Value Stream Mapping

Chapter 1 Introduction

1.1 Research Overview and Background

Large companies function in larger supply chains which expand around the world and compete globally (Irfan and Wang, 2019). Therefore, these companies work on controlling the core phase of the supply chain. That can be achieved by utilising effective supply chain risk management (SCRM).

This thesis specifically focuses on the operational phase of processing milk and white cheese products in Egypt. The processing of these products is the introductory phase of any other dairy product like cooking cream or processed cheese, which relies on the remains of milk products such as the excess fat. The dairy sector is one of the most perishable sectors (Fattahi and Keyvanshokooh, 2017). Therefore, many companies must focus on developing a well-established precaution risk management strategy to ensure the stability of supply chain performance (SCP) (Wiengarten et al., 2016). That is essential for the success and sustainability of a dairy company and consequently the dairy sector in Egypt (El-Nakib, 2015).

Undoubtedly one of the focal purposes of supply chain management is the prevention of supply chain interruptions, ranging from delivery delays to product quality issues. Risks differ from one industry to another (Bier et al., 2020). But because dairy products are highly perishable, it requires speed and precautionary actions to avoid any sources of risks affecting its safety during the production or the supply of raw materials. A detailed emphasis in this thesis will be on the operation phase of the dairy producers in Egypt to overcome those risks. Keeping this in mind, the dairy products perishability and hygiene factors, which are a result of a complete series of reliable and secure operational capabilities. While traditional SCRM has allowed corporations to deal with the most well-known supply chain concerns, for instance, recent events have shown that more specific and more sophisticated risk management techniques are essential to better protect globalised supply chains (Ali and Shukran, 2016). This has become a significant issue during the COVID19 pandemic, shining a light on the lack of risk and resilience in supply chains, which had a devastating impact on all industrial sectors and the dairy sector specifically (Qingbi et al., 2020).

This thesis is exploratory and inductive in nature. Selecting this research paradigm covers a holistic view on the research phenomena. It is conducted by selecting the case-studies to provide in-depth understanding of the phenomena. This research will investigate the operational capabilities of large sized Egyptian dairy producers, by adopting the Supply Chain Operation Reference (SCOR) model's attributes in a proposed framework, through a case-study approach, to develop a best practice operational and SCP measurement framework for dairy producers in Egypt. The SCOR model has been selected as it provides a framework that clarifies the appropriate SCP measures and processes required to achieve best practice (Delipinar and Kocaoglu, 2016), which has been lacking historically in the Egyptian dairy producers. This best practice should enable the producers to operate efficiently, and effectively and mitigate against supply chain risks and consequently, ensure safe and secure supply of dairy products in the local and global market (i.e., products of consistent quality, standards, hygiene, and proper protective packaging). The operational capability is defined by Yiu and Jong (2020) as the company's effective ability in transforming the operational resources into outputs. These resources include assets, equipment, employees, and capitals. It reflects the company's ability to enhance its productivity by their ability to manage the resources, skills, information, and processes.

According to Van (1989:486), "*nothing is so practical as a good theory*" to cover these gaps and link them to the practice. This thesis proposes a framework to address these gaps and help Egyptian dairy producers optimise their operational and SCP, represented in the production of a sufficient amount of safe and secure dairy products to fulfil the local demand and expand their exports. The development of a best practice performance framework is underpinned by three key organisational theories in the business and supply chain research to help contextualise the findings. Those are the institutional theory (IT), the resource-based view theory (RBV) and the network theory (NT). First, institutional theory helps to contextualise the pressures large dairy producers are under and how this influences their operational capabilities and processes. That will appear in proposing a best practice model framework to the Egyptian dairy producers by following the mimetic approach. Second, the network theory clarifies the ties and interrelationships between the supply chain members, in what can be a complex and interconnected supply chain. Finally, RBV helps to shine a light on the capabilities and resources required by dairy producers to provide safe and secure supply of dairy products. Those theories help in understanding what is going on and ultimately what is required to boost production and performance, by addressing the reliability and the flexibility of dairy supply chains. The theories along with the research approach and methodology will then be discussed in detail in Chapter Four.

Egypt is considered one of the most promising countries in Africa and the Middle East that is expected to achieve significant growth in the future (Griffin, 2015: Tate, 2017). It is a developing country that has been neglected by the academic researchers but has a promising future in the dairy sector as part of the agricultural sector economy (Radwan, 2016). Forty percent of the agri-sector research has been devoted to the developing countries in comparison to sixty percent for the developed countries (Euromonitor, 2018). This is because it is currently focusing on enhancing its dairy products' safety by comparing it to the European standards like the European Commission (2001) and striving to increase its production to fulfil the local market demand and expand its exports (Ismail et al., 2020).

The demand is outstripping supply in the Egyptian dairy sector since 2012 (CAPMAS, 2017: Ismaiel et al., 2020). This is due to the increase in the Egyptian population and their increasing consumption of milk products. Egypt is known globally by its high variety of dairy production lines (Radwan, 2016: Euromonitor, 2020). According to Euromonitor (2020) dairy products are a must in the daily nutrition consumption for the Egyptian consumers and it represents a main player in the Egyptian economy. The dairy products will remain the main player in achieving the high share in the food sector and the Egyptian economy if there is enough production to fulfil the local demand. Other researchers mentioned that the dairy products are classified under The Fast-Moving Consumer Goods (FMCG) sector in Egypt, which is ranked the fifth in the local economy with a total market size of 42.6 billion US dollar (El-Nakib, 2015), and remains to increase until 2020 (Ismaiel et al., 2020).

Recently, Egypt witnessed an increase in dairy products consumption rate and a potential to re-open to the global market through increasing the dairy products exports (Euromonitor, 2017). Considering this potential, Egypt needs more investment and improvement in the operational phase of the dairy sector to increase the amount of production and the quality of products according to the global safety and security measures like the European Commission (2001), ISO9001, ISO22000, and HACCP. Further, the food safety and quality standards are a growing concern for human health globally because milk contamination in dairy products causes severe health risk (Ismaiel et al., 2020). Considering the hygienic conditions, the dairy products perishability nature, and the short shelf life, this represents a challenge in the supply chain. Therefore, enhancing the operational capabilities of the large dairy producers specifically will ensure the increase of the production of safe and secure dairy products for the local and global market.

A significant amount of dairy products available in the Egyptian market does not comply with the Egyptian National Food Safety Authority (NFSA) standards like the high bacterial counts in raw milk. That reflects the amount of contamination during various stages of production, reflected in the microbiological quality of raw milk and dairy products, which are found to be highly contaminated (Lotfy et al., 2017). Besides spotting some common constraints in the developing countries such as the lack of resources, the high cost of milk production and most importantly the animal health (Subburaj et al., 2015). This prelude to the research motivation which is discussed in the following section. Utilising the SCOR model's attributes with the operations and SCP measurement metric through applying the case-study methodology will connect and reflect the real ongoing practices in the large dairy producers in Egypt, which will consequently help in improving the operational practices.

1.2 Research Motivation

The motive for doing this thesis appeared after focusing on two main problems emerging in the Egyptian dairy sector: namely the lack of domestic consumption fulfilment and the lack of products' safety and security. Firstly, the insufficient local production compared to the local consumption, led to an increase in the imports of dairy products to fulfil the local demand (El-Nakib, 2015). Secondly, the lack of dairy products' safety and security led the consumers to rely mainly on packaged milk products produced by the large size dairy producers in Egypt instead of purchasing the loose unpackaged milk products by the small producers (Mohamed, 2015: Euromonitor, 2020). Therefore, the thesis focuses on enhancing the operational capabilities of dairy producers to improve the production of safety and secure products.

Six case-studies will be selected from the Egyptian large-size dairy producers in the top two major cities with the maximum number of dairy factories: Cairo and Alexandria, where the main sources of daily fresh milk are located near these big cities. According to Euromonitor (2018), ten dairy companies represent ninety-seven percent of the packaged milk supply and are leading dairy producers representing the majority of the market share. In this thesis, the top six Egyptian milk producers are selected for investigation in this research, given their pivotal role in the production of milk and dairy products to the Egyptian market, given the volumes of milk processed.

There is also a significant shortage of Egyptian cattle and buffalo productivity in comparison to the developed countries. However, there is a potential opportunity to enhance the milk production in Egypt. It has been found that there is an increasing demand for the Egyptian white cheese in the Arab and European markets. Apart from the American market, which imports a special Egyptian cheese which is called domestically (Old Mish Cheese). Also, there is a surplus in the liquid milk and the fatless cheese i.e., cottage cheese-Qarish cheese and butter (Soliman and Mahhour, 2011). As such, the thesis will focus specifically on packaged milk products. As it records an increasing sale and increasing demand of the limited supply of safe and secure milk products (CAPMAS, 2017: Ismaiel et al., 2020).

Damietta Governorate in Egypt serves as a focal point for the dairy industry in Egypt. It is famous for producing cheese specifically, which represents around twenty-five percent of the total dairy production. Ninety percent of the local dairy production is allocated for local consumption and only ten percent for export (Soliman and Mahhour, 2011). Also, cheese is considered the most popular dairy products globally. The world's cheese production, including the different varieties of cheese, has increased exponentially over the last twenty years in Egypt (Ismaiel, 2020). This relies on the utilisation of raw milk in producing different kinds of dairy products to benefit the local consumption and the global market with better offerings of dairy products.

Large-size dairy producers struggle to fulfil their demand regardless of their existing capabilities and do not fully utilise them to optimise their performance. Although, producers do apply some international food health and safety standards to boost production of qualified products coping with the local and international safety standards. The majority of supplied raw milk does not meet the food safety standards which is a significant issue. Small and Medium Enterprises (SMEs) lack the funds which enable them to hire personnel with a high level of education. SME dairy producers need to improve all the Food Security Monitoring System (FSMS) activities (Njage et al., 2017). Based on the updated reports by Euromonitor (2018), the SMEs market share ranged between two percent to seventeen percent. As they provide loose milk and other dairy products to the consumer, and they do not produce packaged milk products with safe and secure standards, which the consumer is demanding. Nevertheless, they do not feel threatened by the increasing market share of large dairy producers because they reside outside the competition (ILO, 2020). The common factor between small and medium producers is the forecasted decline of their shares in the dairy sector. However, that keeps a space for them to be included in the study if they work on having the basic capabilities. That represents a real challenge and contradicts the research goal of creating a best practice for all dairy producers in Egypt, which lead us to shift toward large-size dairy producers, which is where the Pareto of the market share exists. The following section reviews the dairy industry in Egypt.

1.3 Industry Profile

The dairy industry represents a major part of the world's food systems, especially in the developing countries and in Egypt in particular. The dairy sector in those countries witnesses' changes in the regulations for the dairy production and trade, technological development in the dairy products manufacturing equipment, and rapid changes in the consumption patterns (Soliman and Mahhour, 2011).

Egypt is considered a major contributor in the African and Middle East dairy sector with a market share of sixteen percent. Regardless of the fact that Egypt takes a major share in the market, it has a negative imbalance between supply and demand. That's due to the increasing awareness of the Egyptian consumers about food safety which led to shifting their demand to the packaged UHT milk products produced by the LEs rather than the loose milk (El-Nakib, 2015). Simultaneously, Egypt is considered an importer of powdered milk to cover the deficiency in the raw fresh milk supplied by the local farms (Tate, 2017). Based on the forecasts till the year 2017, the consumption is expected to remain higher than the local production (Euromonitor, 2018).

The dairy sector in Egypt takes a major part in the food sector. It has recorded a significant expansion during the last years. In addition, it is known by its variety of production lines that contribute to the production of several products such as milk, butter, cheese, yoghurt, condensed milk, dried milk, and ice-cream (Euromonitor, 2018). The expansion was detected in the number of companies registered under the food industry chamber, the production of safe dairy products in a protective modern package, and wide diversity product types (Soliman and Mahhour, 2011). Although, Egypt is considered as a net importer of the processed dairy products (Tate, 2017). That is due to the increasing population and their increasing consumption of milk and dairy products in general.

Nowadays, the consumers are more aware and seeking the healthy lifestyle trends and ongoing urbanisation through following the digital media. Therefore, they rely on the dairy products including the drinking milk, yoghurt and cheese in their daily nutrition routine (Michel et al., 2021). The western culture is growing in Egypt recently and the increasing younger generations interested in the healthy lifestyle, led to increasing the expectations of new products and contributed to the growth of consuming the packaged food and dairy products. Although, affordable prices are the key for increasing the market penetration, so considering the affordability of the mid and low income consumers is a must. As they represent a minimum eighty percent of the Egyptian population (Euromonitor, 2020).

Due to the growing awareness of the Egyptian consumers regarding the health and hygiene, it made a shift from unpackaged dairy products to packaged dairy products. Manufacturers focus on probiotic variants of drinking yoghurt, which help in boosting health. However, the rising sales of flavoured yoghurt led to a decline in the flavoured milk, which is then perceived as less healthy than the drinking yoghurt (Euromonitor, 2018). In addition to the decline of skimmed milk powder for two consecutive years in 2020 (FAO, 2021).

Despite the disturbing political situation that has been affecting Egypt since 2011, Egypt has witnessed positive changes in the dairy sector represented in; Nestle' announced to furtherly increase its investment in the country at that time, and opened a new factory in 2014. In addition, Arla the international company formed a joint venture with Egypt based dairy company-Juhayna to buy Juhayna's distribution channel and expand the availability of Arla's dairy products in the Egyptian market. Furthermore, Danone bought Halayeb, which is one of the oldest cheese producers in Egypt. Juhayna Food Industries is ranked the first on the top 20 dairy companies in Egypt in 2016. The top dairy products produced and sold by the Egyptian dairy producers are, the plain yoghurt ranked the first, then followed by cooking fats, unpackaged hard cheese, soft cheese, full fat fresh milk, and the list goes on (Euromonitor, 2017).

There are six Egyptian large size dairy producers representing the major contributors in the dairy sector's production with over eighty percent of the Egyptian market based on the (Euromonitor, 2018). Those companies are in both major cities; Cairo and Alexandria in Egypt according to the annual industrial report by Geijer et al. (2017) and Euromonitor (2018). Imam et al. (2016) reached the fact that the top five companies dominating the Egyptian dairy sector are Juhayna, Nestle' Egypt, Enjoy, Beyti (owned by ALMarai), Lamar, and Domty. According to Euromonitor (2017) packaged milk products' sales increased. Therefore, more focus should be given to packaged milk producers to enhance their operational performance. El-Nakib (2015) and Ismaiel et al. (2020) recommended enhancing the production of safe milk and cheese products free of any sources of contamination to fulfil the local demand and expand globally. That will help them to cope with the market needs of packaged milk products. Also, according to CAPMAS (2017) the dairy products' exports decreased by sixty-five percent. Furthermore, Mohamed (2015) and FAO (2021) indicated that the local consumption exceeds the local production of dairy products, and the International Labour Organization (2020) approved that the local production fills only seventy-two percent of the local demand. Moreover, the Egyptian dairy producer relies intensively on the imported milk powders to fulfil this percentage, due to the lack of raw milk local supplies. Last, Tate (2017) highlighted some challenges related to milk suppliers represented in, farmers' hygienic standards, dairy herds, and transportation.

The following paragraphs provide a brief background on each dairy producer participating in this thesis. The information included are the outcome of gathering data from online sources, company's annual reports, governmental reports, semi-structured interviews, and observations held by the researcher.

Company-A is one of the top companies in the Egyptian dairy sector. It was established over 23 years ago with the acquisition of the largest commercial dairy farm in Egypt from a Saudi Group. It is identified as one of the largest producers of milk, juice, and yoghurt in Egypt. The Saudi group invests in developing Company-A's operations with the most recent technologies to possess more than half of the Egyptian dairy sector. The ownership of Company-A was transferred in 2009 to a joint venture (JV).

The JV benefits Company-A by utilising the Saudi's group's deep knowledge of the regional dairy industry. It has over 3,000 employees. It invested in a multi-million-dollar construction of a fully automated facility on the pivotal Cairo-Alexandria desert road, supported with the utilisation of the most recent food processing innovation techniques and layouts to maximise the factory efficiency, that can be achieved by employing high-speed processing machinery. Those machineries produce a wide variety of dairy products with the highest quality standards of hygiene and safety.

They manufacture their plastic packages for Company-A's milk products within their factory. They ensure the application of the highest international manufacturing standards, which ensures the hygiene and safety of the products.

Company-B was established in 1985, which started as a supplier producing high-quality raw milk to other manufacturers, who will use it in the production of dairy products. Company-B started producing their own branded milk in 2012. Its goal is to produce a product of excellent quality that qualifies them to compete in the global dairy market.

Their farm is in Nubaria on almost 3000 acres, it is located between the top two cities recorded with dairy milk consumption, nearer to Alexandria than Cairo. It holds over 3000 Holstein cows, planting their cows' feed of corn and green fodder. They care about the cows' health in terms of ensuring that they are being happy, healthy, and capable of producing the highest quality and quantity of milk. The cows are chosen for their high genetic traits in terms of producing milk. The barn is equipped with automatic milking stations and facilities that provide comfort to the cows such as cooling. They are capable of milking 360 cows per hour and nearly 1200 cows per day.

Company-B relies on its farm most of the year. By doing this, they can have control over the manufacturing processes in their farms. They are a classic example of vertically integrated SC, i.e., they own the farm with Holstein cows. They provide a fully integrated milk process in one place. Nevertheless, Company-B outsources milk in cases of emergency in shortage season from one trusted supplier. At the same time, they perform the required audit on the outsourced milk to ensure it is classified and ranked the same as their internally produced milk with the same quality and parameters of milk (Grade-A).

Company-C was established in 1983, producing dairy, juice, and cooking products. It dominates the dairy sector currently and is considered the market leader who first introduced the UHT packaged milk to the Egyptian market. It has started to expand in the Middle East with its wide range of high-quality and safe products' standards. Also, its products are exported to over forty-eight countries, including the US, Europe, and the Gulf countries. It is the first company to partner with TetraPak, in 1991, the global packaging company. Currently it possesses over sixty-five percent of the packaged dairy sector market share.

Today the company is vertically integrated with seven different state-of-the-art manufacturing facilities in Egypt, three of them for dairy products, a retail and logistics operation, and an agriculture and livestock business from which it sources most of its raw materials. It has three dairy operational facilities, working with over 4000 employees, and a wide network of distribution centres serving over 65,000 retail outlets nationwide. Also, it was ranked the third company worldwide to use the new TBA-Edge packaging technology, which ensures the highest quality of milk products. It became the executive supplier of dairy to leading global fast-food chains and airlines. It is the main player in the sector by producing 200 tons of milk daily.

Company-D's first year of production was 1952. Company-D milk factory is a 30.000sqm, located on the outskirts of Alexandria. Company-D became the first dairy production factory in Egypt, producing pasteurised fresh milk on a large scale. They focus on increasing the staff's efficiency and ensure they are aware of the latest technologies to stay updated with the recent production practices and technologies to enhance their performance by offering higher quality products under the strictest quality specifications. Also, upgrading the production standards to meet the international hygiene and quality parameters. Company-D has managed to secure its niche by introducing pasteurised milk. Pasteurisation involves heating milk above 60 degrees centigrade for 30 minutes to kill all harmful bacteria. Company-D's milk is 100% cow's milk. Its pasteurisation process is held by state-of-art equipment under strict food safety and quality assurance systems, all of which are ISO22000, and HACCP certified. Company-D's products are currently sold across Egypt and in 30 other countries. Their exports of cheese products were directed to KSA, Syria, Libya, Yemen, and some gulf countries.

Company-E was announced by TetraPak packages as one of the biggest white cheese producers in the world for many consecutive years. Company-E was established in 1990. It started with only two products; white and mozzarella cheese, and it is currently expanding its products' portfolio. It has two large factories on 6000sqm and 27000sqm with a production capacity of 300 million pack per year. Both factories are in the industrial zone of the 6th of October city in Egypt.

Company-E is known for its consistency in being the biggest global white cheese producer in TetraPak packages. Also, it holds 40% of the local cheese market share. This success relies mainly on its long-term partnership with TetraPak Egypt. Company-E is an innovative company that is committed to introducing new products, flavours, and package sizes to the market.

Company-E deals with a hundred and ninety suppliers for all raw materials, services, and supplies for the wide variety of products it produces. Thirty of them are dairy farms and MCCs to balance between the quality and prices required. It relies on milk from the USA and western Europe (e.g., France, Sweden, Germany, and New Zealand). Company-E rarely imports from Eastern Europe in contingency situations (e.g., Ukraine, Poland) and India. That is due to the high nutrition facts required in their production. They require a high percentage of protein which is available in Grade A-high-quality milk. Also, it relies on local packaging suppliers that meet their quality specifications, besides the collaboration with TetraPak, to avoid the challenges combined with the imported materials.

Company-F was established in 1987 with 377 cows from the USA. It has become Egypt's and Africa's largest private integrated dairy farm with 8,000 milking cows. The farm is established over an area of 10,000acres strategically located on Cairo-Alexandria desert road close to the major local consumption markets and the coastal city of Alexandria. It is built with the aim to ensure sustainable productivity and growth by maintaining smooth workflow and capacity building. It is the only Skimmed Milk Powder (SMP) factory and the largest fresh milk producer with a seventy percent market share of the pasteurised milk market specifically in Egypt. The company ensures the cow's health and welfare by installing a cooling system on the dairy units. It expanded through the years by constructing two new milking units in 2009 and two milking stations in 2013.

Company-F produces its own branded pasteurised fresh milk, flavoured milk, milkshake, rayeb, yoghurt drink, yoghurt, cheese, butter, and skimmed milk powder in addition to selling raw milk to other local and international dairy producers in Egypt. They use the most recent technologies and production practices to fulfil the local market demand and enhance the Egyptian top quality food exports. It has specialised nutritionists to focus on the cows' health, feed, reproduction, and their milk quality and quantity.
Also, it has specialised labs well equipped with the latest technologies and qualified vets with an updated follow-up system. The cows are milked three times a day. It goes through a rapid cooling system and then stored until it is delivered to the factory for packaging. It has a refrigerated fleet responsible for the daily distribution of Company-F's fresh milk products.

The map in Figure 1.1 identifies the location of the top six dairy producers' factories between the two major cities with the largest population which is Cairo, the capital, and Alexandria.

Figure 1.1: Dairy Producers' Plants Location on Egypt's Map

Juhayna Food Industries takes the lead in sales in 2017, taking twenty percent of the market share. Then, followed by Danone Egypt-Danette with nineteen percent of the market share. Although, the International Company for Agro-Industrial Projects-Beyti led the sales of the fruited yoghurt. Juhayna is expected to sustain the strong lead in the cream production. Dairy companies focus to expand in the large areas, where there is greater potential for more scope growth (Euromonitor, 2018).

One of the recent projects made on the Egyptian dairy sector is LACTIMED, which is financed by the EU that aims at enriching the production and distribution of dairy products in the Mediterranean countries. This project covered the dairy industry in Egypt in terms of farming and milk production, animal feed, the dairy market trends, and the traditional Egyptian dairy products, focusing the study on two cities: Alexandria and Beheira. The study was based on field surveys with the dairy farmers and dairy producers, and proposes a strategy that strengthens the dairy sector's SCs (Lapujade, 2015).

Egypt has several official organisations to assess and measure the safety of the dairy production. These organisations are the Central Agency for Public Mobilization and Statistics (CAPMAS), Economic Affairs and Statistics of the Ministry of Agriculture, Livestock Production Sector of the Ministry of Agriculture, Food and Agriculture Organization of the United Nations (FAO). There are several quality control certifications applied in the Egyptian dairy sector, some of them are ISO and HACCP. The application of those certificates is more applicable on the modern large sized companies, rather than the small sized. The certificate controls and ensures the production of healthy secure food products (Soliman and Mahhour, 2011).

There are many quality and safety management systems applied in the Egyptian food industry (e.g., HACCP, ISO9000, and Total Quality Management). Most food safety and quality rely on testing the final product to assure the product safety. However, testing the whole process from the beginning will help ensure an efficient production system of safe and secure products and reduce products' waste (El-Hofi, 2010).

Many dairy producers in Egypt have attempted to adopt the HACCP to detect the contamination at all production stages. Pasteurisation is a milk treatment tool, a form of heat treatment that is required by law for all dairy products. However, small dairy plants made dairy products from unpasteurised milk. Some small-scale dairy producers use boiling as the raw milk treatment tool. Boiling leads to the loss of milk nutrients. The urban consumer awareness increased regard the healthy and safe food supply (Soliman and Mahhour, 2011). Heat treatment is called Ultra Heat Treatment (UHT). It is used for products with long shelf life, which reach up to six months (Aita et al., 2012). The milk treatment represented in the following steps: filtration to remove foreign particles, deaeration (degassing) to expel gases and malodorous volatile substances, separation to skim the cream from the milk, standardising the fat and nonfat solids (SNF) content by mixing cream and skimmed milk, homogenization to reduce the size of the fat globules, and pasteurisation to kill all pathogenic microorganisms (Aita et al., 2012).

The industry lacks the experienced skilled human resources. Where there is a lack of commitment in the application of food standards in the dairy processing companies in Egypt (Soliman and Mahhour, 2011). The CCPs in the small cheese production plants in Giza governorate in Egypt were identified as a preliminary step for the HACCP application. The CCPs are represented in; the location of the plant, plant design, absence of air filtration, absence of resistant glass windows, machinery layout, keeping records, absence of protective maintenance of equipment, controlling the cooling system, and water analysis. These CCPs work as a preliminary phase to develop the HACCP to improve the hygiene and safety of produced cheeses (El-Gendy et al., 2010).

Soliman and Mahhour (2011) studied the Egyptian dairy sector and classified it into two systems. The study included a sample of both systems, the large-scale modern companies, and the small dairy plants in Egypt. According to Geijer (2017) and Imam (2016) there are an overall of three hundred and five dairy factories in Egypt, including both the private and the public factories. Focusing on the processing stage in the large-scale modern companies, four modern companies were visited by Soliman and Mahhour (2011). The modern large-scale dairy companies obey the legislation that indicates the pasteurisation of milk before processing. Though, only twenty-seven percent of the small dairy plants follow the regulations. The dairy plants are classified into three categories in terms of the size. The first category is the small plants with less than 100sqm, which represent eight percent of the total number of dairy plants in Egypt, the second category is the medium sized from 100 to 300sqm and represent around seventy percent of the total plants, last category the large plants with more than 300sqm, representing twenty-two percent of the total number of dairy plants in Egypt (Soliman and Mahhour, 2011). There is a potential opportunity for the small enterprises to enter the Egyptian dairy market, that is for the limited barriers to entry, however, the large enterprises dominate the market with its large capacity and operational capability to supply the market with safe and secure products following the food hygiene safety standards for mass consumption (Mohamed, 2015).

Large dairy companies in Egypt such as Danone and Juhayna focus their investments on the upstream side of the SC by expanding the dairy farms to increase the supply of fresh raw milk. Juhayna is one of the leading companies in Egypt in the agriculture and dairy sector. Juhayna is vertically integrated by controlling its agricultural activities focusing on the livestock and milk. Having full control on the supply side of the SC i.e., raw milk supplies, enable the company to focus on milk production and other dairy products and benefit them to manage the risks (Euromonitor, 2017). According to CAPMAS (2017), the agricultural sector takes a large share of the public total. The records increased from the year 2009 until 2015 from 4614 gross weight (G.W) to 6555G.W.

Misr Company for Dairy and Food in Egypt is one of the leading producers in the dairy sector in Egypt. It produces an average of 7200 tons of dairy products annually (Dubeuf, 2004). Most of the dairy production in Egypt relies heavily on buffalo and cow milk. The type of milk used is correlated to the type of product produced. The collection of raw milk is either from specialized dairy farms, or from collection points dispersed in a specific administrative centre (Soliman and Mahhour, 2011).

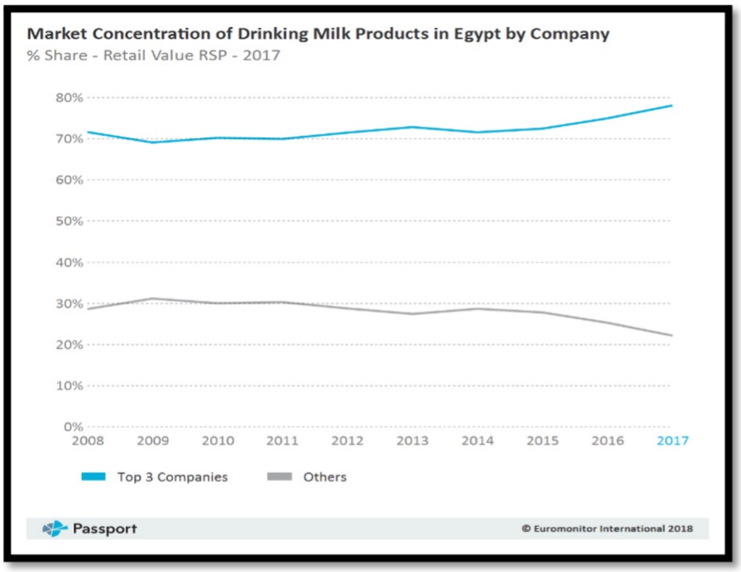
CAPMAS (2017) indicates that, between July 2016 and 2017 a drastic increase in the food sector consumption was reported in the food sector, increasing from nineteen percent to forty-three percent. The dairy sector, including milk and cheese, specifically out of all the food sector contributed to this increase which was proved to sustain this increase of cheese exports by FAO (2021).

Regardless of the fact that Egypt is one of the African countries that the EU abandoned in terms of the Egyptian dairy products exports (Mohamed, 2015). Egypt succeeded in participating in several international exhibitions, through renting plants in some selected EU countries to manufacture the local Egyptian dairy products within the EU countries, and consequently proving the availability of the Egyptian products in the international market and eventually removing the export barriers in the coming period.

The Egyptian producers work on empowering the traditional dairy products exports and attract international investments and advanced technologies in the dairy sector (Mohamed, 2015). Based on LACTIMED 2016 most of the project participants whether suppliers or manufacturers agreed that Egyptian dairy products are banned from the EU zone, because of the lack of application of the international standards and specifications after the Egyptian revolution in 2011. A report by the Egyptian ministry of trade and industry highlighted the decline in the total Egyptian exports generally with the international market. The total exports decreased by twenty percent and eight percent in the food sector exports specifically between the years 2011 to 2015. The LACTIMED project summarised the milk cleanliness measures in the Egyptian cluster as follows; the farm level including the animals in terms of (feeding, housing, and animal health), cleanliness of the milking equipment, milking practices hygiene system and cooling temperature (GAFI et al., 2014).

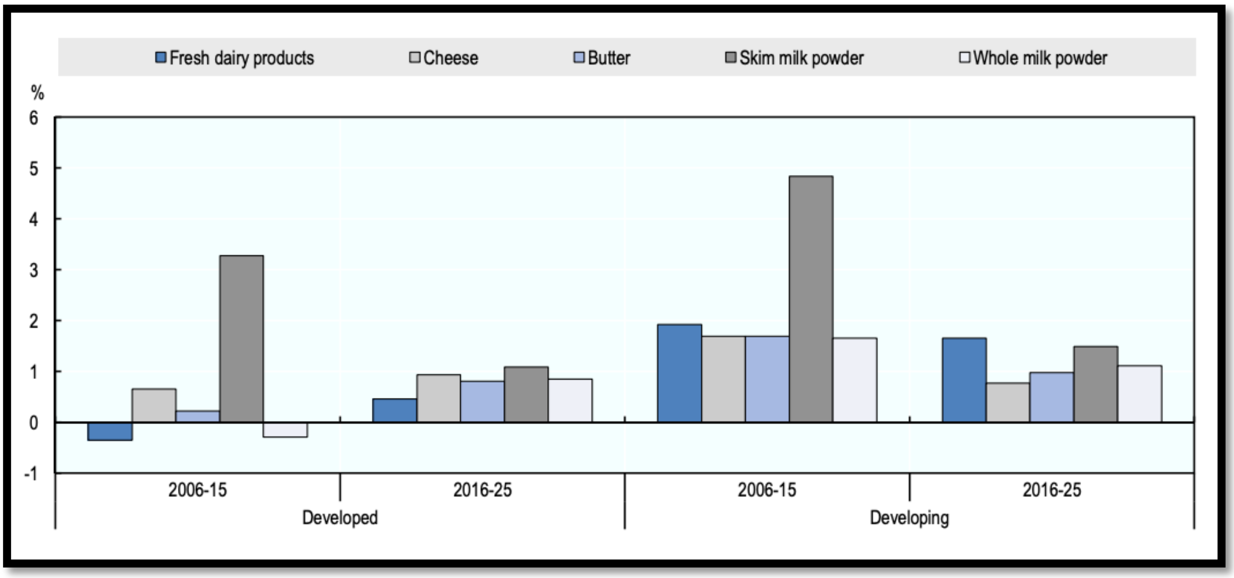
The overall retail sales of the dairy products record increases by twenty-five percent in 2017 with sales reaching 721 million Egyptian pounds. Figure 1.2 clarifies the top three leading companies; Juhayna, Nestle', and Danone, marking a noticeable increase from 2008 until 2017 in contrast to the other companies which record the opposite (Euromonitor, 2018).

Figure 1.2: Market Concentration of Drinking Milk Products in Egypt by Company-Source: (Euromonitor, 2018:P.4)



Egypt's average milk production between the years 2011-2013 is 5842 thousand tons and the forecast was to increase in the next couple of years. The imports take a big share of 1650 thousand tons in comparison to the exports which represent 656 thousand tons. Therefore, an intensive improvement regards the exports needs to be done to compete in the international market with the traditional Egyptian dairy products (CAPMAS, 2017). Based on the Fast-Moving Consumer Goods (FMCG) index, cheese as a dairy product currently record the third place after packaged food and expected to reach the second place in 2019 until 2022 (Euromonitor, 2018). Also, drinking milk products keeps proving that it is one of the most promising products among the other FMCG industries as expected until 2025 (FAO, 2021). Figure 1.3 Shows the increasing growth rates of milk consumption in the developing countries compared to the developed countries for the period of 2016-2025.

Figure 1.3: Annual Growth Rates of Per Capita Consumption for Dairy Products-Source: (FAO, 2021:P.4)



Yoghurt and sour milk products witnessed an increase in the retail value sales in 2017 by eighty-five percent to reach EGP 16.7 billion. This increase is due to the shift of the Egyptian population towards the packaged yoghurt from the unpackaged, which is still sold in small retailers and grocery stores. Therefore, the demand for this unpackaged yoghurt is almost diminished. Plain yoghurt achieves the highest value growth with the retail volume by eighty-eight percent, reaching 747.800 tons. In addition, drinking yoghurt also witnessed growth in the same year by twenty-two percent and it is widely available in different distribution channels in the Egyptian market with a wide variety of flavours. Consumers are expected to keep shifting to packaged yoghurt and sour milk. Consequently, companies will keep offering new products and promotions to sustain the growth. (Euromonitor, 2018).

Egypt's major imports of dairy products (excluding cheese) is 208,889 Metric Ton (MT) for $595.7 million from New Zealand (NZ), France, Germany, and USA. The cheese imports reached 32.260MT that cost $145.3 million from Netherlands, New Zealand, Poland, and USA (Tate, 2017). Egypt's most famous cheese production varied in many kinds.

As cheese is universally recognized as first class feed. The Egyptian fayoumi cheese is found to be up to the Egyptian and the international standards, however, it is found that all types of cheese still need to be improved. Also agreed the processing conditions and post heat treatment have a major impact on the microbiological quality of milk which needs to get improved (Sayed et al., 2011).

Finally, Egypt is found to achieve its dairy products' sales from hypermarkets, supermarkets, and convenience stores as a retail distribution network. Therefore, there is a positive correlation between the increasing sales with those markets, as the availability of refrigerators in the transportation process and the shops is a must in order to avoid the products’ spoilage and poor quality (Euromonitor, 2017). So, the Egyptian dairy sector is witnessing great focus by researchers to note its potentials for development regarding the dairy products' safety and the deficiencies in managing their operational practices and risks as explained in the next section. Thus, it has a promising future in expanding to fulfil a larger share of the local demand and expand globally by its exports.

1.4 Research Problem

The research problem is that there is a significant lack of production of a safe and secure supply of dairy products to fulfil the local demand from large dairy producers in Egypt and a lack of products’ consistency. Thus, there is a need to enhance the dairy producers’ performance and operational capabilities which will lead to improving the continuity and quality of supply, while at the same time enhancing the SCP, as they supply over eighty percent of the market demand nationally.

There has been a noticeable drop in the Egyptian dairy production in 2011 (Soliman and Mahhour, 2011). Since then, the dairy producers strive to increase their production of a wide variety of safe and secure products. Such drop can be due to raw milk scarcity or condition, delivery to plants, governmental laws and regulations, hazard risks in terms of accidents for example and the variation in quality and taste of the consumers. This has led to the need to enhance the operational capabilities of the large size dairy producers in Egypt to ensure the production of sufficient amounts of safe and secure products.

A lack of applicability and consideration has been given to this research area in the developing countries and Egypt specifically. Egypt represents one of the leading milk producers in Africa and the Middle East (Euromonitor, 2020). However, there is a noticeable negative balance between the supply and demand, where demand exceeds the supply respectively since 2008. The deficit is quite limited and can be recovered through the development in the dairy sector (El-Nakib, 2015).

SCRM is a key issue that should be accurately specified and tested in any sector and the agri-sector specifically. This issue has a major role in affecting the flow of proceeding any operational process smoothly (Borodin et al., 2016: Gorton et al., 2006). Moreover, many articles on the agri-sector and the dairy sector specifically have been developed during the last few years. For instance, Mishra and Shekhar (2016) explicitly clarified that managing the risks perishability doubled when it relates to the products or raw materials of high perishability nature like the dairy products. Thus, SCRM is crucial to achieve the safety and security measures required in the production phase of the dairy products.

1.5 Research Aim and Objectives

The aim of this thesis is *to investigate how to improve the operational and supply chain performance of the Egyptian large sized dairy producers to ensure the production of safe and secure products against the different supply chain risks.* The operational challenges or as referred to later in this thesis as the operational risks and the critical control points (CCP) in the operational phase, will be determined in the processing phase of the large dairy producers in Egypt. Many international food safety tools and standards are available in the academic literature and applied by the different dairy producers around the world. Some of those tools are the Food Security Monitoring System (FSMS), Hazard Analysis and Critical Control Point (HACCP), and ISO22000.

Njage et al. (2017) confirmed that, designing and applying one or more of the food safety measures or standards enhanced the dairy operations and consequently, improved the quality of the dairy products in Kenya. In addition, the BRC report (2014) confirmed that most of the food products quality decreased from grade-A to grade-B after the economic crises of 2011. So, it is recommended for all food manufacturers to create a detailed profile of the risks involved in their processes.HACCP system can be beneficial and work as a preventative tool for dairy producers and the overall supply chain (Aiad, 2013).

In addition to the utilisation of such international safety tools, if utilised with the application of the SCOR model's attributes, will add value to the overall dairy operational performance, speed up the system implementation, support the organisational goals and improve business agility (Moazzam et al., 2018). The SCOR model is interconnected, interactive and hierarchical in nature. It is used to link business processes, performance metrics, practices, and people skills into a single unified structured framework (APICS, 2018).

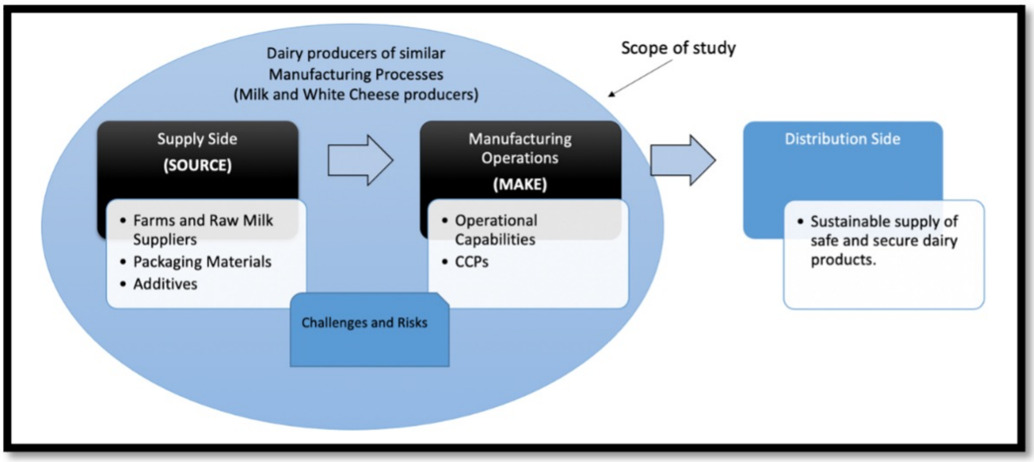
SCOR is defined by APICS (2018:15) as: "*the world's leading supply chain framework, linking business processes, performance metrics, practices, and people skills into a unified structure*". The SCRM can be considered and included during the application of the SCOR model's attributes on the Egyptian dairy sector. As the SCOR model works in a proactive way in dealing with the different kinds of SC risks and uncertainties especially when applied in the operational phase, consequently it ensures the supply chain success and eventually the provision of safe and secure products. Organisations employ the SCOR framework to increase the system implementation speed, support organisational learning goals and to improve the inventory turns.

Achieving an operational framework to improve the overall dairy SCP can be reached by applying the SCOR model dimensions and attributes. According to Delipinar and Kocaglu (2016) and Erkan and Bac (2011), the SCOR model provides a standard description and systematic approach to describe, categorise, and evaluate the complex supply chain processes, performance metrics, best practice and enabling technologies. The model specifies different metrics measuring the enterprises' performance through the application of case-studies. Sellitto et al. (2015) also agreed that the SCOR model is widely proven reliable in assessing the SCP in different sectors. The authors categorised the model into two dimensions: the SCOR model processes (plan, source, make, deliver and return) and performance standards extracted from the SCOR model (cost, quality, delivery, and flexibility). The overall SCP can be obtained by adding the performance of all indicators at different hierarchical levels. Thus, SCOR will be central to this thesis in the development of an initial conceptual model and in classifying the key capabilities, risks, and practices of large sized Egyptian dairy producers, with the aim of developing a best practice performance framework to improve the supply of safe and secure dairy products.

Large dairy producers focus on fulfiling the local Egyptian demand (Euromonitor, 2020). In addition, they strive to increase the exports of long shelf packaged milk. Based on the Egyptian economic situation since the revolution of 2011, some obstacles may be faced when starting to apply the SCOR model on the practical side. The obstacles of applying the SCOR model may be challenging in terms of labour and cost intensive (Irfan et al., 2008). That will be explored throughout this study. SCOR is also a western developed tool, thus there may be a lack of understanding of it within a developing country context.

As the SCOR Model is built on six major pillars that subdivide the processes within a typical supply chain: *Plan, Source, Make, Deliver, Return and Enable* (APICS, 2018). The scope of this thesis will focus on the 'Source' and 'Make' supply chain processes (i.e. operational phase) of the Egyptian Dairy Supply chains to answer the research questions. All other processes remain out of scope. The selection of this scope is based on the risks hindering the dairy producers' optimal performance. Such risk resides in the upstream side and the production phase of the dairy supply chain to control the source of bacteria and contamination in the raw milk supplied and the processing of the dairy products (Ismaiel et al., 2020). By focusing on the operations management 'make' this excludes financial measures (Figure 1.4). The reason for this is to propose a set of operational and SCP measures (i.e. KPIs) to optimise the operational and SCP for the Egyptian dairy producers. The operational phase is responsible for fulfiling the mismatch between the supply and demand and controls the SCP dimensions in terms of reliability, responsiveness, agility, asset management, and cost (Mishra and Shekhar, 2016).

Figure 1.4: A Scoping Diagram for the Thesis-Source: Author



Introducing a best practice operational and SCP conceptual framework to the Egyptian dairy sector by consolidating the capabilities and practices of the top dominating Egyptian dairy producers is the focus of this thesis. To investigate this, the unit of analysis is to obtain the views of the operations, quality, and supply chain managers who work in these large sized Egyptian dairy producers to benchmark their SCP. That will be achieved by conducting individual and cross case analysis to analyse the results and compare the findings to the literature and industrial reports from Egypt and other developed countries (New Zealand). Lahat and Shoham (2014) noted that the comparison of similarities and differences between the data yielded from the different sources will help to build up a best practice operational and SCP framework of a unified key performance indicators (KPIs) for the Egyptian dairy producers.

The research objectives are as follows:

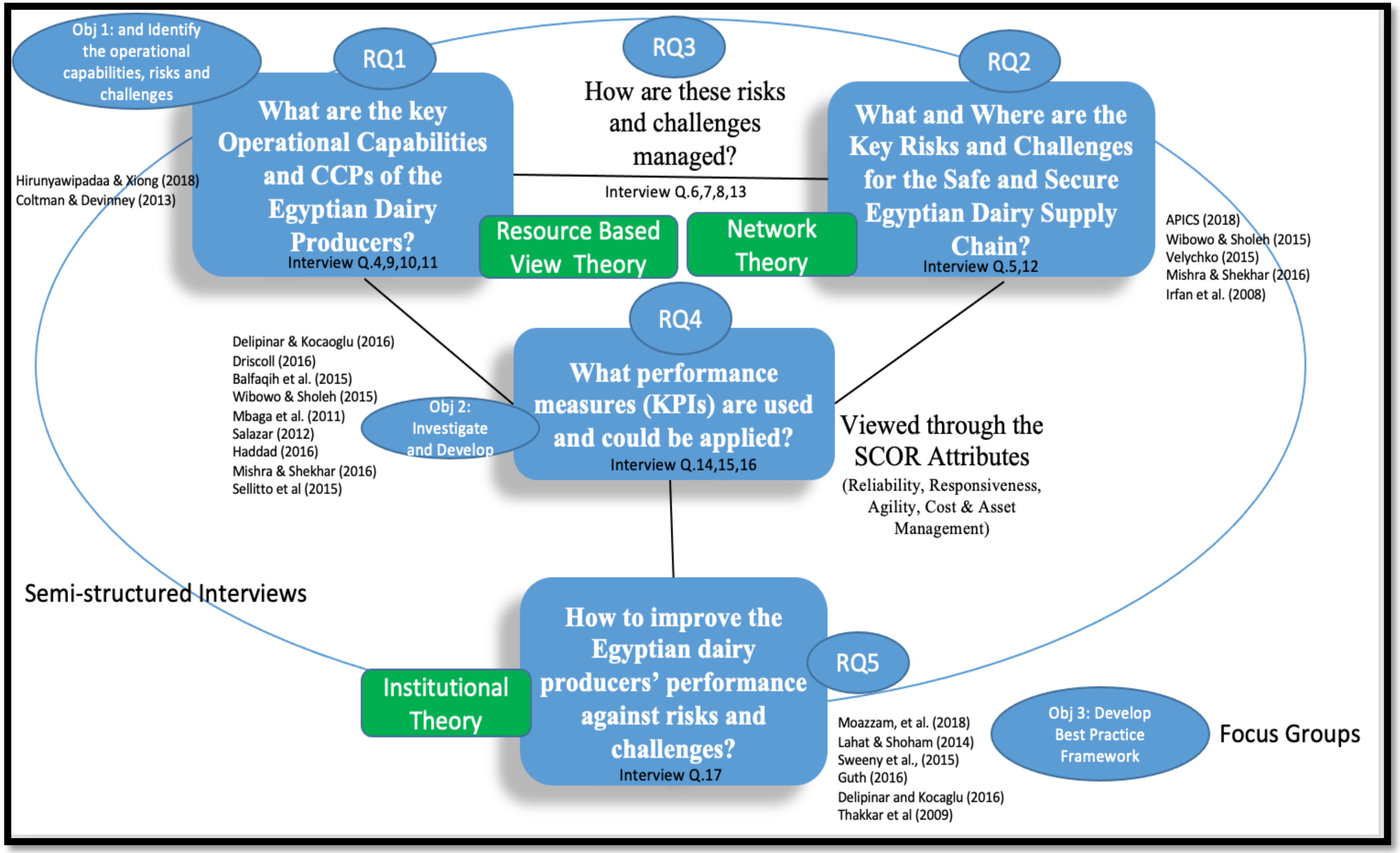
1. To identify the current operational capabilities, critical control points (CCPs), risks and challenges affecting large dairy producers in Egypt.
2. To investigate and develop a set of operational and supply chain performance indicators (KPIs) to improve and transform the dairy producers' performance from the "as-is" state into the desired process of "to-be" or a best practice state.
3. To evaluate whether the SCOR model supply chain attributes (i.e., reliability, responsiveness, agility, cost, asset management) could be applied and integrated within this best practice framework to improve the production of safe and secure dairy products in Egypt.

1.6 Research Significance and Contribution

This thesis contributes to the academic research by filling the gaps found in previous literature related to operations and supply chain risks. El-Nakib (2015), Radwan (2016), Wiengarten et al. (2016), Tate (2017) and Ismaiel et al. (2020) investigated the risks and food safety in the Egyptian dairy sector. But they did not investigate its impact on the operational SCP. This research adopts a case-study approach to understand more clearly the risks faced by the Egyptian dairy producers and their operational capabilities, CCPs, KPIs to address the following gaps. Those gaps generally are first, the lack of the previous relevant literature to the researched area as addressed by (Munir et al. 2016: Liu et al., 2019: Ismaiel et al., 2020). Second, a drop in production was detected in terms of the quality of providing safe and secure products and the quantity of production to fulfil the increasing local demand and the exports of milk (Soliman and Mahhour, 2011: Ismaiel et al., 2020). Besides, considering the possible variations existing in all production systems (Chen et al., 2013).

The thesis will introduce a best practice operational performance framework to the Egyptian dairy sector by consolidating the operational capabilities and practices of the top dominating Egyptian dairy producers. This will be achieved by conducting an individual and cross-case analysis of six large sized Egyptian dairy producers. Then the results will be analysed and compared to the literature and industrial reports from developed countries. Lahat and Shoham (2014) showed the comparison of similarities and differences between the data yielded from the different sources will help to build up a best practice operational and supply chain management performance framework of a unified KPIs for the Egyptian dairy producers. Figure 1.5 is an inclusive diagram that combines the proposed framework with the theories, the key research questions (RQs), objectives, and the methods to validate this framework. This represents a road map and purpose for this thesis.

Figure 1.5: A Conceptual Road Map Diagram Source: Author



1.5.1. Theoretical Contribution

The value in any supply chain chain can be achieved by utilising the strategic SCM to excel in terms of flexibility, cost, quality, and speed. According to Ketchen and Hult (2006), the organisation theories, including the network theory, resource-based view theory, and the institutional theory, are the best suited to the value supply chain and should be given critical consideration and attention in future SC research. Although there is no specific supply chain theory (Sweeny et al., 2015), the three theories will be used as a lens to view the research problem by helping the researcher identify what operational capabilities, CCPs, and performance measures are existing and what are missing and why. That is to propose a best practice performance framework for the Egyptian dairy sector. Thus, this thesis introduces operational and SCP measures within a conceptual framework with detailed elements and sub-elements to suit the dairy sector in Egypt as one of the developing countries. In addition to assessing the relationship between the operational capabilities and the SC attributes and their impact on the SCP. Also, the lack of risk classifications detected in the Egyptian dairy sector will be identified in the SC attributes constructed in the conceptual framework by referring to the network theory's ties. It provides a wider understanding of the ties connecting the SC members' interrelation and how it impacts their performance, including the suppliers, producers, or distributors in terms of the existing risks among them and how they overcome it. That can be achieved by following the mimetic approach to conduct a comparative case-study methodology among the selected six large producers to explore how the dairy producers face the risks to maintain their performance. Moreover, the researcher will use the RBV to understand their capabilities and resources to reach their current operational performance and explore their areas for improvement.

Research gaps were identified in many articles, most notably in Yu and Huatuco (2016) who studied the Chinese dairy sector. They recommended the need to focus more on multiple case-studies rather than only one, through face-to-face interviews to capture the respondents' gestures and body language. As it provides deeper understanding for the dairy sector. Another paper that provided a conceptual model on the global food supply chain in China, New Zealand, USA, and EU prepared by (Deep and Dani, 2009) acted as a base and starting point for this thesis but applied specifically to Egypt and the dairy industry. Their model worked on a predictive basis and proposed a structure to translate scenarios into operation changes and offers a proactive tool for the food industry to avoid or minimise the disruptions in the SC. Their study lacked the empirical application which will be covered in this thesis by exploring the operational capabilities, risks, and performance assessment measures in the large Egyptian dairy producers. Vanany et al. (2009) stated in their literature paper the lack of exploratory research on SCRM. Another research highlighted the need for further studies that handle the uncertainty in the agricultural sector by empirically testing the design of an agricultural system (Borodin et al., 2016). Another case-study research reached the need for process design optimization (Jonkman et al., 2017). Mentioning the lack of research on the dairy sector in Egypt and its benefit on the dairy producers' operations and profitability (El-Nakib, 2015: Eldawy, 2021).

1.5.2. Methodological and Practical Contribution

The motivation and compelling case behind this study is to address the mismatch between supply and demand in the Egyptian dairy sector, which is recently recorded by (Euromonitor, 2020). In addition, there is a lack of empirical exploratory research in this research area, particularly case-based approaches (Jonkman et al., 2016: Borodin et al., 2016: Tate, 2017) to investigate the foregoing research problem in the Egyptian dairy producers. Further, according to Euromonitor (2020), the Egyptian population is achieving a consistent increase from the year 2001 and it is expected to maintain this increased rate until 2030. Egypt and the Middle East achieve the highest increase rate worldwide. This represents a great potential for Egypt to increase the demand for dairy products, moreover, a good opportunity to export globally including the Middle East market specifically. Supporting that, the overall retail sales of the dairy products' records increased by twenty-five percent in 2017 with sales reaching 721 million Egyptian pounds.

As there is lack of research on the dairy sector in Egypt, this thesis is the first to qualitatively explore the operations and supply chain management practices in a detailed in-depth view to understand the risks and challenges to assist the dairy producers in closing these supply gaps. The major contribution in this thesis is the development of a best practice framework for the operations and SC in the dairy producers by utilising the comparative case-study approach and the qualitative research methodology which is rarely used to explore the operational capabilities and identify performance measures for the dairy sector. It is viewed through the lenses of the three theories: the resources-based view theory, the institutional theory, and the network theory. An inductive approach is used to explore these phenomena as it is a largely unexplored research topic. Thus, the research directs the supply chain and operations practitioners and demonstrates the need for a performance measurement tool represented in the proposed framework customised in accordance with the dairy sector's perishability nature. This practical framework can work as a best practice for the dairy producers in Egypt. The framework developed from the literature will be explored by interviewing practitioners from the top dairy producers contributing to the Egyptian economy. Those companies used as case-studies in this thesis. Then, the findings will be validated by focus groups with the support of governmental authorities and suppliers

1.7 Research Process

The thesis process covers the research steps starting from the theoretical background behind the selection of the topic to the data collection and analysis. It should be consistent with each other. It starts with the research philosophy and approach. Then, followed by the research strategy and data collection methods supported by the time horizons. Finally, the research credibility including the research validity and reliability are also discussed.

Figure 1.6 illustrates a detailed diagram of the thesis structure and the process followed in preparing this thesis in a flow chart diagram. Part one consists of three chapters representing the background literature. Starting with formulating the research topic supported by the theoretical background behind choosing it. Then, followed by conducting the narrative literature to identify the research gap(s) in previous literature and extract the three objectives. Based on previous literature and the previously identified gaps, a conceptual framework is proposed to assess the dairy SCP and the operational capabilities regarding the suppliers involved in these SCs. Part two represents the empirical research phases. Semi-structured interviews, observations, and focus groups will be held with the dairy producers and other SC members to validate the proposed framework that will be qualitatively analysed. Finally, conclusions will be reached, and recommendations will be provided in addition to identifying the research limitations that can be further researched in the future.

Figure 1.6: The Thesis Process Diagram-Source: Author

Chapter Chapter One: Introduction This chapter highlights the research structure and gives a brief introduction about the topic. After this introductory chapter the thesis contains seven further chapters as follows.

Chapter Two: Literature Review and Analysis This chapter follows the narrative literature review approach in presenting a comprehensive theoretical background about the topic starting with general information about supply chain risk management, followed by the classification of the different types of risk management strategies with a clear emphasis on the operational risk in the dairy industry as it is the core of this thesis. Different kinds of hazards have been highlighted, and finally global supply chain risk management mitigation models have been explained and reviewed for further implication. In addition to the provision of review on the dairy sector in the developing countries and Egypt specifically then shedding the lights on the operational challenges in Egypt. Also, it provides a conceptualised framework that assesses the operations and SCM relationship. The framework incorporates the operational capabilities that might impact the SC attributes. Thus, this chapter focuses on developing a framework to identify the operational capabilities in the dairy sector, the SCP attributes, and the SC KPIs and how those elements help in improving the SCP and the dairy products safety and security. This chapter concludes with the research gaps found and formulating the RQs that relate to the research objectives and are connected to the research methodology in the following chapters.

Chapter Three: Research Methodology This chapter includes the research philosophy, the research ethics and highlighting the relevant research approach used in this thesis, which is primarily the qualitative approach. Using the case-study as the research approach and explaining its design and applicability in details will be provided. Followed by the data collection methods that will be used in this thesis.

Chapter Four and Five: Data Collection and Analysis These chapters focus on the two phases of collecting the primary data through self-conducted interviews, observations, and focus groups to be analysed to provide an in-depth understanding of the case-studies that will be held by using NVivo12.

Chapter Six: Discussion of Findings This chapter contrasts the data analysis with previous literature to highlight the research contribution to the existing theories. It is outlined according to the findings to answer each RQ individually. Then, ending the chapter by proposing KPIs metric within a best practice framework.

Chapter Seven: Conclusions and Recommendations This chapter includes conclusions that summarise the whole thesis and recommendations for this thesis, in addition to highlighting the research limitations regarding future research that could be conducted in the near future and may contribute to the development of this research area.

Chapter 2 Literature Review and Analysis

2.1 Introduction

The Egyptian dairy producers are striving to increase their production of safe and secure dairy products as mentioned in the introductory chapter. This chapter provides a detailed outline of the whole supply chain processes against the different kinds of risks and the operational capabilities' performance specifically to improve the final products' safety and security. Then, the operational performance will be explained thoroughly at the of the chapter accompanied by a proposed framework with a detailed emphasis on SCOR model.

Most risk management plans fail because they ignore the fact that risks are usually interconnected and comprehensive. The main characteristics of risk management are to identify, measure, prioritise the different kinds of supply chain risks, then develop a mitigation plan, monitor, and control those identified risks through the creation of a coherent value chain (Aqlan and Lam, 2015).

This part of the research provides a comprehensive review of SCRM in relation to food safety and security. SCRM identifies the potential sources of risks and evaluates the consequences of those risks on the SCP and eventually the final product, and finally, provides the appropriate corrective actions for it (Yu and Huatuco, 2016). Then, followed by a detailed emphasis on the operations of the dairy sector, ensuring the food safety and security start with the production itself. Therefore, ensuring a production process following the safety standards will lead to safe and secure products at the end. The purpose of this literature review is to understand what has been published so far in relation to this topic, identify the gaps and constructs of the RQs, and conclude a conceptual framework that will guide and provide the best practice framework for this research. Egypt is chosen as one of the promising developing countries in the dairy sector but there are major problems around the sustainability of milk products production and key RQs which need addressing.

This chapter starts with the selection criteria of the resources used in the preparation of this thesis. Then, classifies the relevant literature under eight main themes modified in accordance with the proposed objectives. The following themes are supply chain uncertainty and hazard identification, risk management strategies, global SCRM mitigation models, dairy sector SCM, identifying the factors affecting the dairy sector, followed by reviewing the dairy products sector in the developing countries, and then Egypt in particular and finally highlighting the operational risks in Egypt. Followed by the theories which contribute to formulating the proposed framework. After that, a clear discussion of the operations and SCP indicators (i.e., KPIs metric). Afterward, a discussion of the SCP measurement is provided in detail which worked as a base that led to the selection of the appropriate SCP framework. Examination of the proposed framework will be constructed in this thesis to act as a guide for further exploration. It aims at identifying practical operational capabilities to improve the SCP and consequently improving the overall performance to provide a process and product quality with safe and secure dairy products. These themes critically review the development of the explored area to identify the research gap.

2.2 Literature Selection Criteria

This chapter reviews the emerging literature which prelude to formulate the research framework to attempt to fill the research gap. This literature follows the narrative approach. It is based on the selection of a wide scope of relevant research papers relevant to the research topic. The selection process focused intensively on the following sources: Science direct/Elsevier, Emerald, Wiley, Springer, Inderscience, Research gate, EBSCO, SCOPUS, Web of Science, PROQUEST, OECD, and Google Scholar. These sources are selected based on their high relevance to the researched area and are the most comprehensive databases (Maestrini et al., 2017: Wetzstein et al., 2016).

Based on a predetermined keyword that will be mentioned in the next paragraphs, some selected databases were targeted to collect articles published in peer-reviewed journals. Top journals in the operations and supply chain management according to the ABS 2018 classification were used to access the selected articles included in this review (Maestrini et al., 2017). Fahimniaa et al. (2015) mentioned the top five contributing journals in the uncertainty in the tactical/operational supply chain planning, taking it as an example, are: International Journal of Production Economics, European Journal of Operational Research, Journal of the Operational Research Society, International Journal of Business and Management, Journal of Business Logistics, Computers and Industrial Engineering and Production Planning and Control. Those journals were used and have a vital role in building this current research.

EBSCOhost, Science Direct, Web of Science and PROQUEST are the main databases used in this review based on the following authors (Al-Abdin, 2015: Wetzstein, et al., 2016: Strozzi and Colicchia, 2015). The rationale for the selection of these databases is restricting the search to peer-reviewed journals, to cover the commonly used databases in the supply chain studies and their sub-disciplines and consequently provide quality control of the search results. Using Google scholar in addition to the previously mentioned databases to cover a broader scope of the collected articles and maximise the number of available sources online. Careful selection of the articles published on Google Scholar was made. The selection was mainly based on the peer-reviewed articles with recorded citation index. Supported by industry reports to collect data on the entitled sector, to seek knowledge and insights on the industry procedures. Euromonitor reports are used thoroughly to obtain updated and comparative statistical data and information along the past few years on the dairy sector and Egypt in particular.

The keywords selected in performing this literature review on the aforementioned databases and stated journals were, risk management, operational risks, risk supply chain management, supply chain security, and dairy supply chain management. Following the narrative literature review allows the coverage of a wide variety of sources and published articles, especially empirical articles on the agricultural sector in Egypt (Ferrari, 2015). That provides a comprehensive view to include the framework's constructs to answer the RQs.

Determining precise keywords sets help in identifying the most relevant contributions in the researched field (Strozzi and Colicchia, 2015). The keywords are selected carefully in accordance with the research objectives. Constructing large sets of keywords helps to avoid too generic and wide results. The keywords varied between: *Risk supply chain management, risk management, operational risk, mitigation, agriculture, dairy supply chain, dairy operations*. Using a combination of the previously determined keywords in addition to the search tools such as: AND, OR, *, and "" will help in specifying the search criteria accuracy.

To ensure the traceability and the repeatability of the search process combined with the good quality represented in peer-reviewed articles. The databases search process is prepared primarily based on one inclusive set by combining all terms: (risk AND security AND operation* AND mitigat* AND agri* OR dairy AND supply chain). This set is typed in each database used to collect articles. That will enhance the reliability of the search process.

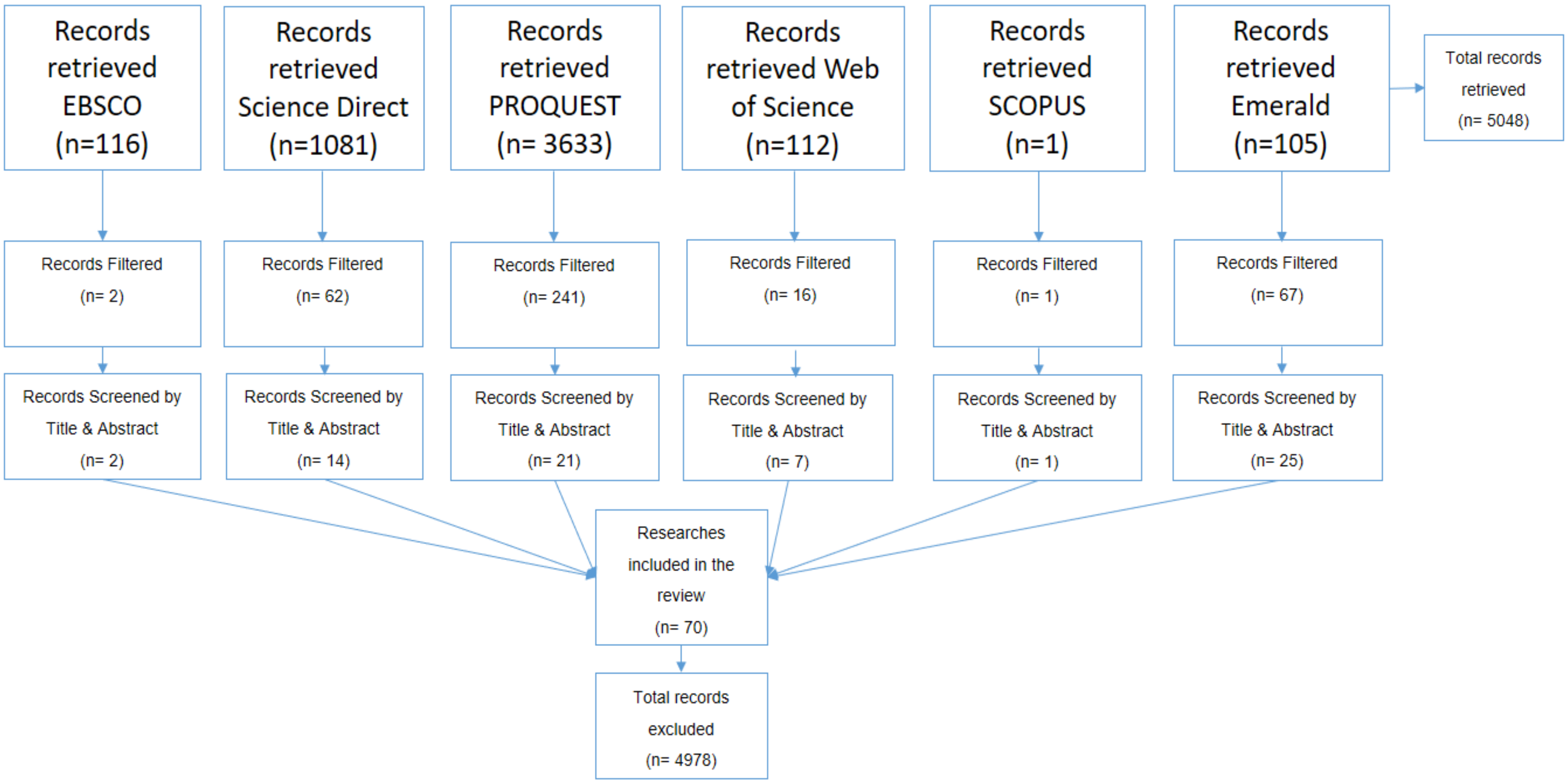
The selection process is based on specific criteria, including a list of inclusion criteria for the selected studies and exclusion criteria for the eliminated studies. Those studies are available on the selected online databases to filter the search results and avoid bias in the search process. One of the primary issues regarding the inclusion criteria is ensuring and maintaining consistency and unity in the search process. Unified search process and avoiding duplication reduce bypassing of the most critically relevant results to the researched area (Al-Abdin, 2015). However, one of the barriers affecting the inclusion criteria, which is mentioned in the next chapters, is the variation of the advanced search criteria of the databases searched.

The inclusion criteria represented articles published in English, published in 20 years, and based on the selected keywords. Then, extended at the end of the research process to ensure nothing has been missed related to the research topic. The selection of these three criteria is due to English being the most common language included in the research and understood by most of the researchers globally. The keywords are derived from the research title and objectives. The time frame is selected according to the development of performance measurement models applied to the dairy sector. However, the exclusion criteria represented in books, editorial materials, reviews, and duplicated studies. Then, the exclusion criteria are articles with synonyms titles, articles irrelevant for the core subject of the research, and technical reports.

The articles are assessed and selected based on its relevance to the researched topic. The screening of the article starts with reviewing the title, then the abstract according to its' relevance to the researched area. If the abstract provided apparent relevance to the research, that would qualify it for further investigation to check the research methodology and findings (Appiah et al., 2015). The relevance to the researched idea represented in studies related to the agricultural sector and the dairy sector specifically. Studies focus on the developing countries due to its similarity to the current research scope, which is focusing on Egypt as one of the developing countries. Similar studies were followed as a guide for using similar measuring models or methodology.

Figure 2.1 illustrates visually the search process according to the previously explained criteria, including the number of retrieved articles and how many included and how many excluded.

Figure 2.1: Literature Selection Process-Source: Author



By using the same search string utilising one set of all keywords grouped, the total number of articles retrieved is 5048. Categorised into; EBSCO 116 papers, ScienceDirect 1081 papers, PROQUEST 3633 papers, Web of Science 112 papers, SCOPUS only one paper, and Emerald 105 papers. The filtration process varied from one database to another, although the time frame is unified in all databases. Based on further filtration and reviewing the title and abstract of the retrieved search results, the total number of excluded articles is 4978. That is due to several filtration reasoning varied among the databases, highlighting some of them as follows: renewable and sustainability research, chemistry, environment, political views, transportation, geography, and engineering. As noted, the numbers of retrieved articles in the selected databases are quite limited. That keeps 70 key research papers left to form the base of this thesis and formulate the research gap. Table 2.5 at the end of the chapter contains a summary of the key research papers' gaps, which formulate the current research contribution and link to the next chapter (formulating an operations and SCP framework). Thus, Google Scholar is then followed using the same set of keywords to expand the depth of understanding of the researched keywords and topics and to help validate that nothing had been missed

2.3 Supply Chain Uncertainty and Hazard Identification

This part of the literature reviews the different kinds of risks and hazards in the SC, how to identify and analyse them regarding the dairy sector's supply chain specifically. Then followed by a detailed classification of two critical areas in the dairy SC; the upstream side of the SC concerning the quality of raw milk supplied to move to the next phase, the operational phase, including the transformation process from raw milk supplies into a variety of different dairy products (Yu and Huatuco, 2016).

Recently all organisations functioned as a part of a global environment that requires an effective supply chain management to compete globally. Consequently, to compete in such a broad and versatile environment, the organisations mostly will have to deal with several uncertainties in different aspects whether in the: resources, planning, operation, workforce, etc. Accordingly, many organisations tend to outsource their activities to disperse the risks (Vanany et al., 2009).

Two different supply chain risks classifications have been provided, the first one provided by Tang (2006) categorised it into; operations and disruptions risks and the other one by Chopra and Sodhi (2004), they extended the classification to a larger scope to be in the form of delays of materials from suppliers, large forecast errors, system breakdowns, capacity issues, inventory problems, and disruptions. El Nakib (2015) specified some factors affecting the production process represented in: raw milk quality and delivery to plants, hazard risks and variation of consumer taste.

Yu and Huatuco (2016) provided a list of SC risks identified in the dairy sector, classified under: supply, demand, operations and control, and environment. In addition, three distinctive elements can be used as a guideline to classify risk events: domain of risk that focus on the internal operations related to manufacturing the product, source of risk related to the external stakeholders including the suppliers and any other member involved in the SC, and last the adverse events (Manuj and Mentzer, 2008).

Bandaly (2012) classified the SC risks into two broad categories: external and internal. First, external risks can include political, economic, technological, or geographical issues, i.e., those risks reflected in IT systems failure, supplier failure, natural disasters, and accidents (e.g., fire or theft). Second, internal risks can include machine breakdowns, import, or export restrictions, transportation failure, increasing customs duty, fluctuation in customers' demand, or technological change.

Bandaly (2012) discussed production risks in terms of four aspects: employees' risk, property risk, environmental risk, and criminal risk. Nonetheless, Chen et al. (2013) studied risks in three types; supply risks, demand risks and process risks in relation to the three types of collaboration; supplier collaboration, customer collaboration, and internal collaboration. Manuj and Mentzer (2008) also provided the same three types of risks in the global supply chains. Figure 2.2 illustrated visually the elements of each type of risk and the relation between them.

Figure 2.2: Risks in Global Supply Chains- Source: (Manuj & Mentzer, 2008:P.201)

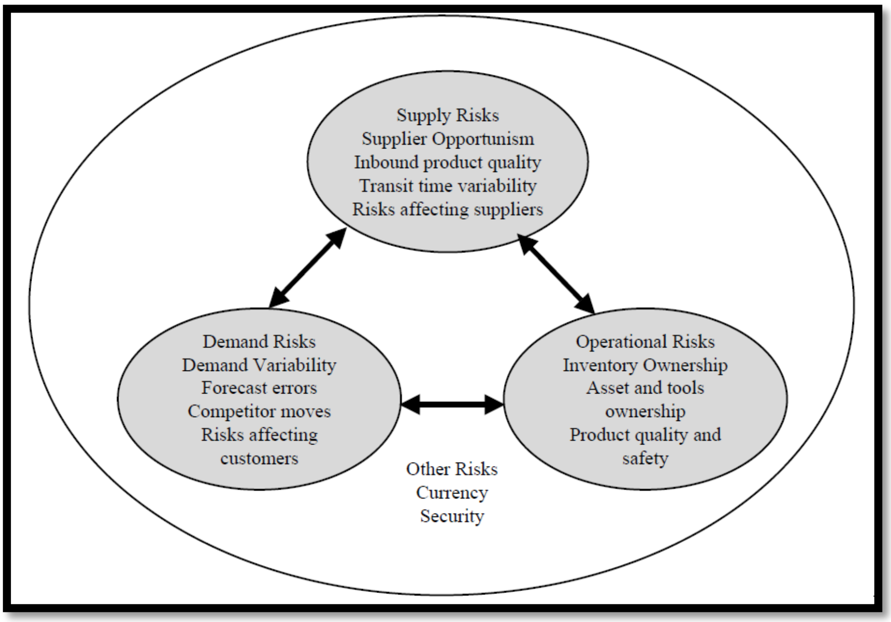


Table 2.1 classifies the domains of risk as listed by a number of key articles as provided by (Bandaly, 2012).

Table 2.1: Comparison of risk domains used in the SCRM Literature- Source: (Bandaly, 2012:P.30)

Our Risk Domains	Rao and Goldsby (2009), adapted from Ritchie and Marshall (1993)	Juttner et al. (2003)	Miller (1992)	Christopher and Peck (2004)
Internal Operations	Organizational risk	Organizational risk sources	Firm uncertainties	Internal to the firm
External Stakeholders	Industry risk	Network-related risk sources	Industry uncertainties	External to the firm but internal to the supply chain network
Marketplace				
Environment	Environmental risk	Environmental risk sources	General environmental uncertainties	External to the network

Other kinds of risks can be represented in internal risks, like production, equipment, and financial risks are located primarily within the organisation. Accordingly, it can often be managed through internal measures, such as improved hygiene or financial management. External risks, which include market and political risks, are rooted in an organisation’s environment, so the management has little control over the incident rates of these risks (Schaper et al., 2010).

Therefore, various food production organisations around the world have grouped to work on establishing quality standards to ensure the health of the consumer. The health hazards are limited to microbiological, physical, and chemical. Different microbiological tests are used to indicate the hygienic condition during the manufacturing of the dairy product (Yilma, 2011).

As food production must be on a specific level of cleanliness and product security from contamination. Food safety risk assessment can be achieved through the implementation of HACCP based food safety programs throughout the dairy supply chain (Michael, 2013). Therefore, the manufacturing facility interior should have specific criteria regarding the design, construction, and maintenance. HACCP set a criterion for the production sites to improve their HACCP food safety plans. EL Gendy et al. (2010) confirmed that milk has always been of the most perishable food products. Along the history, the industry experts used to test the final product to ensure the product safety. Quality assurance (QA) programs are now essential to ensure the product quality and safety. One of these programs is the HACCP which controls the dairy products from production to consumption. Other authors refer to it as farm to market. Aiad (2013) confirmed that all food manufacturers should have a full profile of the risks involved in their practices, starting from the raw milk supplies through to consumption. The HACCP system can be used as a preventative tool for all dairy producers. Then, determining the CCP is a preliminary step in the HACCP application. The CCPs is based on a preventative, structured, systematic, and documented procedure to ensure food safety.

The HACCP is an international tool used in assessing the food safety sector and ensures the quality control standards. It manages hazards and provides safe products ready for consumption. The HACCP process helps in constructing an accurate process flow diagram, which represents all the steps involved in producing the product. One of the benefits of applying the HACCP system, that it works in a proactive manner, includes preventative measures that assess hazards, estimates risks, and establishes specific control measures that focus on prevention rather than waiting to test the final product. HACCP identifies and assesses the process of food production hazards and risks in terms of manufacturing, storage, and distribution of food products. HACCP works on eliminating the hazards from CCPs of the production line. HACCP developed as a ‘zero defects’ system to ensure the provision of only safe food products to the final consumer (El-Hofi, 2010).

Applying the HACCP requires a series of steps includes; 1) support of senior manager, 2) a team of production manager, production engineer, food hygiene and sanitation consultant, food microbiology consultant and laboratory technician, 3) products description in terms of ingredients, processing, packaging, storage and distribution, 4) preparing a process flow diagram from raw materials through processing, packaging and storage, 5) identify the hazards, 6) observing operations in terms of receipt of raw materials, storage, heat treatment, cooling and packaging, then, fermentation, concentration, homogenization, additives, temperature, packaging and storage, last, the working conditions includes; personal hygiene, education, health, cleanliness, habits, premises, equipment, floors, walls and ventilation, 7) measuring operations, time and temperature applied during the production and storage of dairy products (El-Hofi, 2010).

The development of a HACCP plan consists of twelve steps, five preliminary tasks for assigning the team and identifying the product intended to be produced and its process flow (El-Hofi, 2010). Then the seven principles are conduct hazard analysis, identify the CCPs, set critical limits, monitor them, corrective actions, verification procedure, and keep record.

One of the most important steps used in the HACCP system application is the receipt of raw materials, the storage, heat treatment, cooling, and packaging. Also, the personal hygiene, cleanliness, premises, equipment, all under the working conditions should also be included. Measuring and testing the operations in terms of time and temperature applied during the production and storage of milk and dairy products should be measured and recorded on the flow diagram (El-Hofi, 2010).

Focusing on the dairy sector's hazard identification in specific, white cheese categorised under the soft cheese in the dairy products. The ingredients and materials involved in the white cheese production are milk, water, salt, rennet, cans, and plastic box. Egypt's milk consumption includes different raw milk such as cow, buffalo, sheep, goats, and camel. The Egyptian organisation for standardisation and quality control recommended that different milk products must be made from pasteurised milk (Ayad, 2004). Therefore, the application of the HACCP ensures the provision of preventative measures for the designated hazards. El-Hofi (2010) identified several CCPs, receiving the raw milk, pasteurisation, processing, and packaging.

HACCP replaced the Good Manufacturing Practices (GMPs) to ensure the production of safe food (Sandrou and Arvanitoyannis, 2000). HACCP is also found to be flexible to adopt various changes and improvements in the processing procedures. For example, there is a specific criterion necessary for cheese production. First, ensuring the raw milk condition which should only be accepted at the dairy plant. Then, rapid cooling of the milk receival below 4°C within 4 hours after milking. On-farm storage time should be limited. The pasteurised milk should be immediately cooled and refrigerated at a temperature below 6°C to prevent the growth of pathogens.

All dairy products should be analysed microbiologically before applying the HACCP. In the dairy products production process, many hazards are detected and classified according to the process step. The process steps include receiving raw milk, heat treatment, pasteurisation, or sterilisation, processing incubation and cutting, and packaging. The hazards include the high microbial load, contamination, and high acidity (Njage et al., 2017).

It has been found that small dairy manufacturers that have not implemented any food safety system have a poor product microbiological performance. A preliminary phase to improve the performance of the FSMS is to assess the current performance and compare different production scales and implementation of food safety programs. Only large dairy manufacturers used the HACCP and ISO22000 in contrary to the small and medium manufacturers (Njage et al., 2017).

2.3.1 Upstream Supply Chain Risks (Supplier Evaluation)

Supplier unreliability is found to be one of the major risks faced by buyers. It led the researchers to identify a set of adverse events regarding such risks, such as: poor quality, price fluctuation and delays in supplies (Manuj and Mentzer, 2008). To improve the final dairy products safety and quality, an awareness should be paid to the hygiene level in the upstream side of the SC. Starting from the raw milk collection from certified suppliers, cleaning and sanitising all food contact surfaces, hygienic training of plant workers to avoid contamination (Aiad, 2013).

Many recent studies analysed the supply side of the dairy sectors in different countries. Bourlakis et al. (2014) studied the firm size and sustainable performance in the food SCs in Greece to classify the findings into growers and manufacturers. Where manufacturers found success, there was no statistical significance between the micro and medium firms' performance, and they found that the small growers were considered more flexible in the provision of extra volume orders and consistency of traceability systems. Moreover, Gillespie et al. (2009) highlighted that previous research focused on operations, farm size and profitability. The results of this research confirmed that the farm size affects the production in Pennsylvania. According to Bier and Lange (2020) the supply network structure will help in identifying the supply chain risks, which will consequently lead us to the next phase, the risk assessment and last the risk mitigation.

Borodin et al. (2016) studied the uncertainty factor in the agricultural SCM, in which the dairy is considered as a sub-sector of it. The authors provided a comprehensive model on handling the uncertainty in the agri-food sector by using simulation modelling analysis. Regardless of the fact that there is a clear gap in the literature that handles the endogenous in that specific sector, the authors were capable of proving a convenient method for managing the farming systems by using simulation modelling.

Designing an agricultural system requires the mix between, modelling, optimisation, or simulation approaches. In addition to that, by using empirical reasoning that would represent a solid basis for the agricultural management systems (Borodin et al., 2016). It is approved that simulation modelling proves to be a highly convenient methodology for application on the farming and agricultural sector, as it provides in-depth analysis of all aspects related to the sector including harvest, price and profit, and last agri-supply chain coordination and redesign.

Akhtar et al. (2015) used structural equation modelling (SEM) to filter the results of the research which indicate the provision of in-depth analysis of how key supply chain leaders can use data driven and adaptive leadership to co-create financial and non-financial sustainability in the agri-food sector. The authors highlighted that there are new practices developed that contribute to the provision of fresh and quality products to the customers. Sustainability can be achieved between the supply chain members by focusing on the operational linkages sharing and using analytical techniques.

As human health, food safety, and quality are a growing concern all over the world. USA developed a quality milk program implemented over the years which includes dairy herd inspection and pasteurisation as a critical control step. Relying on good hygienic milk will help in the production of safe dairy products with a reasonable shelf life that suits the consumer demand. Consumers usually demand products of consistent quality, standards, hygiene, proper protective packaging, and ease of use (Yilma, 2011).

There are three classifications of food hazards as provided by El-Hofi (2010), whether microbiological (M), chemical (C) and physical (P). As raw milk is the main ingredient in almost all dairy products, it is prone to the three types of hazards (MCP) that can be prevented by storage under 4°C with proper sanitised transfer equipment and proper personal hygiene and handling. Microbiology is still proved to be the main potential hazard in dairy products.

According to Soliman and Mahhour (2011) and Rousing et al. (2020) some obstacles are detected in the farms level; the health condition for the milking animals limits the opportunity of large-scale dairy plants to receive the supply of small farmers, lengthening the filtering period and using an appropriate processing tools lead to decrease the cheese production, lack of adequate equipment in the collection points including the filtering equipment, test equipment, fat content and sampling bottles. Another obstacle other than the supplies was detected, the high cost of packaging. The cost of the protective package may exceed the cost of the content itself, which represent constraints to the growth of the industry. That will require us to review the risks that may affect the core operations in the business.

2.3.2 Operations Risk

Operations are considered as the value creating activities in the supply chain, which transform the inputs into a final product. Value chain is defined as a tool for developing a competitive advantage as defined by Michael Porter in (Soliman and Mahhour, 2011).

Much recent research focused on studying the supply chain disruptions and its impact on supply chain design decisions. An accident can cause production stoppage and may impact the product quality (contamination as an example in the food industry). Unintentional food contamination may result in illness, hospitalisation or death for the consumers (Speier et al., 2011).

Supply chain operational risks, i.e. process risks refer to the internal production process of the focal firm. It impacts the overall supply chain performance. Process risk is defined as the potential deviations from producing the specified quality and quantity at the specified time, keeping in mind that variations exist in all production systems. Therefore, supply chain operational risk negatively affects the overall supply chain performance. The production process fluctuates by the unpredicted changes in the supply or orders changes from customers, and that increases the process risk (Chen et al., 2013).

Operations risk is defined as the possibility of an event associated with the focal firm that may affect the firm's internal ability to produce goods and services, quality, and timeliness of production, and/or the profitability of the company. Sources of operational risk reside within the firm and may result from a breakdown in core operations, inadequate manufacturing, or processing capability (Manuj and Mentzer, 2008).

It is worth mentioning that the operations risks are associated with uncertainties rooted in a supply chain, which include, supply, demand and cost uncertainties while disruption risks are those caused by major disasters such as flood, earthquake, or economic crisis (Chen et al., 2013). Both operations strategy dimensions, whether cost leadership or differentiation through innovation strategies, interact with the supply chain integration (SCI) and risk (Wiengarten et al., 2016). Identifying the risks in an organisation can be done by implementing the risk management strategies, which will help in responding to those risks successfully (Schaper et al., 2010). Bier and Lange (2016) used the simulation methods to identify the supply network risk, which consequently helps in risk assessment and risk mitigation eventually.

Managing the operational disruptions through process improvement can be more beneficial if it is detected at the industry level rather than the firm level. Risk managers should not view and deal with the operational losses in one view homogeneously, as it differs according to the event types. The categorization of operational disruptions i.e. event types determined at the level of industry sectors (Mizgier et al., 2015).

Managers define risks in terms of the magnitude of loss or the worst case instead of the expected loss. They usually focus on meeting and accomplishing the performance targets, and they get rewarded for that (meeting performance targets i.e. good outcome) instead of taking good decisions. Most companies skip investing in the resources and time to plan for mitigating the supply chain risks (Tang, 2006).

Both Jonkman et al. (2016) and Borodin et al. (2016) investigated the food system selection design from a different perspective. However, Borodin et al. (2016) handled the uncertainty factor by using simulation modelling, which in turn overcame the lack of optimisation in previous studies.

Vanany et al., (2009) highlighted the trend towards adopting an effective risk supply chain management especially in the operational phase by several companies starting from 2004. As competition is between supply chains rather than individual firms, the supply chain partners will be dispersed globally around the world, which will expose the supply chain partners to be more vulnerable to a number of external risks. However, some supply chains still operate on a domestic level that makes them prone to other kinds of risks (Manuj and Mentzer, 2008).

Clarifying two different kinds of operational breakdown whether within the company such as current facilities obsolete and other uncontrollable elements such as, the inconsequential effect of the operating profit like the variance in the exchange rates or foreign competition. In addition, Manuj and Mentzer (2008) summarised the operational risk represented in a breakdown of operations to: inadequate manufacturing or processing capability, high levels of process variations, changes in technology and changes in operating exposure.

Manufacturing system has two main types of variability. First, process variability, which is caused by different detectors such as equipment breakdown, setups or operator unavailability. Second, flow variability, caused by the way the work is released to the system and the movement between stations (Hoyer et al., 2019).

High levels of process variations, changes in technology that may render the current facilities obsolete, and/or changes in operating exposure are considered as sources of operational risk. One of the examples that is considered as a change in operating exposure is the exchange rates that often affect the operating profits of organisations that have no foreign operations or exports but face important foreign competition in the domestic market. The process risk is highly exaggerated by the supply risk and demand risk. So, the mitigation process risk and demand risk has a direct impact on the SCP (Chen et al., 2013).

Identifying potential operational risks can be reached by developing cross functional process maps or flowcharts, that facilitate the understanding of supply chain products and information sharing. Firms periodically mock events with their supply chain partners in order to simulate recalls, contaminations and information hackers. Simulations designed to test the effectiveness of SC security capabilities (Speier et al., 2011).

Manual operations by personnel greatly increase the risks of contamination in the processes of food products. SMEs lack the funds that enable them to hire personnel with a high level of education. SME dairies need to improve all the FSMS activities (Njage et al., 2017). The large size dairy producers are mostly committed to apply the international food health and safety standards to avoid any expected risks.

Mishra et al. (2011) investigated the dairy sector's operations. They concluded that by controlling the hygienic requirements of the dairy products' operations, an effective and efficient supply chain management could be planned. Regardless of the fact that the dairy supply chain is considered as a high risky business no matter how much precautions you are taking. To overcome this high intensity of risk, modelling and simulation tools were also kept being introduced and utilised, which have a major role in decision making and optimisation without putting the real process at risk. Process simulation works on analysing process operation, performance, and process or product variable trends (Munir et al., 2016).

Some elements of the operational risks in the dairy sector were specified in the previous literature. EL-Nakib (2015) mentioned some factors that affect the dairy production quantity and quality. Those are; first, difficulty in delivering the raw milk to the factory, whether imported powder milk or fresh raw milk from the farms. Second, the variation in the quality and taste required by the local consumer may affect the operational processes. Third, the hazards risk represented in accidents or electricity shut down also may hinder the smooth functioning of the production process. Njage et al. (2017) analysed the operational elements required for the application of the FSMS into; product, process, organisational and environmental characteristics. The operational elements concerning the product are; the risk of raw materials, the risk of the final product and the extent of safety contribution and the packaging concept. The operational elements concerning the process are; the extent of intervention steps, the degree of production process changes, and the rate of product/process design changes. Speier et al. (2011) focused on the product risk in relation to the disruption design themes; SC security process management, SC security information sharing, supply chain partners security management, and supply chain service provider management. Tang (2006) argues that a company's profitability is measured based on efficiency and resiliency. Efficiency enables the company to manage the operational risks efficiently, and resiliency enables the company to sustain its operations during a major disruption and recover quickly after it. Both elements ensure the profitability and continuity of any business especially when dealing with the SCRM.

Decisions for each planning and scheduling period for the dairy products were provided by Sel et al. (2015), selecting the key decisions that matches the focus of this study are; (1) finishing time of each product on each line, production time of each product and overtime, (2) maximum completion times of each product and each line, (3) number of incubation operation required for each product and incubation sequence of the products, (4) production assignments of each product and changeover assignment between products on each line.

Mizgier et al. (2015:3) studied the loss distribution approach (LDA) of the operational disruptions i.e. operational risks in terms of two inputs; the frequency and the severity of the disruptions. The operational risks was defined as; "the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events".

Operational and disruption contribute to the design of a responsive SC (Fattahi and Keyvanshokooh, 2017). Creating an optimisation model by adding risk constraints in order to limit the level of risk responsiveness. Supply chain disruptions may have a significant effect on the company's short term performance. Tang (2006) provided robust strategies for mitigating operational and disruption risks. Most available quantitative models designed to manage the operational risks by the provision of cost effective solutions.

Robust strategies are recommended in order to improve both elements, efficiency and resiliency. Robust strategies such as; increase the number of suppliers and make broad selections around the world and robust information management sharing, reflecting the supply chain visibility and access to information between all supply chain members (Tang, 2006).

2.4 Risk Management Strategies

According to APICS (2015) the risk management manager should work in a proactive and wise manner to position the organisation in its safe supply chain against the different types of risk, for both the tactical and the strategic level. SC operations must align with the overall strategy of the organisation.

Risk management deals with both the known and unknown risk. Known risks include process breakdowns, supplier failure, poor material and component quality, excessive demand instability, inadequate logistics and distribution activities, criminal action, and natural disasters. SCRM is wide and extensive in nature, it extends to cover all areas of the supply chain. SCRM seeks to manage and overcome a real or potential risk to the supply chain performance. Effective risk management is required to reduce the probability and the impact of the supply chain disruptions on the supply chain overall performance. Setting a SCRM strategy requires discovering the cause of the risk which is a difficult task. Some challenges will be faced such as; the high complexity, missing information and lack of communication. Risk is not easily measurable, that was due to, growing the uncertainties because of changing the laws, regulation or liabilities, slow the SCP compared to competitors, and focusing on efficiency at the expense of risk responsiveness (APICS, 2015).

Effective SCRM is essential for a successful business. It is also considered as a competency and capability many enterprises have yet to develop. In some areas, both problems and practices are well defined and determined. In another area, the problems are defined, but practices are still developing. In contrast, the definition of the problems and the practices needed to address them are both indefinite (Manuj and Mentzer, 2008).

Many previous studies in the risk supply chain area dealt with different types of risk sharing whether, sharing, transfer, or avoidance. Systematic risk management allows farmers in the upstream side of the supply chain to identify, quantify, control, and monitor risks and potential losses. Risk management strategies are implemented to identify risks in an organisation and to respond to those risks effectively (Schaper et al., 2010). However, APICS (2015) classified the supply chain risks to two categories: coordination risks and disruption risks. Coordination risks covers the daily supply chain management, using principles such as safety stock, safety lead time and overtime. Additionally, disruption risks caused by natural or manmade disasters such as hurricanes, earthquake, and terrorism.

Bandaly (2012) restricted the risk management approaches into only three categories: avoidance, prevention, and mitigation approaches. Mentioning that such classification facilitates the selection of the risk management decision and planning process that facilitates the implementation of risk supply chain management strategy.

Risk management strategy mix as listed by Schaper et al. (2010) are.

· *Risk avoidance* includes measures that reduce a company's exposure to internal or external risks. It allows a company to avoid risks associated with milk production; at the same time, however, it means that the farm loses the income opportunities associated with milk production.

· The *risk reduction* strategy consists of measures that reduce incident rates, or potential damages or losses. This category includes such diverse measures as the use of technical aids, such as fire alarm systems, and the diversification of farm activities to improve the mixture of risks a farm is exposed to. This strategy can be used in a much more flexible way than the risk avoidance strategy. It can be implemented by hiring subcontractors instead of investing in one's own machinery and it guarantees strategic flexibility. Horizontal cooperation between farmers is also a means of reducing risk.

· With the help of a *risk transfer* strategy, the consequences of risk incidences are transferred to other professional risk-taking institutions.

· The *risk acceptance* strategy is preferred where risks have not been identified or where other strategies are technically impossible. However, this measure can also be used deliberately to avert cost intensive risk avoidance, reduction, or transfer strategies.

· *Risk control* is the final phase of the risk management process. Its aim is to assess whether the implemented risk management strategies achieve the desired degree of security. It allows identifying new requirements and improving the cost-benefit ratio of specific measures.

Yu and Huatuco (2016) and Sweeny et al. (2018) highlighted that one of the best ways to mitigate risks and achieve largest rates of performance improvements can be obtained through supplier and/or customer integration with the manufacturer or even internal collaboration. That is determined according to the research scope focuses on which part of the SC. This thesis focus on the supplier manufacturer collaboration and its impact on the dairy manufacturer's performance. They ensure that the level of integration had a positive impact on the supply chain agility that works as an indicator to respond rapidly to changes and disruptions. SC collaboration minimises and mitigates the SC risks. Collaboration of efforts between the supply chain members, through sharing information, knowledge and expertise smooth and ease the operations and enhance the competitiveness by jointly solving problems and developing new products (Chen et al., 2013). Dani (2015) also approves to the previous studies that collaboration is a major element among the various stakeholders involved in the food value chain.

Due to the criticality of the food sector regarding: the food safety, food recalls and traceability. A collaboration between the supply chain members, especially the suppliers and the manufacturer ensures the hygiene and safety standards of the sourced raw milk and supplies achieve a high level of traceability. Therefore, collaboration is the key to help setting a platform for all the food supply chain members, which will help in the elimination of wastes along the SC (Dani, 2015).

2.5 Global Supply Chain Risk Management Mitigation Models

No matter the kind of risk that the companies are prone to, it hinders the companies to perform with full capabilities with their integrated supply chains. Recently, companies invest in risk management tools including risk mitigation practices and contingency planning (Wiengarten et al. 2016).

An integrated Mixed Integer Linear Programming (MILP) model has been introduced for the planning and scheduling problem of yoghurt production. Sel et al. (2015) developed a computational efficient decomposition heuristic and MILP/constraint programming (CP) approaches to handle the problem complexity. Sel et al. (2015:59), mentioned that: “MILP models provide mathematical frameworks to represent specific characteristics of problems and to get optimal solutions. The MILP is an extensively accepted tool in the dairy industry for well-defined problems. A mixed integer linear programming formulation is introduced to integrate tactical and operational decisions”.

Karlsson and Mardan (2013) used a case-study that applies the model on the start-ups and shutdowns in the dairy production plants. The main objective of the model is to minimise the system costs. There are many modelling methods other than the MILP/CP that vary from stochastic programming (SP) and simulation (SM). However, simulation tools are commonly used in the dairy industry as part of the decision-making process. Simulation modelling is an advanced tool that may work as a completion to other modelling tools in the near future to enhance the decisions support. The decision support includes risk management and optimisation. Using a combination of those tools increases the reliability of the results and provides better solutions (Karlsson and Mardan, 2013).

Sel et al. (2015) contributed to the research area by focusing on the production and distribution of the yoghurt, which is similar to other kinds of dairy products such as cheese, butter, and ice-cream. Using the MILP model as a representation of quantitative models used in the dairy supply chains and as an extension to the application. They applied it on the packaging and fermentation/incubation operations which strongly matches the production phase. The timing and capacity constraint was considered in the extended model application.

Risks expanded on a wider scale when we measure it on a global supply chain rather than limiting it to the firm, that is in terms of wider competition scope and increasing number of vulnerabilities which resulted from the interdependence between the chain’s members (Cohen and Kunreuther, 2007). Risk management practices are implemented based on the severity and the likelihood of risk events. Risk events vary between disruption of supply, production failures or forcast inaccuracies and many others (Wiengarten et al., 2016). According to Manuj and

Mentzer (2008) that any company cannot devote enough resources to mitigate all kinds of risks. The changes are a constant basic factor in the current dynamic global market, as a result, risk management must be an ongoing process, because risk mitigation tools become obsolete on a very short-term basis.

Aqlan and Lam (2015) presented a supply chain risk assessment framework consisting of three main parts; survey, Bow-Tie analysis, and fuzzy inference system (FIS). First, the survey used to identify the risks factors, their likelihood and impacts. Second, the Bow-Tie shows the relation and linkage between the potential causes, preventative and mitigative controls and consequences of risks in a diagram form. It is used to measure and calculate the aggregated risk impact and likelihood. Third, the FIS measures the total risk score, the risk predictability and risk management parameters.

Manuj and Mentzer (2008) suggests using a risk map, which integrates the supply chain business-process model with a diagnostic model. The model provides a risk portfolio that is considered as a major step forward, it helps in deciding the organisation's risk profile, accomplished by preparing an organisation's inventory of risk. The portfolio provides the organisation with a methodology to prioritise cost and risk elements to achieve a best-cost outcome.

Other popular risk identification techniques and frameworks are used in the risk identification phase as provided by (Yu and Huatuco, 2016) in the following table:

Table 2.2: Factors Considered When Selecting Framework- source: (Yu and Huatuco, 2016:P.476)

	SCM	Checklists	FTA	FMEA	CEA	SCOR
Risk identification (qualitative risk)	X	X	X	X	X	X
Risk assessment (quantifying risk)			X	X		
Potential effects of failure				X		
Action plan				X		

Note SCM Supply Chain Mapping, *FTA* Fault Tree Analysis, *CEA* Ishikawa Cause and Effect Analysis, *SCOR* Supply Chain Operations Reference

A Chinese case-study held by (Yu and Huatuco, 2016) focuses on identifying and mitigating the supply chain risks by using the FMEA framework. The risks spotted in this study have been identified, assessed, and then prioritised. As mentioned by the authors, there is a research limitation in finding any SCRM program on the operational level in this study that represents the dairy sector in China.

Tsarouhas and Arapmaztzaki (2010) handled the FMEA with its developments around the years. The main purpose of the FMEA is to prevent defects, enhance safety and increase customer satisfaction. They referred to it as Process Failure Mode Effect Analysis (PFMEA) as it focuses on the production process and the product assembly to be more specific. The analysis includes all aspects of the production process, machinery, operators and controlling instruments, materials and finally the working environment.

FMEA used to analyse the product design, the production processes and the potential failures that may occur, that will increase the reliability and safety of the whole process. It also works on identifying the cause and effect of the main problems in the researched sector. Tsarouhas and Arapmaztzaki (2010) introduced the FMEA in terms of three factors as follows: Severity (S) the consequence of the failure, Probability of Occurrence (O) the probability or the frequency of the failure, and Probability of Detection (D) the probability of the detected failure before realising the impact of the effect. The analysis is made based on the historical information and the entitled industry experts' opinions. Multiplying the three factors (S*O*D) will result in a value called the risk priority number (RPN).

Carlson (2014) mentioned that FMEA helps in preventing problems, reduce cost, shorten the product development times, and most importantly achieve high reliability products and manufacturing processes. Some of the most distinctive objectives of the FMEA are to identify and prevent hazards, enhance the test and verification plans, improve process control plans, consider changes to the product characteristics and manufacturing process, identify product and process changes and develop prevention maintenance plans for machinery and equipment.

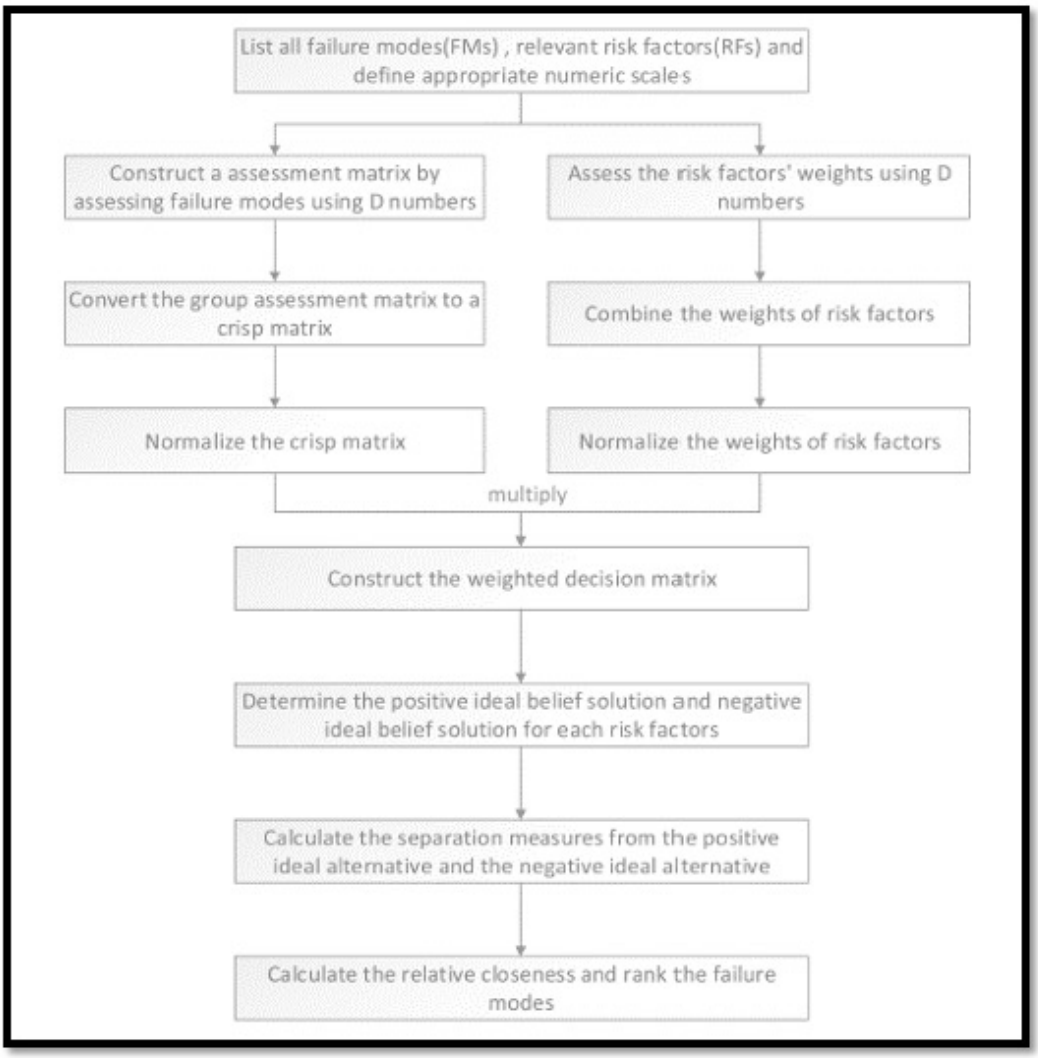
More tools and techniques emerged to add to the FMEA and overcome its weaknesses (Bian, et al. 2016). Zegordi and Davarzani (2012) studied disruptions in relation to studying and tracing the operational performance of a supply chain. Petri-nets-based mathematical model was used for determining how supply chain disruptions related to each other and how to resolve them. Recently, petri-nets can contribute in the process of creating contingency plans. Bandaly (2012) mentioned that there are many risk management models that are applicable in different industries. To build a SCRM strategy there must be three basic elements available as follows; visualise and understand the risk, then measure the impact of the risk, and prioritise and take the action to hinder that risk.

Many risk mitigation tools were found in reviewing previous literature, which can be briefly gathered in this paragraph. Manuj and Mentzer (2008) employed a grounded theory methodology that is appropriate for building and exploring a phenomenon with an inadequate theoretical base. In addition, simulation modelling is the widely used technique to measure the SC risks, this technique enables the users to easily identify the best suitable SCRM strategy (Mishra and Shekhar, 2016). Yu and Huatuco (2016) used the FMEA and the multivariate regression modelling in their research. Multivariate regression analysis has been used to assess the production practices and the varied number of properties in terms of size and characteristics (Borges et al., 2017).

Figure 2.3: FMEA Process- Source: (Bian et al., 2016:P.148)

Shortcomings of the FMEA and limitations were detected when evaluating the Risk Priority Number (RPN). Many risk assessment methods based on the multi-criteria decision making (MCDM) were proposed to improve the FMEA, such as analytic hierarchy process (AHP) (Bian et al., 2016). The shortcomings are potential failure, inaccuracy of calculations, the RPN does not reflect all important factors, and inconsistency (Figure 2.3).

Figure 2.4: FMEA Model Flowchart- Source: (Bian et al., 2016:148)



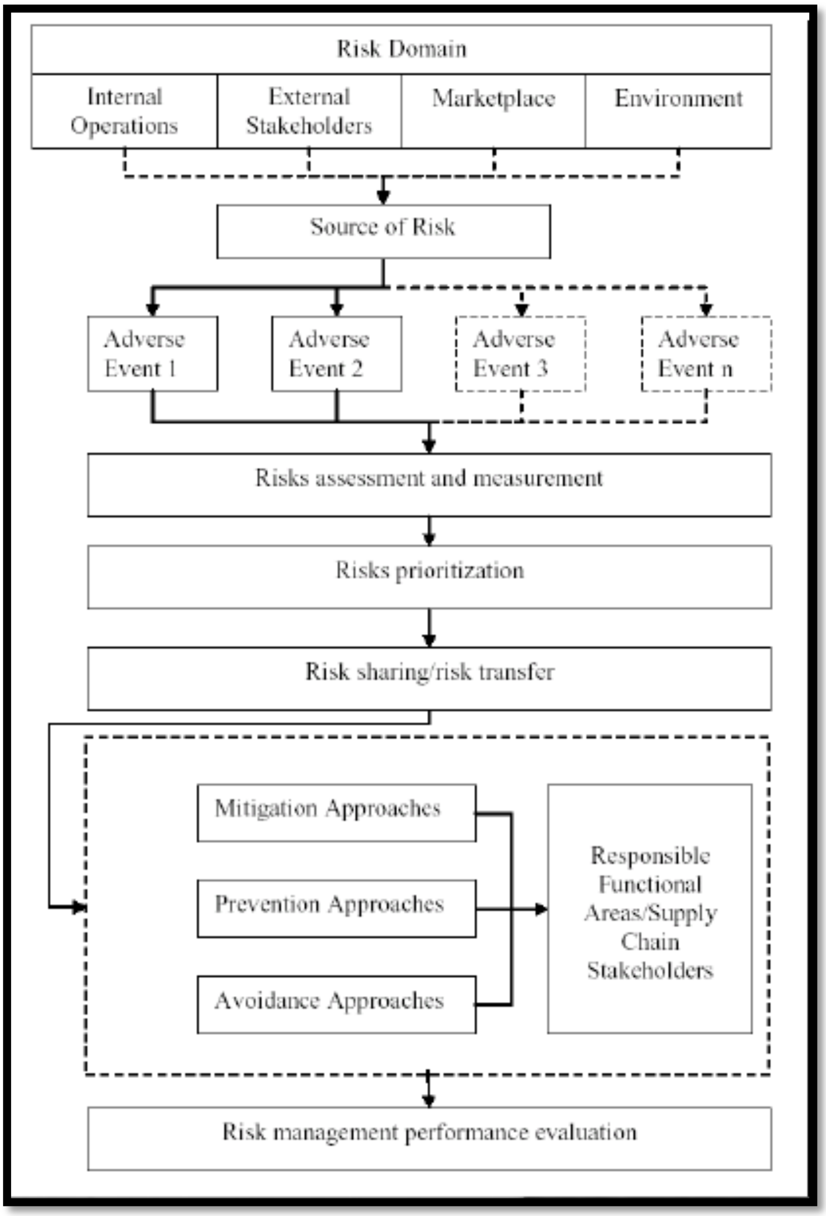
Septiani et al. (2016) assessed the risk management in the dairy sector by utilising the FMEA as explained in Figure 2.4 and Hierarchical Risk Breakdown Structure (HRBS). They measured the relation between risks and risk severity events quantitatively by using linguistic variables and fuzzy logic. A system was proposed and designed by the Intelligent Decision Support System (IDSS). The proposed model worked on improving the decision-making effectiveness in the dairy SC risks.

Based on previous literature, the research problem can be answered by applying the FMEA. Taking (Yu and Huatuco, 2016) as a reference to the application of this framework to the dairy sector in similar previous studies. But the FMEA proved to have many limitations which require the need to adopt a more reliable model. Therefore, El-Nakib (2015) stressed on the importance of managing the SC security issues including the risk mitigation and the cost reduction and best utilising the perishable dairy supplies. That can be achieved through the application of the SCOR model, which is integrated with processes that identify potential risk elements throughout the SC, define metrics to assess the potential impact of these risks, and enable companies to control the impact and mitigate service disruptions (Manuj and Mentzer, 2008).

A mix between the three factors of the FMEA can be used as the basic risk measuring model in addition to more factors extracted from other risk evaluation models. For example, the SCOR model, can be added to create a more precise model that assess the SC risks more thoroughly and overcomes the shortcomings of the most widely used FMEA framework. That will work on creating better risk mitigation plans especially in such perishable industries i.e., the dairy sector. Manuj and Mentzer, (2008) developed a model focuses on the operational risk, inventory ownership, asset and tools ownership, and product quality and safety.

Bandaly (2012) determined a set of risk prevention approaches that possibly limit or eliminate the disruption effect, mentioning the reliance on multiple suppliers to reduce the deficit or the failure of one supplier by substituting him with the others. The more suppliers the producer rely on, the safer and reliable he can operate and ensure the production of its quality product on time, that is illustrated in Figure 2.5.

Figure 2.5: SCRM Framework- Source: (Bandaly, 2012:P.47)



According According to Aqlan and Lam (2015) decision makers need to focus on the significant risks that affect the business's operations after identifying the risks, taking in consideration the risks factors and the risks management factors.   was recommended in order to analyse the SC risks and identify proper mitigation strategies for each risk based on the risk scores obtained by the fuzzy inference system (FIS).

Accordingly, many risk identification and mitigation tools were evolved. Some of them are Food Security Monitoring System (FSMS), Hazard Analysis and Critical Control Point (HACCP), Value Stream Mapping (VSM), Probabilistic Risk Assessment (PRA), and Supply Chain Operation

Reference (SCOR) model. So, after clarifying and mapping the SCRM framework, one of these tools can be utilised in order to avoid risk and enhance the firms' operations and ensure the production of healthy and safe food products. FSMS is a risk diagnostic tool used to evaluate food processors and the dairy processors in particular. It is proved that the FSMS application in the dairy sector improves the quality of milk products. The ultimate purpose of applying the FSMS programs is to improve the safe food production (Njage et al., 2017).

Steur et al. (2016) applied the value stream mapping (VSM) on the food and drink industry in the United Kingdom (UK). VSM is defined as the simple process of directly observing the flows of information and materials as they now occur, summarising them visually and then envisioning a future state with much better performance (Melvin and Baglee, 2008). Another definition is provided by Steur et al. (2016) as a tool that helps the organisation to see and understand the flow of materials and information of a product as it makes its way through the value stream. It is chosen in the food SCs as a tool for collecting information, as it was proved to achieve successful results by many organisations to plan and identify internal improvements. In addition, if it is used properly, it can achieve many benefits for the process industry, some of them are improving the product quality and obtaining better operational control.

VSM is an effective tool in visualising, summarising, presenting, and communicating the key features of a process within an organisation. The VSM were applied on a yoghurt producer to identify the waste and suggest solutions to eliminate these wastes from the value stream. By visiting the yoghurt factory and interviewing the key persons starting from the supplier's department to the production department, it enables the provision of details about operations; including the number of labours involved in the processes and the processes cycle times. Applying the VSM enabled the yoghurt producers to overcome some problems related to the factory operation, such as: maintaining temperature, technical errors, inappropriate layout, and repetitive handling (Melvin and Baglee, 2008).

Steur et al. (2016) proved the compatibility of VSM with lean strategy tools, i.e., continuous improvement strategies giving many examples such as the simulation modelling and the just in time (JIT). The JIT system is a typical example of a widely adopted SC practice that exposes firms to material shortage risk. Its applicability enhances the time and functional dependencies within the SC, enabling it to adapt and survive against potential disruptions (Bandaly, 2012). Chen et al. (2013) recommended the need to furtherly research the conceptualization and operationalization of the SC.

According to the BRC (2014) The British Retail Consortium (BRC), the global standards for food safety assessment provides a robust framework for food manufacturers to ensure the production of safe food, manage product quality and meet customers' needs and expectations. A field study report studied food manufacturers in the UK, Europe, USA, and China. The study focused on pest control, management commitment, housekeeping and hygiene. The companies notified with the non-conformities that have been noticed and reported. Afterwards, the non-conformities should be solved to improve the food safety plans.

Thakkar et al. (2009) introduced a metrics of performance measurement to include: 1) the capability to extract the essence of organisational performance, 2) measurement system to ensure an appropriate assignment of metrics to the most suited areas, 3) limiting the deviation between the organisational goals and the measurement goals, 4) reflect an adequate balance between the financial and non-financial measures to achieve strategic alignment, 5) reflect the clear linkages with various levels of decision making such as strategic, tactical and operational.

Accordingly, integrating the best features of the two well-known contributions in the field of performance measurement; the Balance Score Card (BSC) and the Supply Chain Operation Reference (SCOR) model can be used to integrate the three levels of management and adapt the logistics Key Performance Indicators (KPIs) to suit the provision of a successful organisational strategies (Delipinar and Kocaoglu, 2016). Also, Balfaqih et al. (2015) developed a modified conceptual framework based on the BSC model and the SCOR model's performance measures. They assured that the proposed framework requires further empirical research to be validated. This integration provides a comprehensive performance measurement framework for the SMEs. Both help managers to gain a systematic insight into their SC problems, take better decisions and undertake the necessary improvements needed in the specified failure phase, whether in the procurement, the manufacturing, or the customer order. The Performance Measurement System (PMS) as a result of mixing both models helps in designing a framework to diagnose their SC functions and strategically plan improvements for the weak areas. Also, it works as a benchmarking tool for current practices with the industry requirements. So, there is a limited literature available on PMS in the area of SCM, specially focusing on system design and measures selection. Performance models should be created to measure the organisational goals and measuring the achievement of the goals (Thakkar et al., 2009).

Most of the performance measurement studies are theoretical and lack practical implementation. Therefore, the SCOR model emerged as a scalable and structured framework.

It is used for deciding, coordinating, and implementing the SC processes through the application of its' processes; plan, source, make, deliver and return (Delipinar and Kocaoglu, 2016).

SCOR model is proven successfully applicable in measuring performance in different manufacturing companies. The SCOR model is powerful on technical dimensions (Delipinar and Kocaoglu, 2016). It can be used to transform the "as-is" state into the desired process of "to-be" in the future state. It can fully function when high levels of details on the current processes are present. It provides a comprehensive operational methodology to improve the overall SCP. In addition, it helps in evaluating the objectives, effectiveness of reengineering, performance, quantification, testing, future planning, and specific process operations in the SC. The SCOR model helps to adapt the SC in a better state in terms of; achieving a competitive advantage, control systems and alterations for an aimed goal (Irfan et al., 2008).

APICS (2015) found that, by including SCRM within applying the SCOR model help organisations minimise costs, mitigate SC disruptions by managing risk proactively and thus, offering a competitive edge. The SCOR model is proven to have several benefits when applied in the operation phase, as it works in a proactive way in managing the different types of risks.

While applying the SCOR model on the factory level, the analysis of the physical, financial and information flows should be considered and described with the total lead time taken by the entitled suppliers. The model enables companies to communicate, compare and learn from competitors and companies, whether in similar or different industries. In addition, it helps in reengineering the SCM processes if needed (Delipinar and Kocaoglu, 2016).

In addition, Thakkar et al. (2009) mentioned that the SCOR model provides a framework for characterising SCM practices and processes that reach best-in-class performance. The basic structure of the SCOR model provides four key SC guidance processes of how to; plan, source, make and deliver. Therefore, to apply the SCOR model, there are four levels that need to be followed. Level-1 defines the scope for the SCOR model. Level-2 identifies how the companies implement their operations strategy. Level-3 defines the company's ability to compete in the market based on specific elements which are information, inputs and outputs, metrics, and best practices. Level-4 defines the practices that achieve the competitive advantage and adapt to changes (Irfan et al., 2008).

Level-1 in the SCOR model requires studying and mapping the current working processes and KPIs in the SC to detect the opportunities and points for improvement in the processes. E.g., reduce the cycle time, reduce inventory, or relocate the warehouses. It helps achieve realistic strategic targets and Benchmarking. Level-2 defines the processes that may represent potential components of the SC. That will help the organisation to detect its optimal or actual operations using these processes. Level-3 provides the information required to successfully plan and set the goals for SC improvements. This includes defining the process elements, setting target benchmarks, defining the best practices, and improving the system software capabilities to enable best practices. This level determines the competitive requirement summary in terms of the workstreams and the sub-processes identified underneath each stream (Irfan et al., 2008: APICS, 2017). Level-4 focuses on the implementation and putting the determined improvements into action (Irfan et al, 2008).

This thesis focuses on Level-1 of the SCOR model in the ‘source’ and ‘make’ of the large Egyptian dairy producers’ SCs (i.e., Large Enterprises-LEs), with their supporting factors and identifying their KPIs. Choosing the LEs rather than the SMEs is based on stabilising and ensuring some essential factors involved in the process of producing safe and secure products i.e., based on a Pareto rule, they may only represent twenty percent of dairy producers since 2017 and the situation remains the same, but contribute to over eighty percent of the Egyptian milk supply and crucial for Egypt’s economy and future global exports of milk products (Euromonitor, 2020). These factors are uncertainty, the feasibility of innovation, and evolution. That is due to the different operational capabilities and processes between both the SMEs and the LEs. Focusing on the LEs with their supporting factors strengthens the argument of choosing the LEs for the current study. The appropriate operational capabilities and performance measures that suit the LEs will act as a best practice for the SMEs to follow. This can be supported by relying on Thakkar et al. (2009) methodology, which works as a benchmarking tool for organisations. The methodology links the organisational performance and the SCP by relying on; ‘plan, source, make and deliver’ on a SC cycle.

2.6 Dairy Sector Supply Chain Management

This part of the literature focuses deeply on reviewing and contrasting the relevant research applied on the agricultural food sector and the dairy sector. Starting gradually from its relation to the agri-food sector, its perishable nature and the productivity of this sector compared to other sectors. The importance of selecting the dairy sector in Egypt will be discussed thoroughly later in the following sections.

Food products are perceived as high risk products, that's for their perishable nature and due to the potential for unintentional or intentional disruptions. Food industry firms use HACCP to identify the risks in the food SC and ensure the final product safety and security. Therefore, relying on information sharing between the SC partners in the food industry helps to strongly position the firm in facing unpredicted threats (Speier et al., 2011).

As the dairy sector is classified under the food system it acts as a vital role in it. That's due to the nutritional benefits of its products to people. It contributes to the sustainable farming industry in the UK in addition to delivering economic benefits across the SC practice (Driscoll, 2016).

Minimum attention was paid for the agri-fresh produce. Shukla and Jharkharia (2013) referred to the complexity of the Food Supply Chain Management (FSCM), based on the perishability nature of its related products starting from the farm to the customer, in addition to other factors; demand and prices uncertainties, and dependency on the climate conditions. Speier et al. (2011) studied the disruptions in the food SCs by empirically studying the large and small firms in the food industry. This sector was chosen for its high impact of disruptions. Thus, the lack of previous literature on the food SC and the operational issues specifically. Clearly considering the perishable goods including the milk will be the focus and contribution of this thesis, in addition to extending the literature shortcomings and gaps in the following years.

The dairy sector problem has the following structure according to Sel et al. (2015); (1) The supply network consists of a single plant which delivers the final products to various distribution centres. (2) The demand has a certain due date and backlogging is not allowed. Unmet demand cannot be transferred to the next period. The unmet demand is discarded at costs. (3) Short-term planning and scheduling for each product, inventory balances are updated daily according to the production output from the plant. (4) Processing times are independent of the schedule. Variable production costs of the products that can be produced at any of the identical packaging lines differ from each other. (5) Products' freshness can be measured with short shelf life (i.e., varying between seven and twenty-one days for homogenised and cooled products under refrigerated keeping conditions). The decrease of shelf life is considered as a loss function. All this highlights how time critical this SC is. There is no room for error or delay both in time and quality.

An illustrative case-study held by (Jonkman et al., 2016) focuses on selecting the food process design from a SC perspective. Some regional and seasonal SC aspects have been determined in terms of, functionality, perishability of products, and the uncertain processes. These aspects affect the decision of selecting the process design, which is determined by the overall performance of the food supply chain (FSC). Their research lacks the robust optimisation of process designs in the FSC field, focusing on the perishability of the dairy products.

Steur et al. (2016) combined the relation between lean manufacturing and the agri-food sector. The research concentrated on the compatibility of VSM to the lean manufacturing in the FSC. Food losses and wastes (FLW) were detected in the developing countries as well as the developed ones. Consequently, a simulation model reliably incorporated to the VSM methodology in addition to tackling the FLW requires an all-inclusive mitigation approach.

Steur et al. (2016) systematically reviewed case-studies only with at least one food producer. They also mentioned that case-studies dealing with lean manufacturing, VSM with one SC actor and relevant quantification for these cases are not available in recent literature.

This section included a review of research studies focused on the dairy sector SCM, highlighting its key areas of development needed to be further explored. Such as, the risks affect the dairy products' safety and security, the processing time, the processing cost, and planning. Accordingly, there is lack of research on this area (Jonkman et al., 2016: Speier et al., 2011: Sel et al., 2015). Therefore, this thesis focuses on exploring the dairy sector in Egypt to optimise the dairy SCP in terms of producing high quality safe dairy products with such perishable nature and short shelf life to fulfil the market demand.

2.7 Factors Affect the Dairy Sector

All industry sectors are prone to different kinds of risks, but the most affected sectors and need a high level of mitigation planning are those with the short life cycles, including the perishable products. Many companies rarely invest in improving the proactive manners because managers do not get credit for fixing problems or mitigating potential risks that never happened. Consequently, managers prefer to ignore the unlikely events and work on mitigating the current risks if something happened (Tang, 2006).

Campagnollo, Ganev et al. (2016) emphasised on the major role of the dairy products and the milk specifically in the daily human diet in addition to other dairy products. A huge concern was directed towards the Aflatoxin M1 (AFM1) contamination which represents a risk that affects the feed in the upstream side of the SC and consequently affects the processing of milk and dairy products generally.

This part emphasises on managing the different types of operational risk in the dairy sector. Schaper et al. (2010) highlighted in their empirical study that radical changes and market volatility have a great impact on the dairy products market. A very high uncertainty for farmers represented especially in the fluctuations in prices, production, and political risks. The selected European countries are Netherlands, Ireland, Switzerland, and France. Using case-studies by interviewing dairy farmers on risk management. The most important risks that dairy farmers currently face are various market risks followed by policy and production risks. The results of the previously mentioned empirical study show that future-oriented dairy farmers operate in a risk-conscious rather than risk-averse way and selectively apply risk management strategies.

Yu and Huatuco (2016) studied the risk in the dairy SC through applying a case-study methodology focusing on operations. The authors classified the sources of risk in the dairy SC into: quality of milking animals, feeding availability, milking handling practices, milk bulking practices and milk transportation. The high cost of feed supplements used by most dairy farms lead to the high cost of milk production and milk products at the end in the food market (Yilma, 2011). Another research on the dairy operational risks and the mould contamination specifically was held. Mould contamination represented a challenging factor for the safety of feed production and processing, due to the high perishability nature of the dairy products (Campagnollo et al., 2016).

Sel et al. (2015) studied and analysed the dairy production processes with a deep concentration on the yoghurt production specifically. Their study focused on integrating planning and scheduling in the perishable dairy SCs by using the MILP. They selected the dairy sector for its perishability. Because most of the related previous literature ignored the interrelation between the tactical planning and the operational scheduling decisions in this sector.

The yoghurt production is considered as a sample of one of the dairy products production processes. The process is explained in detail by (Sel et al., 2015). First, the collection of milk and then passes on the pasteurisation, standardisation, homogenization, culture addition, fermentation/incubation, packaging, cold storage, and distribution. The pasteurisation process is a special type of heat treatment which is used to get rid of pathogenic organisms in milk. The milk must get pasteurised as soon as possible, once it arriveS at the dairy plant direct from the farms. This is one of the first critical control points in production.

A cross-country comparison has been held by (Kimura and Sauer, 2015) on Estonia, Netherlands, and the United Kingdom (UK). The research handled the dynamics of the dairy farm productivity growth, supported by a deeper analysis by using the multivariate regression model. The analysis on measuring and comparing the farm size in comparison to the dairy sector productivity growth. Previous research also on the Greek dairy sector measured the sustainability performance indicators by doing a cross analysis between the various firms in the Greek dairy SCs, the authors noted a lack of empirical analysis in the field mainly based on the sustainability performance indicators. It was noted that the most important products in the dairy sector are milk and cheese in terms of production and sales value (Bourlakis et al., 2014).

Aiad (2013) studied the microbiological contamination of a local white cheese plant in Alexandria Egypt, as one of the fatal factors affecting the agri-fresh sector. Microbiological hazards are considered the main potential hazards in the dairy sector. Microbial quality and safety of the Egyptian soft white cheese is the main concern for consumers, producers, and public health authorities. The quality standard depends on the raw milk microorganisms, efficiency of processing and hygienic practices of the dairy plants whether small size plants, large size plants or informal producers. Therefore, hygienic measures for dairy producers lead to improving the quality of the final products. The hygienic measure includes cooling the milk, heat treatment, use of clean water, personal hygiene of the cheese handler, sterilisation of equipment and prevent post contamination during manufacturing. As mentioned before, the HACCP applicability proved to ensure the dairy products safety by assessing the risks and improving the manufacturing practices of all its stages.

Aiad (2013) assessed the potential microbial hazards in traditional dairy plants in Alexandria city in Egypt. He evaluated the microbial criteria to improve the hygienic quality of the plant to prevent contamination and produce safe dairy products. According to the Egyptian standards (2005), all examined samples of soft white cheese products did not comply with the standards. So, a hygienic standard should be followed in the production practices to ensure the production of safe products, especially in cheeses where unpasteurised milk is involved in its production.

Some common factors affecting the FSCM agreed on by researchers and practitioners are as follows: globalisation, technological innovations, trade agreements, consumer awareness, blockchain technology, and environmental concern (Osei et al., 2021). A study focused on the innovation in the dairy sector applied to a group of countries including Belgium, Italy, Finland, and the UK. Mandolesi et al. (2015) concluded from the study that SC members were not prepared neither accepting the innovation in the dairy farming sector.

This thesis is similar to Janssen and Swinnen (2017) who focused on dairy products in developing countries. They took India as a case of the study based on its similarity to Egypt. Both are developing countries. Utilising modern technologies and spreading information and supporting the modern procurement systems work on improving the productivity of the dairy products and the welfare of the poor farmers in the developing countries.

This section reviewed elements to manage the risks affecting the dairy supply chains globally, and in the developing countries specifically. Those are centred around technological innovation to provide on-time visibility and control over the operations in the factory and connect the global and domestic suppliers to overcome any uncertainties such as the COVID-19 Pandemic which emerged during the research process and impacted the global world. The following subsections explain the most relevant factors related to this thesis. These factors help in formulating the contribution of this thesis supported by its dimensions and including the research scope i.e., Egypt.

2.7.1 Globalisation and Trade Agreements

There are several trade agreements between Egypt and the European Union (EU), the Grain and Feed Trade Association (GAFTA), The Common Market for Eastern and Southern Africa (COMESA) and Turkey. These agreements work as an opportunity to open the international market and expand the exports (Tate, 2017).

Great potential for agricultural and dairy products international trade expansion in the future were recorded in the first half of the year 2016. The EDA report included a highlight on the need for legislative stability in the European dairy sector. Netherlands was chosen as it is considered as the world leader in the dairy products and takes the lead in the worlds trade for the dairy sector for many reasons, its strategic location in the centre of Europe and the world, the country's climate and grass for the cattle health which help in milk yielding and production, the good access for potential markets and the well-established logistics infrastructure. The

Netherlands dairy sector produces more than just milk by processing ninety-eight percent of the raw milk and transforming it into other dairy products such as cheese, butter, pasteurised milk, and milk powder. The Netherlands annual per capita milk products consumption exceeds the 100klg and the annual cheese products consumption exceeds the 19klg (Bier and Lange, 2016).

Based on the assessment held by the NSW government, the safety of milk and dairy products has been extensively reviewed by regulatory agencies in Australia and internationally. Many risk assessments and risk profiles have been undertaken. It examines the risks across the entire dairy SC and conducts in-depth evaluations of it (Michael, 2013). Nevertheless, Qingbi et al. (2020) assessed the impact of COVID-19, the most recent pandemic, on the dairy sector in China and the United States of America (USA). They found that milk production has been affected for a limited time compared to the USA but has noted significant improvement since March 2020. That is because the US community does not encourage the use of UHT milk. They prefer the fresh milk stored in refrigerators, unlike the Chinese community who used to consume the UHT milk with long shelf life, which does not require refrigerated trucks.

2.7.2 Consumer Awareness

As SC disruptions affect both the short and long-term operations
, it will be reflected in the loss of consumer confidence and lead to collapse of brand equity. Many companies lack the investment in sustainability and have difficulty in fully assessing the potential of SC disruptions and responding to it (Speier et al., 2011).

Bourlakis et al. (2014) highlighted that consumer confidence in the quality and safety of food products are essential and considered as a critical factor between the chain members. Clear information on the nutritional and dietary characteristics of the food products are a basic consumer demand. Good quality packaging enhances the consumer trust in the product quality and safety.

2.8 Dairy Sector in the Developing Countries

Generally, in developing countries, there is a high dependency on dairy products. One of the largest milk production development programs was launched in 1970 known as operation flood program that dealt with increasing the milk production and income for small rural farmers (Janssen and Swinnen, 2017). Velychko (2015) highlighted that the milk production has increased in the developing countries. This section covers the dairy sector in different developing countries, supporting the opportunities and promising future of this sector in the coming years.

There is a lack of investments from governmental and non-governmental initiatives to add value to the farmers in the developing countries. Consequently, new regulations and standards emerged in the dairy industry. HACCP was used to monitor the milk quality control. The reason behind choosing the HACCP is for its applicability and adaptability to small-scale cheese production beside the large-scale producers (Michael, 2013).

The main potential hazards in most dairy products are the microbiological. Raw milk contamination, inadequate heat treatment and lack of hygiene during packing is one of the main hazards in the dairy products sector (Ibrahim et al., 2015). As, the HACCP originally generated as a zero-defect program ensures food safety. The CCPs differ according to the product type, starting with the reception, the heat treatment, cooking, packing and storage (Ammar, 2017). It is proven that the application of the HACCP system on the processed cheese had less microbial count, and higher standards reach the Egyptian specifications and ensures the production of excellent healthy cheese. As recently consumers are demanding safe and secure products with long shelf lives.

El-Hofi (2010) also focused on the white cheese production specifically of all the dairy products. HACCP system is proven to ensure the product safety and security based on “farm to table” methodology. Applying this system by the food producers gives them better coordination and control on production and better manufacturing practices. The HACCP was introduced for the white cheese production to ensure the final product safety in Mansoura city in Egypt. CCPs were determined to control the identified hazards. The HACCP system was developed and applied step by step on the white cheese production. To simplify the application of the HACCP, few hazards should be handled as a preliminary phase before applying the HACCP.

Abd El-Razik et al. (2016) studied the application of HACCP on one of the well-known Egyptian dairy products (the Egyptian Kishk) on small-scale enterprises. HACCP is needed to improve the safety of producing Kishk. It is a mix of fermented milk with wheat grains, and the milk can be replaced by yoghurt or buttermilk. The hazards can be classified into biological, chemical, and physical according to each preparation step and recommend control measures for it. The preparation steps vary according to the product type, but generally, it starts with receiving the raw materials then the heat treatment. The control measures can be through maintaining the Sanitation Standard Operating Procedures (SSOPs) and the Good Manufacturing Practices (GMPs). The hazard analysis should be implemented on the raw materials and during the production steps. The HACCP was used as a tool to analyse potential hazards in operation and determine how far it may affect the consumer safety of the provided products. HACCP creates a control system that works on preventing the hazards rather than relying only on testing the final product. Corrective actions for receiving the raw ingredients can be done by suppliers' guarantee. Checking and repairing the incubation and temperature control in addition to monitoring the procedures.

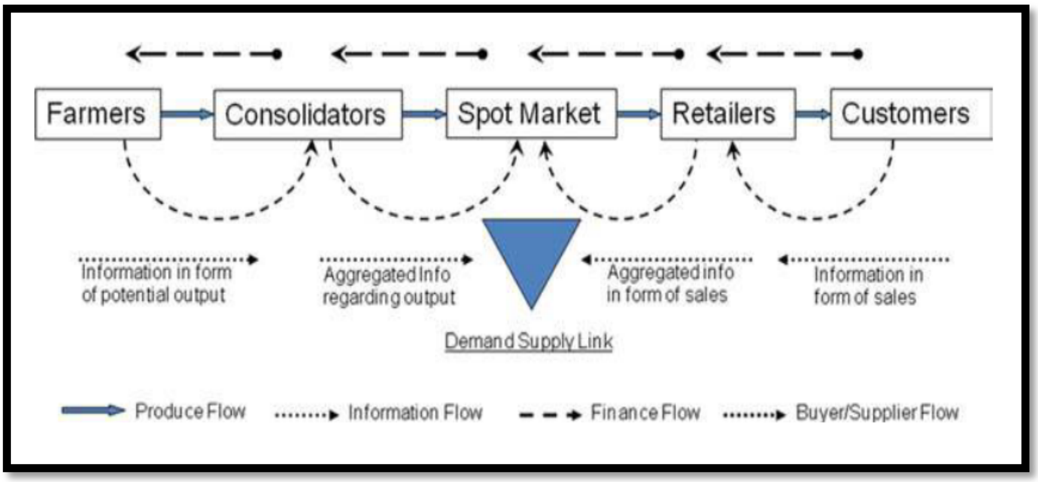
The dairy sector should monitor the improvements and the investments paid in this change to be feasible in the dairy products market. Therefore, to improve the dairy production in terms of regularity and good sanitary standard, there must be technical support from the government. Producers and farmers need education regarding nutrition and the adapted production techniques (Dubeuf, 2005).

According to Dubeuf (2005) dairy products consumption in the developing countries is considered as a very diverse sector and determined based on the cultural and economic conditions and standards of living. A study on the milk products reported that Africa's favourable weather conditions encourage the milk production. As Egypt is part of the African countries, it is considered as one of the major importers that could witness future growth (Griffin, 2015).

After reviewing articles analysing the dairy sector in different countries worldwide, a report by the Food and Agriculture Organization (FAO) highlighted the overall worlds' production in thousand tons. The estimated production for the year 2014 was 788533 thousand tons and forecasted production for year 2015 was 804517 thousand tons. The developing countries overall production amounts exceed the developed countries. Egypt is ranked the second after Algeria in the dairy production in Africa. Indicated statistics shows that Egypt's milk and milk products production achieves estimated production of 5950 thousand tons for the year 2014 and forecasted production of 6000 thousand tons for year 2015 (Griffin, 2015).

Figure 2.6 illustrates the current working status of the agri-fresh produce SCs in the developing countries. Then, followed by reviewing and analysing some research held on different developing countries, including India, Ethiopia, Turkey, China, and Egypt.

Figure 2.6: Current Status of Agri-fresh Supply Chains in Developing Countries- Source: (Shukla and Jharkharia, 2013:P.141)



India is identified as one of the largest milk producers in the world (FAO, 2021). It has resulted in the increase of the dairy production and consumption as well and it is expected to grow in the coming years. The recent developments in the Indian dairy sector was due to several factors; the favourable climate that ensures the availability of good green fodders, the well-based transportation infrastructure that ensures the needed transportation for the fresh dairy products, and the extensive governmental support to the dairy sector producers (Janssen and Swinnen, 2017).

Subburaj et al. (2015) conducted research on India that focused on strengthening the operational efficiency of the dairy SCs. The research is based on field study that focuses on improving and strengthening the operational efficiency of the dairy SC. They reached the following findings: milk value chain lacks the minimum resources of land, labour, water resources and capital, major challenges deteriorate the milk production e.g., animal health, and the high cost of milk production that represent the major constraint in the industry.

In China, milk and other dairy products take a good share in the daily diets. The Chinese food industry grows around twenty percent annually and the food exports represent two percent of the exports. In addition, there is an increase in the demand for dairy products in southeast Asia. Additionally, the dairy products category is the second dominant category in western Europe (BRC, 2014).

Yilma (2011) classified the dairy production systems in the Ethiopian dairy sector into three major classifications: traditional smallholder, privatised state, and urban and peri-urban farms.

The milk production system includes small and large private farms located in the central highlands. The Ethiopian dairy sector witnesses a mismatch between supply and demand due to seasonal, spatial, and cultural barriers. Alternatively, the increasing population, urbanisation, and income represent a great opportunity to develop the dairy sector. Several challenges were detected in the Ethiopian dairy sector, some of them are poor genetics of the cattle which represent a main production problem and result in a low milk output, inadequate feed resources that decreases the milk production, animal diseases, absence of an effective breeding program. Therefore, it was recommended the application of HACCP at the farm level in Ethiopia, that will assure the dairy farm safety and consequently improve the dairy production phase.

Euromonitor (2017) studied the dairy sector in the Middle East and Africa. The dairy sector and the drinking milk products specifically witnessed growth over the past years. The forecast proves to proceed increasing in the coming years. The markets entitled are particularly; Saudi Arabia, the United Arab Emirates, Egypt, South Africa and Iran. The Middle East and Africa overtaken Australia, Eastern Europe, North America and Western Europe to hold the third place in the fastest growing regions for dairy production of 2016.

Food and agricultural sectors represent between ten to twenty percent of the total industrial activities in the Mediterranean countries. The Regional Activity Centre for Clear Production RAC/CP (2002) referred to the Egyptian dairy sector importance with forty-seven percent among all other food and agricultural enterprises. Egypt is ranked the second after Turkey in the Mediterranean countries by the number of dairy firms, and the fifth major milk producing country in the Mediterranean countries after France, Italy, Turkey, and Spain.

The Mediterranean countries rely mainly on cow's milk beside the sheep's, buffalo's, and goat's milk. Turkey and Egypt are classified by their important local dairy production. However, it witnesses low national production of fresh milk. That is a result of relying the local consumption on the dairy farms' direct sales to consumers. Direct selling from farms to consumers increases the risk of low levels of hygiene and safe products (Dubeuf, 2004).

The Mediterranean area is the main producer of goat milk and cheese. Goats can represent a real potential to the dairy sector if it works as an alternative to cow and buffalo milk production. However, it is not popular in the developing countries regardless of the fact that it is available in the markets and consequently not widely sold. Alternatively, in northern Europe, goat milk disappeared because of the intensive production competition of cow milk. Goat milk is relatively expensive and targets the children and wealthy populations. That will contribute positively to the dairy sector prosperity (Dubeuf, 2004).

Between the years 2011 and 2016, sales growth rates increased in the three markets: Egypt, Saudi Arabia, and Iran. In the last few years, those three countries attracted foreign investments through joint ventures from international dairy players such as Arla. Egypt has already recorded an upgrade in the foreign investments and is expecting to attract more with the recent currency devaluation. Some large international companies such as Unilever, Nestle', Kellogg's and Arla are seeking collaboration in the Egyptian market or expanding their current operations. Egypt is considered a strong potential in the Middle East and African countries, regardless of the fact that it is relatively underdeveloped per capita expenditure on dairy products. The SC of the dairy products in Egypt is well established, therefore more products will reach the consumers. Increasing the investments and the governmental regulations will improve the current cold SCs and allow more refrigerated stores to offer dairy products (Euromonitor, 2017).

Egypt, Saudi Arabia, Algeria, and South Africa represent the growth markets and the strong drivers for additional sales. Egypt is ranked the second after Iran in the Middle East and African countries between the years 2011 to 2016. Egypt is expecting an increase in the demand in the coming years, due to the increasing number of female participation in the workforce. Since the year 2002, the dairy sector is achieving consistent growth in the Middle East and Africa and it is still expected to sustain the growth until 2021 (Euromonitor, 2017). That lead us to provide deeper insights on the Egyptian dairy sector as one of the promising sectors and countries in the world's economy.

2.9 Dairy Sector's Operational Risks in Egypt

Even though Egypt produces large amounts of dairy products, its imports reach One billion US dollars per year. In addition, the Food and Agriculture Policy Research Institute (FAPRI) highlighted that during the period of 2010 to 2013 the milk consumption exceeded the domestic milk production in Egypt (Mohamed, 2015). International Labour Organization (2020) assured that the problem resides the same, where Egyptian production fills only seventy-two percent of the local demand and the Egyptian dairy producers relies intensively on the imported milk powders to fulfil this percentage, due to the lack of raw milk local supplies. Egypt faces a strong competition from the EU and others. The exports of the dairy products decreased noticeably in 2015 by sixty-five percent excluding cheese (CAPMAS, 2017). Besides, the dairy sector in Egypt, including all its branded dairy manufacturers, achieved a consistent increase in sales in the last years from 2011 to 2016, with a different variety of milk and dairy products (Euromonitor, 2017). Sel et al. (2015) studied and analysed the dairy production processes. They focused on integrating planning and scheduling in the perishable dairy SCs by using the MILP.

The Egyptian producers work on empowering the traditional dairy products exports and attract international investments and advanced technologies in the dairy sector (Mohamed, 2015). Schaper et al. (2010) focused on the organisation's need to optimise its opportunity-risk profile while considering the organisation objectives and strategies by implementing risk management instruments. As there is a high dependency on the dairy products in the developing countries, one of the largest milk production development programs was launched in 1970 known as the operation flood program that dealt with increasing the milk production and income for small rural farmers (Janssen and Swinnen, 2017).

There must be support from the government to improve dairy production. In addition, producers and farmers need education regarding the nutrition and the adapted production techniques as recommended by (Dubeuf, 2005). One of the challenges in the dairy sector, if the production/yield per cow is low then that will lead to devastating results, scarcity in meeting the demand, many of the stakeholders will operate at a sub-optimal level of performance, the cost of production would be higher and the farmers will end up with a low or no profit at all (Mishra and Shekhar, 2016).

According to the Euromonitor (2020) Egypt has witnessed a noticeable growth in the drinking milk sales, as it represents a nutrition necessity for the Egyptian consumer. The increasing number of brands operating in the dairy sector with the support of the extensive promotional campaigns helped in boosting the sales. The sales growth included both the fresh loose milk and the branded shelf stable packaged milk. The sale is divided into ninety-seven percent for shelf stable milk and only three percent for the loose milk, due to the ease of handling the packaged milk with long shelf life, in terms of storage on a regular shelves in retailers, no need for refrigerators,. In addition to lower prices compared to loose milk, the consumers tend to buy shelf stable milk especially in large cities and urban areas. Therefore, more focus on the packaged long shelf life milk should be provided and investigated.

The dairy milk availability in the local Egyptian market is considered relatively low compared to the demand. Therefore, many dairy producers invested in increasing their production capacity in 2016 to fulfil the increasing demand. The local Egyptian manufacturers manage to absorb the increasing production cost, because drinking milk is considered a necessity for the Egyptian consumers, and they are price sensitive for such products (Euromonitor, 2017).

All the Egyptian imports of dairy products or cheese are the result of the limited domestic production which does not meet the demand and the advantages of the international suppliers in terms of low-cost production in NZ and the EU duty free access. The Egyptian dairy market offers great opportunities for growth and expansion in the coming years. Some of the major characteristics of that sector are the unprocessed milk provided by the small-scale farmers, lack of hygienic standards and care to the dairy herds, and improper transportation (Tate, 2017).
Other dairy products witnesses' growth in both the retail value growth and the retail volume growth. Other dairy products represented in; condensed milk, cream, coffee whiteners and shelf-stable desserts. Most of the other dairy products are imported, therefore their prices are high and expected to keep increasing, due to the economic instability and the high inflation rate in 2017 (Euromonitor, 2018).

Regarding the daily raw milk procurement, it is composed of cow's and buffalo's milk. The milk collection period takes a maximum of a week. The distance between the supplying farms and the manufacturers usually does not exceed 2.3 kilometres, although some rare cases may reach 25 to 30 kilometres at most. Farmers and manufacturers usually discuss and agree on the suitable animal feed to increase milk productivity, and some other technical and veterinary advice on how to deal with the infected animals should be offered to the milk suppliers (Tate, 2017).

Juhayna is still dominating the shelf stable milk products (Euromonitor, 2020), followed by the international company Nestle' Egypt. Juhayna prepared to launch two new types of milk for the young consumers. Both products are full of nutrition which helps children to grow healthier. The second product targets young children and is full of Calcium and vitamin D to grow stronger bones. Reviewing those newly developed products supports the idea that the Egyptian dairy sector is thriving for development (Euromonitor, 2017).

This section reviewed the key risks affecting the Egyptian dairy sector. Firstly, the shortage of raw milk supplies and the lack of hygiene at the farm or the production level. That affects the operations at the factory (i.e., Production). Secondly, the increasing prices of imported powdered milk to fulfil the supply needed. This increased the production cost. Thirdly, the long distance between the suppliers or farms and the factory. That exposes the supplied materials to spoilage or delay, which will put the SC at risk. All this gives a glimpse of the literature gap identified which is explained in the next section.

2.10 Theoretical Foundation

Following the five broad questions regarding theory provided by the Academy of Management Review (2016); 1) what is theory and what is not? 2) should we care about theory? 3) where do new theories come from? 4) how do we build a new theory? and 5) how do you get your theory published. Starting with "what is a theory?" refers to what we know about specific theory and its characteristics and how we can make a theoretical contribution. That includes, *what* are the factors of the theory, *how* those factors are related to each other, and the boundaries and conditions of its applicability represented in *who*, *when* and *where*. The following paragraphs explain the relevant theories to this thesis.

According to the Academy of Management Review (2016) that the new management theories are basically based on the inductive approach and derived from case-studies. Thus, this thesis complies with the recent trend in the management area by following an inductive approach, which is based on the concept of building new theory not testing an existing one. The proposed conceptual framework is based on the use of three organisational theories (OT); the institutional theory, resource-based view theory and the network theory. The reason for utilising those theories in the design of the research framework is based on two dimensions. The first dimension includes the institutional theory and resource-based view theories, which set the base of the organisational operational capabilities of the proposed framework. That will work as a tool to achieve benchmarking to similar producers. Then, the second dimension is based on the network theory, which handles the ties between the SC members, represented mainly in the supplier(s) and the producers. It addresses the reliability and flexibility which in turn enhance the SCP. Theories will then be discussed in detail concerning the current research and how it formulated and shaped the creation of well-established framework with its constructs.

2.10.1 The Institutional Theory:

The institutional theory has emerged as a dominant in the OT theoretical paradigm but has a low impact on the operations management (Guth, 2016: Rogers et al., 2007). It uses the industry recipes and best practices (i.e., benchmarking) to inform and guide the SCM activities (Ketchen and Hult, 2006). It focuses on conformance DiMaggio and Powell (1983), which means it relies on the industry recipes and the best practices to address and guide the SCM activities. Imitating what works for the industry's SCs icons is usually considered a rational approach. Therefore, applying this theory suggests the following questions: to what extent does a formula for creating best value SCs exist in any given industry? Can such formulas be applied across different industries and countries? How do institutional forces shape the competitive actions of best value SCs? As the institutional pressures' operationalization is not yet sufficiently developed, Kauppi and Hannibal (2017) and Zsidisin et al. (2005) discussed the three institutional pressures, which cause the isomorphism in organisational form. The institutional pressures are normative, coercive, and mimetic.

The institutional mechanisms impact the organisational practices. Therefore, it is of critical importance to focus on the impact of adopting certain practices rather than investigating their origin. Rogers et al. (2007) studied the supplier development program concerning the gap of the institutional theory and recommended that it is easier to implement the daily operations based on the institutionalised practices rather than the interview or observational data, which are widely used in the OT and the operations management (OM). Therefore, this thesis adopts the institutional symbolism in adopting and assessing the operational capabilities in the Egyptian dairy producers. Using interviews and observations to study the dairy producers' operational capabilities and evaluate their current performance. The mimetic approach applied in the part of taking the SCOR model attributes to work as a base for the existing framework and consequently conclude the relevant research propositions. The research propositions are based on concepts and lead to empirical research, in contrast to the research hypotheses based on measurements (Whetten, 1989). Institutional theory is used as a lens to understand some of the issues and risks the Egyptian dairy producers face in their supply and production phase.

Focusing on the mimetic pressure in the applicability of the institutional theory in this thesis. Both mimetic and normative adopts the taken for granted managerial decisions rather than rational strategic decisions. Also, according to DiMaggio and Powell (1983:151) the mimetic isomorphism is "a response to uncertainty; when there is no clear course of action, it can be safer to imitate others' behaviours". As the industry peers have a magnificent impact on a firm's environmental strategy, mimicking can be applied by selecting an organisation with a similar structure. In addition, organisations in the same channel can copy the structure and the processes of other channel members against which they benchmark. The mimetic pressure is applied to the large successful firms to enhance the adoption of assessment against standards and create a platform for the organisations to achieve and share the best practice. It is used when the organisational goals are ambiguous and unclear, due to environmental uncertainty. Therefore, organisations may work as a model for their fellow organisations in the same sector.

It is also used when the organisation faces problems with unknown causes and unclear solutions (DiMaggio and Powell, 1983).

2.10.2 The Resource-based View Theory

According to Kraaijenbrink et al. (2010), RBV theory is one of the most influential theories in management research. It aims at creating a sustainable competitive advantage. It encourages the organisations to focus on obtaining valuable, inimitable, rare, and substitutable capabilities and resources and can utilise them to create core competency.

This thesis involves identifying and assessing operational capabilities and their impact on SCP. So, considering the RBV theory as one of the organisational theories is essential to this thesis. Supporting that, Shaw et al. (2020) mentioned that much SCM research relies extensively on the RBV theory. It focuses on how an organisation assesses its unique set of capabilities to sustain a competitive advantage and assess its performance. Also, it supports the institutional theory in terms of studying the firm's structure and operational capabilities. Both theories serve in collaboration with the network theory to connect the functioning organisation in the SC and assess the overall SCP on a relational view. As the RBV theory includes all the resources within the SC not only within an organisation. So, it works on a relational view like the network theory (Theriou et al., 2009).

Based on the RBV theory, diversity in the resources can enhance the organisational competitive advantage (Yang and Konrad, 2011: Theriou et al., 2009). That enables the organisation and the SC to fulfil better market demand. According to Theriou et al. (2009), performance is the result of the specific resources and capabilities of the organisation and the SC. By utilising the RBV, this thesis creates an in-depth view of this researched area. The contribution resides in thoroughly investigating the relationship between the operational capabilities and the SC attributes and its impact on the SCP. According to Yang and Konrad (2011) managers seek to acquire resources and capabilities to achieve and maintain a sustainable performance competitive advantage represented in the sustained flow of safe and secure dairy products.

The organisation should have the capability of fully utilising its own rare and unique set of capabilities to sustain its competitive advantage (Yu et al., 2018: Yang and Konrad, 2011). So, the institutional theory focuses on the organisational homogeneity and the RBV focuses on the heterogeneity between the different organisations involved in the SC which link to the network theory. Further, it helps as a lens to view what resources and capabilities Egyptian dairy producers have within their toolkit to deliver a sustainable supply of milk products and manage key risks.

2.10.3 The Network Theory

Third, the network theory reflects the SC nature of being an interconnected network of ties that ranged between strong and weak ties that fulfil the SC needs and enhance the SCP (Ketchen and Hult, 2006). The strong or weak tie is based on case-by-case rather than strategically. The strong ties involve firms that are tightly grouped or coupled together, which reflects the reliability. The weak or loose ties involve the weakly connected firms, which address and enhance the flexibility. This theory describes, explains, and predicts relations among linked entities or organisations. SCs are somehow a kind of a network. Therefore, the network theory could reveal interesting facts about the chains.

A mix between strong and loose ties match the SC needs, reflected in the reliability and flexibility to maximise the SCP. The appropriate questions of applying the network theory are: how best value SCs match strong and weak ties to various contingencies relative to traditional SCs? What are the implications of these differences for agility, adaptability, alignment, and the competitive priorities? (Kauppi and Hannibal, 2017). It will provide a view on the relation between the suppliers and the producers, whether they are functioning in a vertically integrated SC or not. That also might involve a connection to the stakeholder theory. It gives an overview of the SC members and their level of participation and impact on their overall SCP. Thus, stakeholder analysis has been conducted to ensure that the right SC members were involved in strengthening the empirical work of this thesis.

Ketchen and Hult (2006) mentioned that the institutional theory and the network theory in addition to other theories adds value within the SC. In addition, a noticeable gradual shift was recorded from quantitative logistics research to qualitative research from structured research to current action research. That increased the acceptance of the research with the "how" and "why" RQs. The following section reviews the literature on operations and supply chain performance.

2.11 Operations and Supply Chain Management Performance

First, defining both the OM and the SCM is essential before discussing their performance. Starting with OM, based on Bertrand and Fransoo (2002:241) it is defined as *"the process of designing, planning, controlling and executing operations in manufacturing and service* *industries".* Additionally, the SCM is defined by Mentzer et al. (2001:18) as: *"the systematic, 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".*

Evaluating and measuring the SC operations performance, in addition to identifying the current operational practices, the core competencies and the areas which need improvements helpS in taking better SCM decisions (EL-Gazzar, 2013). Therefore, providing value to customers relies mainly on the SCP. The customer value represented in the very basic dimension of product availability, product safety, and quality. Therefore, there is a need to standardise and benchmark the SCP measurement and improvement. Examples of measurement represented in; the total SC cost, cycle time, flexibility in production and performance on deliveries required (Salazar et al., 2012). Besides, Amanfo (2014) introduced an operations performance dimension. They are frequently used as dimensions of manufacturing competitive priorities. Those are: quality, cost, flexibility, speed, and dependability.

It was proven in previous literature that an effective implementation of SCM can positively boost the firms' performance. As there is a positive relationship between SCM practices and competitive advantage through controlling the SCM practices. The higher the levels of SCM practices, the higher the organisational performance and better competitive advantage (Sweeny et al., 2015).

Models that measure performance vary according to the product nature. Measuring the SCP can be held by utilising the SCOR model's attributes which can act as a KPIs and represent part of the proposed framework. Some factors can help in the success of the SC; those are the readiness of the contractor, supplier partners, SC strategy, and the labour ability. This step helps in identifying the KPIs that influence the SCP (Wibowo and Sholeh, 2015). Then validating the KPIs is required to find the required data.

Measuring the overall SC depends on measuring its performance through the evaluation of previous behaviour and via benchmarking. The KPI's are the most crucial dimensions that lead to the success or failure of an industry (Balfaqih et al., 2015). Delipinar and Kocaoglu (2016) assured that, to successfully plan a set goal for the overall SCP, the following should be considered; defining process elements, setting target benchmarks, defining best practices, and improving system software to enable best practices.

There are many classifications for the dimensions that can be classified to assess performance. Here are five major dimensions for measuring the SCP, namely, efficiency, flexibility, responsiveness, product quality, and process quality. The product quality in the dairy sector represented in, taste, shelf life, safety, and reliability of the product. These parameters are based on the nature of the raw milk received and its criticality at every stage of the production, processing, and distribution of such perishable dairy products to ensure its delivery to the final consumer in a fresh and safe condition. Process quality is based on the raw materials and the skilled manpower for example, that is what makes it superior to the product quality. In addition, traceability is considered as one of the most important criteria for having superior processing (Mishra and Shekhar, 2016).

Products with the nature of short lifecycle, high variety, unpredictable demand, and long or inflexible supply processes represent main sources of risks and uncertainties of the SCP. Therefore, measuring performance by using the SCOR model is highly recommended to identify the significant challenges in the SC and recommend solutions according to the different situations (Sellitto et al., 2015).

There are six KPIs specified to measure the operational performance in any organisation: 1) quality, refers to the number of defects per unit, the level of customer complaints, mean time between failures and customer satisfaction score. 2) Speed refers to the order lead-time, frequency of delivery and cycle time. 3) dependability, the percentage of orders delivered late, the average lateness of orders, the proportion of products in stock and mean deviation from promised arrival and schedule adherence. 4) flexibility, refers to the time needed to develop new product or service, machine change-over time, time to increase activity rate, average batch size, average or maximum capacity and time to change schedules. 5) cost, refers to the utilisation of resources, labour productivity, added value, efficiency, and cost per operation hour. 6) process knowledge, refers to the process of improvement where there is always a scope for further improvements (Mishra and Shekhar, 2016). Yet, based on the SCOR model, there are eight different parameters that measure the overall SCP, which conforms to (Mishra and Shekhar, 2016) operational performance indicators with slight difference in classification and naming, those are 1) cost, 2) inventory turnover, 3) quality, 4) lead time, 5) delivery precision, 6) internal performance, 7) customer satisfaction and 8) service grade (Haddad, 2016).

Haddad (2016) highlighted a major barrier that may affect the SCP, this barrier represented in the conflicting KPIs of operations and SC, in case found. Managers should allow their metrics to reflect market forces. Therefore, organisations must assess their performance to assess their operational level and highlight the obstacles and bottlenecks that might hinder the process. That highlights the importance of developing the SCP measurement system to achieve efficient SCM practices. Regardless of the massive amount of research found on SCP measurement in previous literature, still, it is a complicated task to develop appropriate SCP metrics. Generalisation of such systems and metrics to be used as the optimal measurement tool is considered as a challenging task. A different set of measures can be selected in different situations for different reasons.

One of the first developed SCP measurement systems is the Function-Based Measurement System (FBMS); it was function oriented rather than process oriented. FBMS includes various performance measures suits assessing both functions and processes in the SC (Haddad, 2016). Moreover, under the BSC it was categorised at first based on five perspectives which are first, financial, internal process, innovation and improvement, and the customer. Then, the second measure's category includes time, resource utilisation, output, and flexibility measures. Third, the location of the predetermined measures should be specified in the SC such as planning, product design, supplier, production, delivery, and customer. The fourth level concern is categorising the performance measures as strategic, tactical, and operational. The fifth category, determining the nature of the measures whether qualitative or quantitative.

Although there is a lack of published case-studies including the SCOR model application as a SCP measurement system. Conducting competitive analysis by using the SCOR model as part of the proposed framework helps in defining clear business opportunities. The SCOR model is a diagnostic methodology and design, but it does not extend to the implementation of change. Therefore, this thesis utilises the SCOR model's attributes in the creation of a practically applicable operational performance improvement framework. The SCOR model implementation requires awareness, education, and collaboration of all SC members, especially supplier and distributor and the support and leadership from the highest management level of the company (Salazar et al., 2012).

The SCOR model is the most recently developed strategic tool to get an overview of all SC elements and processes to help analyse, measure, and set performance targets and identify improvement opportunities (Salazar et al., 2012). SCOR model combines the performance metrics, the best practices and the software required to provide a detailed business process model. It is used to identify the KPIs in any performance measurement system. The SCOR model integrates major concepts like benchmarking, business process re-engineering, best practice analysis, and process measurement. In addition, it allows managers to focus on the main processes and measures with major influence on SCP. SCOR model is proved to be the most practical oriented model providing standardised SCP metrics assessing specific performance attributes for various SC processes according to Haddad (2016). The usefulness of applying the SCOR model is defined by the clear identification of the components, activities, strategies, KPIs that manages the whole SC. There is a need to further investigate the application of the SCOR model in the production processes, as it was proven effectively applicable and contribute to the efficient logistics operations along the SC (Salazar et al., 2012). The standardised performance attributes of the SCOR model as proposed by APICS (2015) are reliability, agility, responsiveness, cost, and asset management.

Sellitto et al. (2015) classified the SCOR model in their applicability into two dimensions: SCOR processes (source, make, deliver, and return) and performance standards adapted from original SCOR (cost, quality, delivery, and flexibility). The SC's comprehensive overall performance was obtained by adding the performance of all indicators. Performance standards were translated as quality (understood as reliability or perfect order fulfilment, and return as assets for clients' satisfaction), delivery time (taken as responsiveness or order fulfilment cycle time), flexibility (or agility), and costs (total costs to serve, including inventory budget and level of sales).

Using the SCOR model's standard processes to map the whole SC process provides a unified standard measurement system for individual organisations and acts as a tool of SCM integration throughout the entire SC (Haddad, 2016). Therefore, the SCOR model can be considered as a solution to the challenges faced by SC partners. Besides, SCOR model attributes focus on intra-organizational cross-functional business processes integration, which may lead to improvement in the organisational performance.

SCOR model benchmarks the operational measurement to create and provide improvements to the organisation's quality performance and profitability. The SCOR model works as a cross-functional framework. It provides a systematic approach to describe, identify, and evaluate complex SC processes. Erkan and Bac (2011) considered the SCOR model limitations in a manufacturing company by covering all the steps and levels related to the SCOR model. Erkan and Bac (2011) applied the SCOR model in a manufacturing industry organisation. The performance attributes detected in their study are classified into customer-facing and internal-facing. Customer-facing classified into, reliability, responsiveness, and agility. Additionally, the Internal facing is classified into, cost and assets.

Velychko (2015) studied the applicability of the SCOR model in the agribusiness and the milk industry in specific. Getting furtherly in the agribusiness, as the dairy industry represents a source of income to all the stakeholders involved in the business, Mishra and Shekhar (2016) and Moazzam et al. (2018) measured the SCP in the dairy sector by using the SCOR model and pre-identified KPIs. The KPIs are identified and assessed at each stage of the analysis according to the various criteria related to the dairy SCs.

This thesis adds to Mishra and Shekhar (2016) and Driscoll (2016) by assessing the operational capabilities and CCPs to optimise the production of safe and secure dairy products. Literature does not include concrete operational capabilities that have been verified to influence the SCP in the dairy sector. Moreover, there are no specific measures assigned in the literature to assess the impact of the supplier/operational integration on the large size dairy producers' performance. This thesis is based on the use level1 of the five main SCP attributes of the SCOR model in the proposed framework (i.e., agility, reliability, responsiveness, cost, and asset management), not applying the whole SCOR model. The SCP is categorised based on financial and non-financial measures (Gunasekaran et al., 2001) or quantitative and qualitative measures (Chan, 2003). Therefore, measuring the SCP focuses on assessing the collaboration and efficiency within the SC. Last, this thesis follows the qualitative research methodology and case-study approach, to fill the gaps found in previous literature.

2.12 Supply Chain Performance Measurements Discussion

Definitions related to the SC and performance measurement models were provided and explained previously in the literature chapter. Accordingly, SCM is concerned with matching the supply and demand. Nevertheless, identifying the customers' needs and criteria in the required dairy products quality and safety standards is essential to create value proposition of the SCM. While the SCM and operations both focus mainly on matching supply and demand in a cost-efficient way, the integration of both disciplines and enhance the firm's performance. This assumption was strongly emphasized in the operations and SC literature. Chemicals are considered a dual factor to produce milk products, as it is used as preservatives to increase their long shelf life and ensures keeping the products safe and out of damage. However, using those chemicals above the optimal level could be dangerous and increase the production costs (Mishra and Shekhar, 2016).

Measuring the SCP is extremely difficult in the agricultural sector and considered relatively new. The agricultural chain consists of equipment and tools, transportation, land and farming, technology, raw materials, storage, environment and the revenues and costs (Salazar et al., 2012). Measuring performance based on the farmers' collaboration would be considered as a difficult task in the developing countries, in contrary to the developed countries, where corporatization of agriculture is considered common. In this case efficiency, flexibility, responsiveness, product quality, and process quality are broadly followed to measure the SCP in the dairy industry (Mishra and Shekhar, 2016).

Quality assurance is an essential factor in every step in the production lines. It ensures that every task, operator, component, tool is performing on the required standard assigned to them. By doing this, defects will be eliminated or detected in time and can be immediately corrected. In addition, testing is also done according to the standardised plan. Any failures or defects in the production lines are detected and reported daily to the operators. Therefore, future failures can be eliminated. Sellitto et al. (2015) claimed that if the failure is due to defected parts, then the failure needs to be reported to the entitled supplier to ensure the immediate replacement of the defected parts and that their future provided supplies are up to the required standards.

A cooperative based dairy SC starts with the milk producers then moving to the dairy cooperative societies, then to the bulk milk coolers and followed by the production plant and to the distribution of the final product at the end to the customers. Including the inbound logistics between the milk coolers and the production plants, accompanied by the physical, information and knowledge flows (Mishra and Shekhar, 2016).

2.13 Supply Chain Performance Framework Selection (SCOR)

The SCOR model is proved by previous literature to help in the provision of a better understanding of the SC and the competitive requirements (Hidayat and Astrellita (2012). Salazar et al. (2012) mentioned that it was proven that companies apply the SCOR model to provide reliable and useful information to the company's current working SC, identify the capabilities for assessment, and find opportunities for continuous improvement. The SCOR model includes KPIs, best practices, opportunities for improvement, and the appropriate use of technology to support communication between the business partners that are part of the SC.

The proposed conceptual framework utilises the attributes of the SCOR model, as it is based on using indicators to analyse and compare the working practices and get the best improvement strategy, guidelines to improve the company's performance. To achieve this, companies and organisations are enabled to develop systems based on successful experiences which will result in better relations with suppliers and customers and consequently integrating the whole SC (Salazar et al., 2012).

The major metrics are identified and compared with the superior performers in the manufacturing sector based on the SCOR model. The metrics are classified into external and internal factors. The external includes delivery, performance, and quality. The internal includes flexibility, responsiveness, cost, and assets. The SCOR metric covered under the external factors are delivery performance, fill rate, order fulfilment and the lead time (responsiveness), and the SCOR metric under the internal factors are logistics costs, value-added employment productivity, inventory days of supply, cash-to-cash cycle time, and the net assets (working capital) (Mishra and Shekhar, 2016).

2.14 Developing Appropriate Operational and Supply Chain Management Framework

While there are many organisational theories available in business research, establishing a preliminary theoretical framework is required in any qualitative research (Zsidisin et al., 2005).

According to the main processes of the SCOR model for SCP measurement. The 'source' process relates to ordering and receiving materials and products. The 'make' process means to schedule and manufacture, repair, remanufacture or recycle materials and products as provided by Sellitto et al. (2015). This represents the focus of this thesis.

According to Sellitto et al. (2015) they suggested that the 'plan' process should be excluded from the analysis of the case(s) as an initial application of the SCOR model on the applied case, as it is carried out only once a year. While the other SCOR processes; source, make, deliver, and return measurements are performed monthly or quarterly. Therefore, applying the SCOR model for measuring performance involves the entire SC partners, the aggregate forecasting, and new products development or replacing current products. All this proves that the planning process is not needed in the initial application of the SCOR model and must be included in further trials of application.

The SCOR model has three levels of metrics to measure the SCP. A metric is defined as "a standard for measurement of the performance of a SC or process" (APICS, 2018:4). Level-one metric can be classified according to the following table to include the SCOR performance attributes (Table 2.3). Each attribute is then defined and explained in the following paragraphs. This level diagnoses the KPIs to set targets towards benchmarking. On the other side, level-two identifies the causes of performance gaps and level-three diagnosis those causes.

Table 2.3: SCOR Model Level One Metric- Source: (APICS, 2018:P.2)

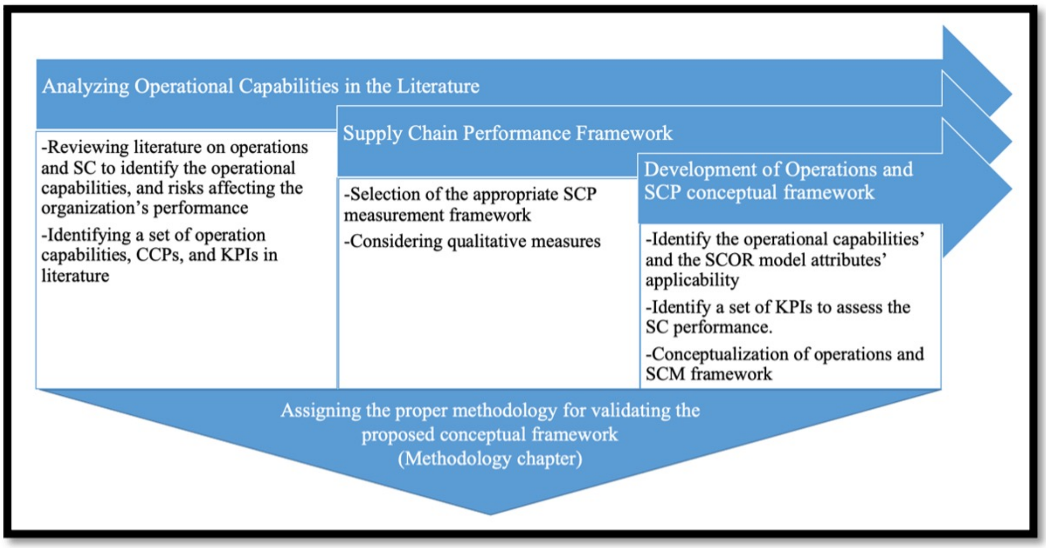
Attribute	SCOR 11.0 Metric
Reliability	RL 1.1 Perfect order fulfillment
Responsiveness	RS 1.1 Order fulfillment cycle time
Agility	AG 1.1 Upside supply chain flexibility
	AG 1.2 Supply chain upside adaptability
	AG 1.3 Downside supply chain adaptability
	AG 1.4 Overall value at risk
Cost	CO 1.1 Total cost to serve
Asset management efficiency	AM 1.1 Cash-to-cash cycle time
	AM 1.2 Return on supply chain fixed assets

To start the implementation of the SCOR model, there is a roadmap to be followed consists of five steps: 1) Build organisation support with the stakeholders, 2) Define the project, 3) Analyse performance by using a metric, 4) Develop project portfolio, and 5) Implement the project without risk.

The goal of developing an effective SCP measurement framework is to ensure its reliability, provision of measurement scope, and feasibility of its strategies. The SCP was classified based on the competitive performance attributes such as quality, cost, delivery, flexibility, resource utilisation, trust, innovativeness, and other attributes. Measuring SC processes also involves assessing the collaboration and coordination efficiency between the SC members, i.e., suppliers and producers. Haddad (2016) also confirms that the SCP literature still needs further investigation and lacks the development of SCP measurement frameworks focusing especially on the SC integration aspect. These frameworks must reflect the corporate strategy and objectives.

After the precise review and analysis of the current available operations and SCP measurement frameworks, now we have a clear vision of the requirements of the next framework. Therefore, developing an appropriate operation and SCP framework that suits the dairy sector's perishability nature is needed based on the literature review analysis. The framework is furtherly explored, validated, and tested using empirical case-studies. That will be discussed in the following chapters. The proposed best practice framework will work as a benchmarking tool, therefore a detailed section on benchmarking the SC operational performance is provided. Last, providing a summary of the whole chapter. Figure 2.7 illustrates the roadmap to formulating the conceptual framework.

Figure 2.7: Roadmap to Operations and SCM Conceptual Framework- Source: Author



The notion of identifying operational capabilities with an impact on SCP is generally considered relatively new to the literature. Relevant operational capabilities still need to be gathered from the literature and practice. Very few operational studies have been carried out on identifying and benchmarking the operational performance to improve the SCP and consequently the dairy products attributes specifically.

After reviewing and analysing SCP literature, performance measures were specified. These measures are classified into four categories, namely: time, cost, quality, and supplier. Each category compiled of a set of KPIs after excluding the repeated and overlapped measures. Most of the KPIs are traditional function based. Abd El-Razik et al. (2016) and Tate (2017) focused on the hygienic standards and the quality standard of a safe and secure product. They mentioned the lack of hygienic standards and care to the dairy herds and the improper transportation of raw milk and recommended that the HACCP is proved needed to improve the products' safety. Also, Michael (2013) approved that HACCP was used as a methodology for monitoring the milk quality control. The reason behind choosing the HACCP is for its applicability and adaptability to small-scale production beside the large-scale producers.

The following table consists of a summary of all related literature papers reflecting the SCP measures reviewed and included in this thesis, inspired by Haddad (2016:68-69).

Table 2.4: Critical Review on Process-oriented SCP Measurement-Source: Author

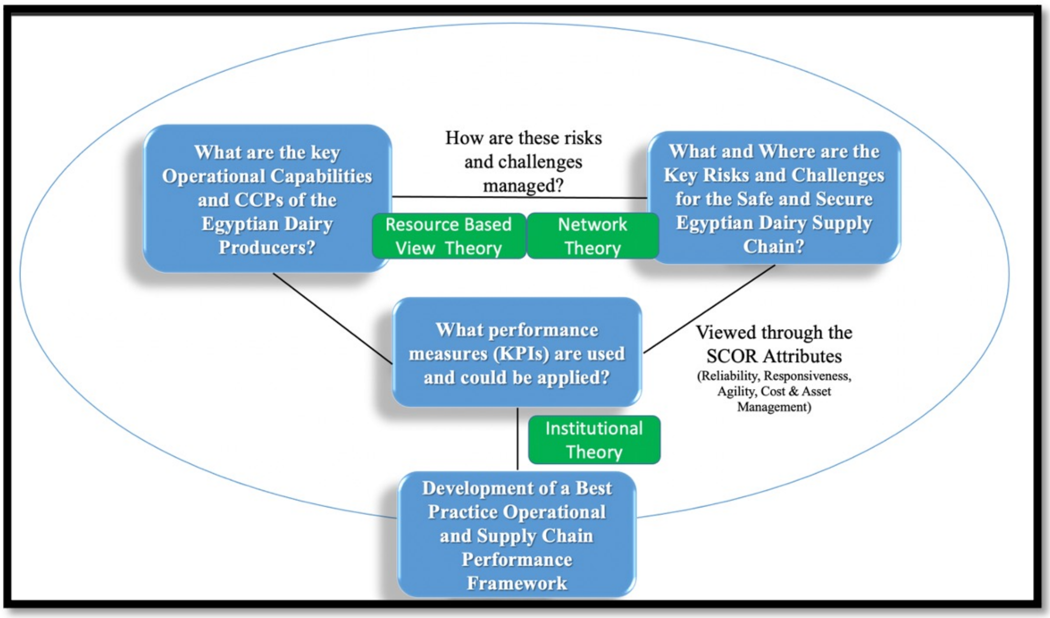
No.	Author	Year	Contribution/Approach
1	El-Gazzar	2015	Constructed a FBMS compiled of several performance measurements related to the various SC processes and functions.
2	APICS	2015	Developed the SCOR which comprises five core processes, namely, plan, source, make, deliver, and return. It integrates major concepts like benchmarking, business process re-engineering, best practice analysis, and process measurement. The SCOR model presents a SCP framework with standardized performance measurement metrics.
3	Erkan and Bac	2011	Applied and identified the SCOR model limitations in a manufacturing company by covering all the steps and levels related to the SCOR model.
4	Salazar et al.	2012	SCOR model provides an overview of all the SC elements and processes to help analyze, measure, and set performance targets and identify improvements opportunities.
5	Sellitto et al.	2015	Suggested to exclude the plan process from the analysis of the case(s) as an initial application of the SCOR model, while the other SCOR processes; source, make, deliver, and return measurements are performed periodically on a monthly basis or quarterly.
6	Wibowo and Sholeh	2015	Measuring the SCP by utilizing the SCOR model as KPIs calculated by using the weighted criteria, AHP.
7	Velychko	2015	Highlighted the increasing trend toward research focusing on the milk industry in developing countries and applied the SCOR model on the milk industry.
8	Mishra and Shekhar	2016	SCOR model is used as a metric covering all SC aspects, used for measuring and improving a firm's performance. Measuring performance can be based on two data collection tools; structured questionnaire using scaling technique or by using records on the SC operations.

An initial SCP measures (KPIs) is proposed to evaluate the operational capabilities and the supplier integration impact on SCP. The KPIs are composed of the SCOR model level-one metric and other qualitative measures extracted from the literature review. The theoretical framework was inspired by (Haddad, 2016). It is developed to conceptualise the relationship between the operational capabilities and the SC attributes and investigate how both impact the overall SCP.

Each performance attribute is defined and coded by (APICS, 2015: Moazzam et al., 2018). First, the SC reliability (RL), is the performance of the SC in delivering the correct product, to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer. SC responsiveness (RS) is the speed at which a SC provides products to the customer. SC agility or flexibility (AG) is the agility of a SC in responding to marketplace changes to gain or maintain a competitive advantage. SC costs (CO), refers to the costs associated with operating the SC. SC asset management (AM), is the effectiveness of an organisation in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital.

Various SCP measures, attributes, and metrics have been proposed in the previous literature. So, the proposed conceptual framework in Figure 2.8 illustrates and clarifies that the operational capabilities identified in the literature are claimed to impact the SCP (Mishra and Shekhar, 2016). In addition to identifying the CCPs by applying the HACCP in the dairy, producers monitor the milk quality (Michael, 2013). Both operational capabilities and the CCPs reside in the 'make' phase in the SCOR model. On the other side, Sellitto et al. (2015) identified a set of risks and challenges impacting the SCP. Accordingly, a list of performance measures (KPIs) should be established, based on Level-1 of the SCOR model and the performance attributes to act as a base of an operational and SCP assessment framework. This figure requires further investigation and validation through the empirical work of this thesis but serves as a starting point to guide the research aims and objectives.

Figure 2.8: Theoretical Framework of Operational and Supply Chain Performance-Source: Author



A firm's operational capabilities are related to managing the sourcing and assembly of the materials and components, which enable the organisation to efficiently utilise its resources and minimise the production cost (Hirunyawipadaa and Xiong, 2018). Therefore, identifying, assessing, and measuring the operational capabilities contribute to the business performance and achieving the organisational objectives (Peng et al., 2008). According to Peng et al. (2008) the manufacturing capabilities are defined as the key manufacturing performance strengths such as cost, quality, and time. The multi-dimensions' measures and operationalization of those capabilities rely on conformance quality, delivery dependability, delivery speed, product flexibility, and cost. Moreover, Coltman and Devinney (2013) defined the operational capability as the capacity of an organisation to purposefully bundle its resource base in ways that enable the organisation to perform the ongoing task of transforming inputs into outputs. They identified six distinctive operational capabilities: active customer engagement (AE), cross-functional coordination (CF), creative solutions (CS), operations improvement (OI), IT infrastructure (IT) and professional delivery (PD). Those capabilities besides the cost, quality, delivery, and flexibility are important as we lack information about the level of capabilities that is required to drive the managerial choices. The best utilisation of the operational capabilities helps in creating superior value to the organisation.

Creative solutions are the ability of a business to create innovative solutions to the customer. Operational improvement usually involves standardised procedures that ensure sustained improvements with error free delivery. IT infrastructure is related to having a wide IT system that connects and shares information about products, management services and locations (Coltman and Devinney, 2013).

To sum up, the operational capabilities are categorised into several parameters by many authors. They can be summed into thirteen parameters after excluding the repetitive parameters, which are quality, speed, dependability, flexibility, cost, process knowledge, equipment and tools, transportation, raw materials or land and farming, technology, storage, environment, and farmers collaboration (Salazar, 2012).

According to (Haddad, 2016: Mishra and Shekhar, 2016), the five SCP attributes (AG, RL, RS, CO, and AM) are the most evident standardised SCP attributes of the SCOR model. It enables the company to compare their business performance to other competitors in the same sector. Table 2.3 clarifies the associated metrics for each performance attribute.

First, the SC Reliability (RL) is measured by the perfect order fulfilment, which is the percent of orders completed with the accurate delivery condition and documentation. Delivery condition represented in the item’s quantity, on-time delivery, packing slips, invoices, or bills of lading.

Second, the SC Responsiveness (RS) is measured by the order fulfilment cycle time, which is the actual cycle time taken to fulfil each customer order. It starts from the customer placing an order until the customer’s acceptance and receiving the order.

Third, SC Agility (AG) is represented in three metrics; the upside SC flexibility, the number of days needed to fulfil an unplanned twenty percent sustainable increase in the delivered quantities. The twenty percent is specified for a benchmarking purpose for some industries, which might be unobtainable by some organisations or the opposite in other organisations. Then, the upside SC adaptability means the maximum sustainable increase in the delivery percentage in 30 days. Finally, the downside SC Adaptability, the reduction in quantities ordered sustainable for 30 days before delivery without inventory or cost penalties.

Fourth, the SC costs (CO), measured based on two metrics; SCM cost associated with the second level of the SCOR model; plan, source, deliver and return. The second metric for the SC costs is the cost of goods sold (COGS), which is the cost associated with buying raw material and producing finished goods, including the direct labour and materials costs, and indirect overhead costs.

Fifth and finally the SC asset management (AM), measured in three metrics. First, cash-to-cash cycle time, which is the time invested to flow back into the company after the company receives payment from the customer for products and services offered. Second, return on SC fixed assets, this includes the fixed assets used in the plan, source, make, deliver, and return. Third, the return on working capital consists of the accounts receivable, accounts payable, inventory, SC revenue, COGS and SCM costs. It assesses the magnitude of investment relative to a company's working capital versus the revenues generated from the SC.

Then, the operations and SCP measurement metrics categories varied between four, six and fifteen different parameters. The most generic categories are time, cost, quality, and supplier. The ten common relevant parameters: (cost, suppliers/quality/reliability, speed/lead time, flexibility/agility, dependability/delivery precision, process/labour ability and knowledge, internal performance, SC strategy, efficiency, product variety) (Salazar, 2012: Mishra and Shekhar, 2016).

The last element of the proposed framework is the SCP, assessed by the product quality and the process quality. The process quality includes raw materials hygiene, skilled manpower, and traceability. Then, the product quality includes taste, shelf life, safety, and reliability (Sellitto et al., 2015). All these measures are qualified to be the parameters of the proposed conceptual framework based on the previous literature.

2.15 Benchmarking Supply Chain Operations' Performance

An organisational existence in the global market relies heavily on improving its products, services, and operations. Beside the fact that much logistics and SCM research is based on a best practice approach (Halldorsson and Aastrup, 2003). Therefore, benchmarking can be used to assess and improve the business performance which will result in higher profit rate, increase the market share, and present a best practice to the industry. Lahat and Shoham (2014) are focusing on performing the organisational activities efficiently and flexibly with the minimum rate of wasting the resources which can be reflected in this thesis core area i.e., the operational capabilities.

According to Sumner et al. (2018), benchmarking is the process of measuring and assessing performance by using a set of indicators and comparing it with other peers to enhance these indicators. It is based on identifying the performance gaps and proposing efficient improvement solutions. Also, benchmarking is defined as: "*a continual, methodical process for evaluating the products, services and work processes of organisations that are recognized as representing best practices for the purpose of organisational improvement*". It works as a baseline for evaluating the processes of one company as a baseline among the peer companies. By sitting a set of attributes in one company to be compared to the same attributes of the peer companies. It specifies significant areas of improvement to enhance the performance (Lahat and Shoham, 2014:999).

Recently, it is common for businesses to rely on benchmarking for comparing practices and performance among the competitors. Any organisation focuses on their financial, marketing, and operational disciplines to understand the organisation's benchmarking strategy and measure its performance. The operational discipline refers to the research and development (R&D) and the manufacturing capabilities (Lahat and Shoham, 2014). Therefore, to develop a benchmarking measure that works as a best practice, it is necessary to identify a set of dimensions with the related KPIs to each. Each KPI in the framework is used to formulate questions to be discussed in the exploratory interviews (Mbaga et al., 2011). The following paragraphs discuss the relevant KPIs to ensure the product safety and the SC quality and the KPIs relevant to the operational infrastructure.

Performance Management System (PMS) work as a benchmarking tool for organisational current practices with the industry requirements, including the LEs will support the research argument to work as a benchmarking factor (Thakkar et al., 2009: Salazar et al., 2012: Manuj and Mentzer, 2008). It is necessary to identify the KPIs that influence the SCP, to set a model that will work as a benchmarking tool (Wibowo and Sholeh, 2015). Then validating the KPIs can be followed. In addition, Driscoll (2016) assured the need to develop a best practice or benchmarking in the dairy sector against the global market, and (Thakkar et al., 2009: Balfaqih et al., 2015: Delipinar and Kocaoglu, 2016) assured that as well. Measuring the overall SC depends on measuring its performance through the evaluation of previous behaviour and via benchmarking. The KPI's are the most crucial dimensions that lead to the success or failure of an industry (Balfaqih et al., 2015). Delipinar and Kocaoglu (2016) assured that, to successfully plan a set goal for the overall SCP improvements, the following should be considered; defining process elements, setting target benchmarks, defining best practices, and improving system software to enable best practices.

This thesis will follow Moazzam, et al. (2018) benchmarked a set of SC KPIs on ten dairy producers and fifty farmers in New Zealand to assess their SCP by using the SCOR model level-1 identification metrics of KPIs. **Reliability (RL);** RL1.1 Perfect order fulfilment, RL2.1 Percent orders delivered in full**,** RL2.2 Delivery performance to customer commit date**,** RL2.4 Perfect Condition. **Responsiveness (RS);** RS1.1 Order fulfilment cycle time**,** RS2.1 Source cycle time, RS2.2 Make cycle time**,** RS2.3 Delivery cycle time. **Agility (AG);** AG1.1 Upside SC flexibility, AG1.3 Overall value at risk (VAR). **Cost (CO);** CO1.1 SC management cost**,** CO1.2 Cost of goods sold. **Asset Management (AM);** AM1.2 Return on SC fixed assets**,** AM1.3 Return on working capital.

The KPIs related to the product safety and quality of the SC are: 1) Quality certification obtained by the organisation e.g., ISO and HACCP. 2) Quality Control Specialists with the required skills in the organisation. 3) Training and knowledge of the workers. 4) Social Responsibility with respect to the workers' health, safety, and welfare. 5) Environmental Management policies and practices. 6) Safety and quality requirements/ specifications as part of the SC partners' contracts and/ or agreements (Mbaga et al., 2011).

The KPIs related to the operational infrastructure are: 1) The processing and packaging technology. 2) The processing and packaging quality, which refers to the materials used to satisfy the customer requirements. 3) Labelling flexibility in processing and packaging to meet the customers' requirements. 4) Storage technology or automation in the organisation's facilities. 5) The organisation storage capacity. 6) The organisation storage quality. 7) The transportation technology utilised. 8) The availability of quality transportation (Mbaga et al., 2011).

Finally, regardless that Erkan and Bac (2011) utilised the SCOR model to benchmark the operational measures and improve the organisational performance, according to Haddad (2016) there is a lack of research on benchmarking the operational performance. That is reflected as a methodology tool to generate the proposed framework for this thesis. The case-study design section in the methodology chapter will clarify its applicability in this thesis.

2.16 Literature Gap Identified

Under this section, Table 2.5 includes a summary of the main publications on the researched area to focus on the research gaps identified which led to the research contribution(s) and the methodology followed to direct the current thesis's methodology. These publications were carefully selected from the top journals in operations and agriculture SC management explained in Section 2.2. The research gap identified is listed and explained in the following paragraphs.

Table 2.5: Literature Themes Summary for Tracking the Research Gaps and Led to Contributions-Source: Author

No.	Author	Year	Methodology	Contribution
1	Guan and Philpott	2009	Quantitative	A multistage stochastic programming model for the New Zealand dairy industry by using observations. The SC model can be expanded to consider the manufacturing sites and storage places in each region to improve our model for uncertain milk supply.
2	Deep and Dani	2009	Qualitative	A Scenario planning study through the application of a conceptual model, proposes a structure to translate scenarios into operation changes and offers a proactive predictive tool for the food industry to avoid or minimise disruptions in the

				SC. The study covered the following countries: China, New Zealand, USA, and EU global food SC. The authors recommended empirically test the conceptual model.
3	Gillespie, et al.	2009	Qualitative	Research on the Pasture-Based Dairy systems. The pasture based dairy systems differ in prominence by region, but also by farm and operator demographics. Pasture-based producers are more likely to be smaller-scale and have lower debt. They utilise more land resource per cow and are relatively more likely to milk cows twice rather than three times per day and are less likely to adopt "intensive" technologies.
4	Bourlakis, et al.	2013	Quantitative	Comparative Greek chain member's analysis in relation to sustainability performance indicators. Lack of studies on endogenous uncertainty in the agriculture sector and the need to design agriculture systems combine modelling,

				optimisation, or approaches with the provision of empirical reasoning for it.
5	Bourlakis, et al.	2014	Quantitative	A study on the firm size and sustainable performance in food SC. A questionnaire-based survey on the Greek SCs. The growers recorded no statistically significant difference between micro and medium firms' performance. The small growers are more flexible in extra volume orders and consistency of traceability systems.
6	Subburaj, et al.	2015	Triangulation	A study focused on strengthening the operational efficiency of the Indian dairy SC. The key findings are where the milk value chain is deprived of minimum resources of land, labour, water resources, and capital. One of the major challenges to deteriorate the milk production is the animal health and the major constraint is the high milk production cost.
7	EL-Nakib	2015	Qualitative	Highlighted the lack of safety standards of the

				dairy products in Egypt which lead the consumption towards the packed products produced by the large enterprises and recommended further empirical studies.
8	Griffin	2015	Quantitative	Highlighted that Egypt is one of the Middle East countries that rely mainly on imports of different dairy products but expecting to achieve growth in the future.
9	Mishra and Shekhar	2016	Triangulation	An empirical study investigated the potential risks for the dairy food SC and investigated their impact at the various stages of the SC. The study used surveys and interviews with the stakeholders. SCOR model is used as a metric covering all SC aspects, used for measuring and improving a firm's performance. Efficient and effective SCM operation could provide measures for hygiene throughout the SC by adhering to the proper food value requirements.
10	Yu and Huatuco	2016	Quantitative	A SCRM case-study on a Chinese dairy company

				used to identify and mitigate the risks. The authors recommended the use of surveys through quantitative data analysis and work on generalising the results.
11	Steur, et al.	2016	Qualitative Content Analysis	A systematic review on lean manufacturing in the agri-food sector. Including case-studies on the developing countries rather than the developed countries with some quantification was recommended.
12	Tate	2017	Qualitative	A report proved the current improvement in the Egyptian dairy sector and highlighted the promising future of the dairy production in Egypt with the support of trade agreements that enables it to enhance its exports to the foreign market.
13	Moazzam et al.	2018	Quantitative	Developed an analytical framework based on the SCOR model to benchmark the SCP in the dairy companies in New Zealand. They noted challenges in accessing data and records to apply SCOR level-3 for confidentiality issues. The

				framework can be applied on other agri-food production SCs.
14	Irfan et al.	2019	Quantitative	Recommended further investigation to the supplier-buyer relationship in the food sector.
15	Yiu et al.	2020	Quantitative	Detected limitations in identifying factors of business information systems on the operational capabilities.
16	Zacharski et al.	2021	Quantitative	The need to focus more on the milk reception to enhance the operational efficiency and overcome the dairy SC obstacles.

Based on the investigation of the previous literature, scholars identified a range of gaps of key areas. The common gaps found in previous literature can be summed up in the lack of empirical exploratory research in this area, lack of studies on endogenous uncertainty in the agriculture sector and designing agriculture systems in the developing countries and in the Egyptian dairy sector specifically. As noted in previous literature, the quantitative methodology predominates the qualitative methodology. Accordingly, many researchers recommended furtherly exploring the phenomenon qualitatively to provide deeper insights and identifications to the factors related to it. Some deficiencies and limitations were detected in the supply side, the production, and SCP measurements, including factors contributing to the successful implementation of performance measurement systems (Irfan et al., 2019). The urgency and criticality of developing a new performance measurement framework to overcome the deficiencies highlighted in Table 2.5.

To summarise, the previous research gaps represented in; the lack of qualitative research methodologies in the researched area, lack of triangulation approaches, introducing the SCOR model's attributes to the Egyptian dairy producers for the first time, and focus on the operations ‘make’ of the SC specifically and identify the supply side ‘source’ potential risks and challenges affecting the supply of safe and secure dairy products. This can be achieved by using a qualitative methodology to identify the elements of introducing a SCP measurement best practice framework for the Egyptian dairy producers, based on the supply and production phase of the SC.

Some key areas relevant to the dairy sector need further focus and need to be developed those areas can be summarised as follows; first, the need to develop new models for investing in biodiversity at the farm level, second, create dedicated areas for biodiversity in dairy production systems, and third, benchmark against best global practice (Driscoll, 2016).

Performance measurement system hierarchy analyses the performance of safety, health, environment, and risk (SHER). A common factor between all SC frameworks that measures performance in the SC is the concern of the whole SC members, not only a single member in the SC. One member of the SC can optimise its process, therefore boosting the overall SCP required participation and collaboration of each member of the SC. According to Sellitto et al. (2015), the performance measurement system framework should include the following categories, time measurements, cost measurements, quality measurements, and supplier measurements. Each of the categories contains a set of metrics. However, most of the performance measurements, i.e., KPIs included in the literature are functional-based rather than value-based. Previous literature shed the light on the qualitative measures of SC relationships and customer satisfaction. Analysing the performance measures at the strategic, tactical, and operational levels help managers make the right decisions. Therefore, future research should focus on designing a measuring framework incorporating the SC relationships and the whole integrated SCM including the intra-organizational SCP (Haddad, 2016).

Combine modelling, optimisation, simulation approaches, empirical reasoning represents the basis for agricultural management (Borodin et al., 2016), robust optimisation of process designs in the food SC context (Jonkman, 2017), some challenges and constraints were identified in an Indian field study by (Subburaj et al., 2015). These constraints are the high milk production cost, minimum resources of land, labour, water resources and capital, and the animal health which affect the milk production.

The previous gaps, which is summarised in Table 2.5, is covered through assessing the operational capabilities ‘make’ and the supplies’ risks ‘source’ and proposing an operational and SCP best practice framework to the large size dairy producers in Egypt. Approving that, EL-Gazzar

(2013) mentioned that recent operations management research requires more empirical research that requires qualitative analysis than quantitative. After reviewing the difference between the BSC and the SCOR model under Section 2.5. The researcher found that applying a performance assessment framework on the dairy producers including the SCOR model's attributes, should benefit the dairy sector and enhance the local production in Egypt. The SCOR model is known as a well-structured and comprehensive model that works on measuring the performance, which will be beneficial when it is applied to the large dairy producers in Egypt to sustain their production of safe and secure dairy products. This was tested by the SCOR model attributes applicability on the dairy sector in New Zealand (Moazzam et al., 2018).

This thesis contributes towards the knowledge by investigating the research problem in a systematic and analytical approach. The contribution is reflected in testing the applicability of the SCOR model on the large enterprises in the Egyptian dairy sector. The model is already applicable in other sectors, despite that, it is furtherly tested in the dairy sector, which is recognized by its high degree of perishability. The operational phase of the large-sized dairy producers ensures the production of safe and secure dairy products against the different SC risk. Accordingly, providing some parts of the literature helped in formulating the current RQ.

Based on the detailed critical review of the relevant literature, a number of RQs were concluded to fulfil the research aim and meet the research objectives that will be answered throughout this thesis. Those are:

RQ1: What are the key operational capabilities, including the Critical Control Points (CCPs), in large-size Egyptian dairy producers?

RQ2: What are the risks and challenges affecting the operation and supply chain performance in the Egyptian dairy supply chains, in terms of the production of safe and secure dairy products?

RQ3: How do dairy producers overcome these supply chain challenges and operational risks and what does good look like?

RQ4: What performance measures (KPIs) do the large-size Egyptian dairy producers currently use and which are missing?

RQ5: How to improve the Egyptian dairy producers' performance against risks and challenges using the SCOR model's SC attributes?

2.17 Summary

The literature on operations and SCP in the dairy sector specifically has been thoroughly reviewed in this chapter. First, it started with a brief description and introduction about SCRM and its role in creating value to improve the performance of the large size Egyptian dairy producers. Then, the methodology followed in the preparation of this review was explained with a clear emphasis on the inclusion and exclusion criteria for the selection of the resources included in this narrative review. Afterward, covering the relevant peer-reviewed studies on risk management, operations management, SC security, SCP models, and the dairy sector's SC specifically used to assess the dairy sector current status, and highlight the gaps in the researched area.

It is proved that there is a lack of empirical studies that are still needed on measuring and assessing the dairy sector operations and SCM performance to ensure the products' safety and security. Therefore, the conceptual framework is formulated based on the previous SCP models. Keeping in consideration the perishability nature of the dairy products' sector.

The framework is made to work as a guide to pass through complexities and challenges that the dairy industry is facing. It focuses on the beginning of the chain (i.e., supply side) and the processing phase (i.e., operation phase) not the end of it (i.e., distribution). As supported by (Driscoll, 2016), a set of guiding principles were determined for 2020. The most essential principle that affects the product quality is improving animal welfare, through improving standards and safeguarding the health and welfare of the dairy cow. The list goes on with, engaging the key stakeholders, investing in innovating technologies and business models that deliver superior nutrition, cooperation, and transparency across the SC by building trust and adding value, ensure the staff development and building their skills and ensure their continuous learning, engage consumers' nutrition preferences and transparency, and minimising the environmental impact.

As the Supply Chain Integration (SCI) reflects the processes integration and sharing of data across the SC, it has a positive effect on the SCP (Sweeny et al., 2015). The conceptual framework will work on improving the SCP by ensuring that the operational capabilities are well established and the integration between the suppliers and the producers is working smoothly and both moving in the same path towards ensuring the product safety and security. The framework assumes that the operational capabilities impact the SC attribute including reliability, responsiveness, agility, cost, and asset management. This impact can be measured by the operational and SCP integrative measures which will lead at the end to improve the SCP, represented in producing safe and secure dairy products.

In this review, the following key-pillars were detected and concluded to shape the gap in literature, it can be summarised in:

1) Controlling and ensuring the quality and safety measures of the supplied raw milk is positively correlated to the operational risks and eventually ensuring the dairy products safety and security standards by using the case-studies to provide in-depth investigation to the studied companies,

2) A significant number of papers agreed that collaboration between the SC members, especially between suppliers or farms and the dairy producers provide better control on the agricultural sector uncertainties, represented mainly in the supplies and the raw milk provided for production. This eliminates or reduces the most influential causes of risks.

3) HACCP has proved to be a useful tool for identifying the different kinds of risks in the food SCs. It is adopted by the large dairy producers in Egypt, which qualify them to react to sudden risks and ensure the smooth flow of the production processes through optimising a process design as recommended by (Jonkman et al., 2017) and produce safe and secure products that fulfil the consumer requirements of a trustful hygienic dairy products (Ammar, 2017: EL-Hofi, 2010: Aiad, 2013),

4) According to the lack of research on the Egyptian dairy sector (EL-Nakib, 2015), a promising future is waiting for the developing countries over the developed in the dairy sector, particularly the African countries, due to its favourable weather and their farming resources as supported by (Euromonitor, 2017: Griffin, 2015: Tate, 2017),

5) The sources of risks and the hygiene measures in the production practices should be further investigated. The concluded results of this review focus on improving the performance in the operational phase of the large dairy producers in Egypt against the different sources of risks and hazards through an exploratory research design. Then, proposing a framework including the SCOR model's attributes lead to empirically study and investigate the Egyptian dairy SCs, and last,

6) Performance measurement is the key driver in any SCM. Performance measurement tools, strategies, and frameworks have been reviewed and analysed. That works as a base for the next chapter and the proposal of a conceptual framework.

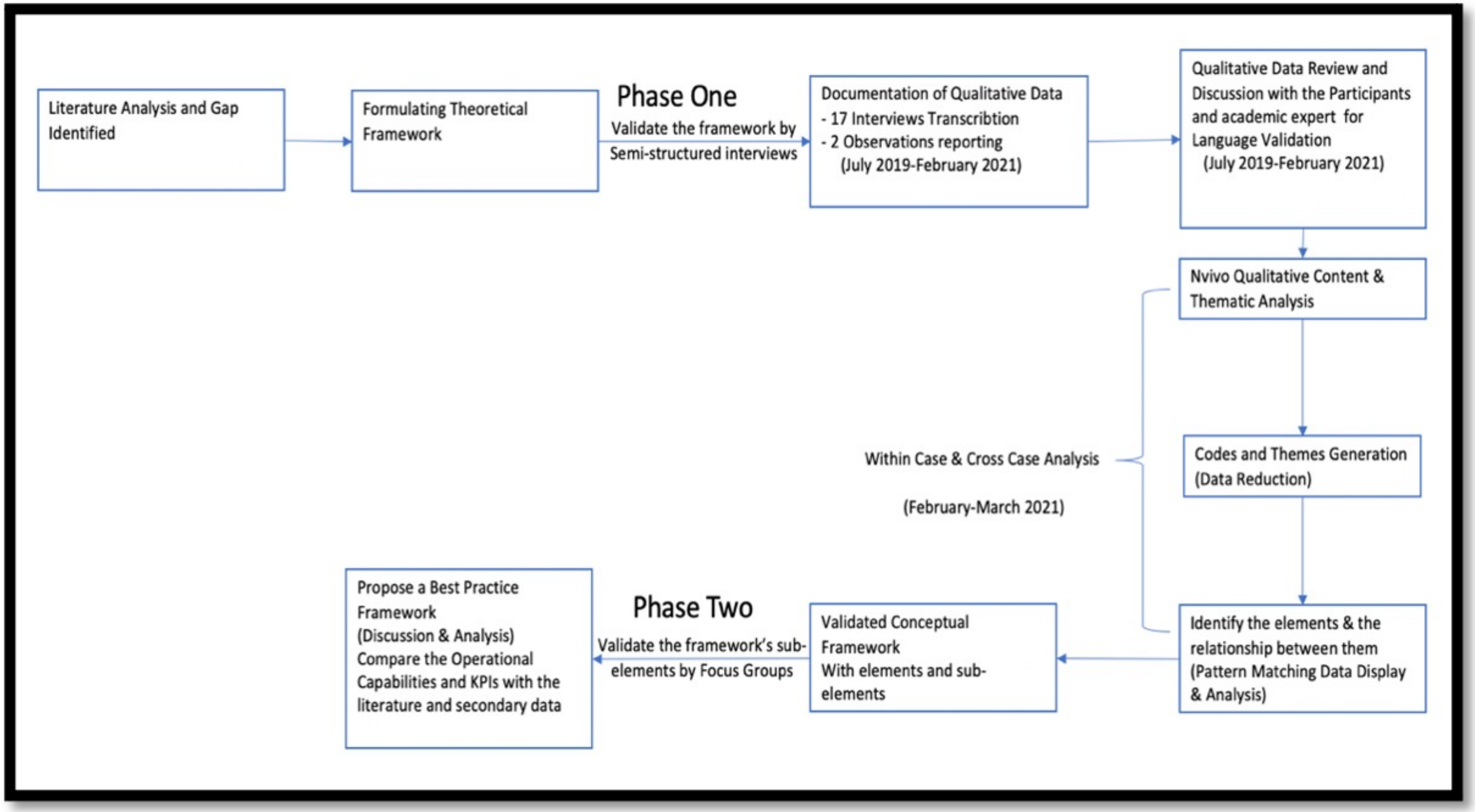
The next chapter will discuss and explain the research methodology that will be followed in the process of measuring and analysing the applicability of the research model and the case-studies that will be held.

Chapter 3 Research Methodology

3.1 Introduction

This chapter covers the methodological approach followed in this thesis as directed by the literature reviewed and the theoretical discussions provided in previous chapters. It begins by reviewing the research objectives and questions. Then, followed by a discussion of the selected philosophical paradigm adopted in this thesis and clarifying the research paradigm position with an emphasis on the theories and the strategy followed to achieve these objectives. That helps to clarify and understand the arguments made in the following sections in terms of research approach choice, methodology, sampling, and data collection methods. The utilisation of the case-study approach as a research design was a suitable approach to understand this relatively new research problem due to the exploratory nature of the proposed framework. The case-study research design is the most appropriate methodology to investigate and understand this social phenomenon and to achieve significant internal validity. Therefore, an evaluation of the application of the case-study methodology is made with reference to other approaches. The framework explores the operational performance measures against potential SC risks. Last, providing an explanation of the data analysis. Finally, a summary of the whole chapter is then followed. Figure 3.1 illustrates the methodological approach process flow of this research.

Figure 3.1: Process Flow of Methodological Approach-Source: Author



This thesis proposes a conceptual framework to optimise the operational and SCP by identifying a set of operational capabilities, CCPs and SCP measures (KPIs) against the different SC risks. There is limited research found studying the perishability nature of the dairy sector (Liu et al., 2019). In addition, there is no performance assessment framework focusing on the operations of the dairy producers, notably in Egypt. This thesis builds on the previous gaps and utilises theories, such as the RBV, institutional, and network theories, by proposing a list of operations and SC measures by using qualitative data triangulation methods (interviews, observations, and focus groups).

According to EL-Gazzar (2013), the three types of case-studies require research propositions which stem from the RQs, either exploratory, explanatory, or descriptive. The difference between the three types is in the exploratory studies, the data may be collected to formulate the research propositions and reformulate the RQs in case needed. But the explanatory and descriptive studies require the propositions first before collecting and analysing the data to support or refuse the research proposition. As in the explanatory studies, it investigates causal relations between variables or events. In the descriptive studies, the researcher describes the different characteristics of the phenomena. This thesis follows the inductive research approach to explore the dairy sector in terms of, the production and the supply side. Detailed discussion of the phases' applicability on this thesis will then be followed in the following chapters.

This chapter provides a thorough examination of the case-study research stages starting from the case design, data collection, data analysis, and report writing. Meanwhile, the case-study is designed to move through two phases, namely: exploratory and explanatory phases. Exploratory, to identify the key elements of the proposed theoretical framework extracted from the literature. Explanatory, to further validate the conceptual framework with the elements and sub-elements of it. That is to introduce a best practice framework valid for applicability by the Egyptian dairy producers. This is held by providing explanations to the data analysed and comparing the cases as a whole. The explanatory analytical logic deal with the cases as a whole rather than parts (Mason, 2002).

3.2 Research Objectives Restated

Table 3.1 demonstrates the alignment between the research objectives with the RQs with the related references from the literature supporting them and the constructed interview questions were created to ensure that the data collected answers the RQs.

Table 3.1: Aligning the Research Objectives and RQs to the Literature and the Interview Questions-Source: Author

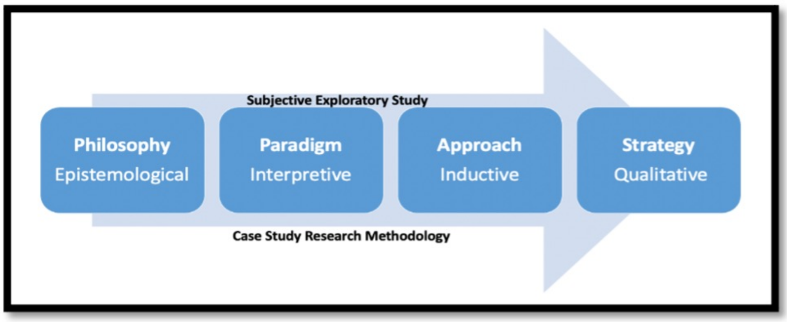
Research Objectives	RQs	Reference	Interview Questions
1. To identify the current operational capabilities, critical control points (CCPs), risks, and challenges affecting large dairy producers in Egypt.	RQ1: What are the key operational capabilities, including the CCPs, in large-size Egyptian dairy producers?	-Hirunyawipadaa & Xiong (2018) -Amanfo (2014) -Coltman & Devinney (2013) -Salazar (2012)	4. How many dairy products' production lines do you have? And what are they? 9. How do you describe the criteria of safe and secure dairy products? What are the quality and safety security measure do you apply, or certificates do you have? Including your suppliers. 10. What are the Critical Control Points (CCPs)? 11. What are the operational capabilities in the company?
	RQ2: What are the risks and challenges affecting the operation and supply chain performance in the Egyptian dairy supply chains, in terms of the production of safe and secure dairy products?	-APICS (2018) -Wibowo & Sholeh (2015) -Velychko (2015) -Mishra & Shekhar (2016) -Irfan et al. (2008)	5. Do you have your own farms, or you deal with suppliers? 12. What and where are the risks affecting the previously determined operational capabilities?
2. To investigate and develop a set of operational and SCP measures (KPIs) to improve and transform the dairy producers' performance from the "as-is" state into the desired process of "to-be" or a best practice state.	RQ3: How do dairy producers overcome these supply chain challenges and operational risks and what does good look like?	-Moazzam, et al. (2018) -Delipinar & Kocaoglu (2016) -Sweeny (2015)	6. How many suppliers do you have? 7. Do you face lack of resources or any other kind of risks? In case yes, how does it impact the operations/production? 8. If you have your own supplier(s) specify the cleanliness measures applied to ensure the quality of raw milk. 13. What is your perspective on the relationship between operations and SCM?
3. To evaluate whether the SCOR model supply chain attributes (i.e., reliability, responsiveness, agility, cost, asset management) could be applied and integrated within this best practice framework to improve the production of safe and secure dairy products in Egypt.	RQ4: What performance measures (KPIs) do the large-size Egyptian dairy producers currently use and which are missing?	-Delipinar & Kocaoglu (2016) -Driscoll (2016) -Balfaqih et al. (2015) -Wibowo & Sholeh (2015) -Mbaga et al. (2011) -Salazar (2012) -Haddad (2016) -Mishra & Shekhar (2016) -Sellitto et al. (2015)	14. How do you measure the supply chain performance in your company? 15. What Key Performance Indicators (KPIs) do you have? 16. Does any of these measures focus on the operations and SCM? Do you recommend any further measures?
	RQ5: How to improve the Egyptian dairy producers' performance against risks and challenges using the SCOR model's SC attributes?	-Moazzam, et al. (2018) -Lahat & Shoham (2014) -Sweeny et al., (2015) -Guth (2016) -Delipinar & Kocaglu (2016) -Thakkar et al (2009)	17. What are your future plans for improving your SCP?

The operational challenges and the CCPs in the operational phase will be determined in the processing phase of the large Egyptian dairy producers. As explained in Chapter Two, the CCPs is a preventative, structured, systematic, and documented procedure during the operational phase 'make' to ensure food safety (Aiad, 2013). Therefore, developing a best practice framework for the Egyptian dairy sector can be used and followed to include a set of operations and KPIs. That will guide the dairy producers in Egypt.

This thesis analyses the SCP measurement based on the related frameworks found in previous literature. Reaching the fact that utilising the SCOR model's attributes as part of performance measurement framework is considered the most appropriate model until now to measure, improve, and develop the operational performance of the currently held case-studies. The SCOR model's attributes work as a base for compiling the proposed framework's SC categories, attributes, and elements. The SCOR model is selected to manage the different types of risks in the operations phase, guide the practitioners to identify and assess their SCP (Thakkar et al., 2009), and it helps in achieving a realistic benchmarking target (Irfan, 2008: APICS, 2017). Therefore, this thesis introduces an operational and SCP conceptual framework based on the SCOR model performance attributes, to improve the overall dairy operations and SCP for the Egyptian dairy producers. The conceptual framework also helps to guide the methodological approach in the study and position the RQs in a logical way, overlaid upon this (Figure 1.5).

The following subheading covers a detailed explanation of the research philosophy, the chosen research paradigm, and approach with the provision of justification for such selections. Figure 3.2 simplifies visually the research methodology road map, which will be discussed next.

Figure 3.2: A Roadmap to The Research Methodology-Source: Author



3.3 Research Philosophy and Strategy

According to Salvador (2018), the research philosophy reflects the nature of knowledge and the development of that knowledge. Most business research belongs to a specific research philosophy which is often referred to as a research paradigm. The researcher's philosophical assumptions shape the understanding of the RQs, justify the research methodological choice, the research strategy, the data collection methods, and the interpretation of the research findings. Also, Saunders et al. (2014) explained the philosophy that the researcher follows reflects how the researcher views the world.

The social science research dimensions that must be applied in every research are ontology, epistemology, the methodology and methods. Each of the previously mentioned dimensions' ranges separately between objective and subjective research approaches which reflects the researcher's view of the research process. Therefore, a paradigm is a very broad and general concept. It is a way of examining social phenomena from which a particular understanding of these phenomena can be gained and explained. Previous research studied the business research paradigms in terms of the ontological and epistemological paradigms in accordance with the qualitative and quantitative research methods. Antwi and Hamza (2015) defined the ontology paradigm as the way the researcher identifies the reality, and the epistemology paradigm as the process the researcher follows to reach the reality identification and last the methodology as the method used to conduct the research.

Based on the research ontology, the researcher must position the research within the ontology. The research is positioned in one of two distinctive opposite dimensions, which are both providing valid research knowledge, those research dimensions namely are the objective dimension-Realism and the subjective dimension-Normalism. The research ontological assumption has a role in formulating the RQs and how the research is conducted (Antwi and Hamza, 2015).

First, the objective (Realism) ontological dimension identifies the notion that social entities exist external and independent to the social actors concerned with their existence. In other words, the researcher is not involved in the results of the research. The second dimension, the subjective (Normalism), social phenomena created from the perceptions and consequent actions of social actors. In the subjective perspective, there is a continuous social interaction between the actors and the phenomena that are constantly changing. Therefore, it is essential to focus on the details of the situation to provide a coherent understanding of what is going on. From here, the social constructionism terminology evolved, which viewed reality as socially constructed (Antwi and Hamza, 2015). This thesis belongs to the subjective interpretive research dimension from an epistemological philosophical position.

As referred to by Velychko (2015) and Burgess et al. (2006) the relevant SCM research methodologies vary between analytical conceptual, empirical surveys or case-studies, which are classified under different philosophical paradigms ranging between positivism and interpretivism research. Salvador (2018) ensures that there is an increasing trend towards empirical research in the field of logistics. Golicic et al. (2005) also approves that most of the logistics and SCM research are classified under positivism. Approving the previously discussed approaches, Boehme et al. (2011) support the need to rely more on the interpretivism paradigm in the recent SCM research.

Highlighting the weaknesses of the ontological and epistemological expectations under the positivism (Functionalism) paradigm, the phenomena is observed as it is independently away from the researcher interaction. In contrary, the phenomenological (Interpretivism) paradigm, the researcher interacts with the research phenomena and acts as part of it (Antwi and Hamza, 2015: Saldana, 2013). Bryman and Bell (2007) claim that the positivist is the dominant epistemological position for studying the organisation based on problem-solving which provides a rational explanation. Nevertheless, the interpretive research paradigm reflects a coherent understanding and explanation of a phenomena especially in SCM (Boehme et al., 2011).

Understanding the researcher’s values and involvement in the research process, which is called axiology, is essential besides the understanding of the ontological and the epistemological assumptions that support the research process. Axiology reflects the researcher’s own values and participation in all research stages. These values play a significant role in the research results (Hart, 1971). Therefore, the researcher values reflect the choice of the philosophical approach and the data collection methods as well. Accordingly, being an academic who is working and living in Egypt facilitated the accessibility to the selected cases and strengthened the position of the researcher among the dairy producers in Egypt. Further details explained in Section 3.3.4. Table 3.2 provide a distinction between the methodologies classified under both research philosophies, the positivism and the phenomenological.

Table 3.2: Methodologies Used in The Positivist and Phenomenological Philosophies- Source: (Haddad 2016:P.88)

Positivist	Phenomenological
Cross-sectional studies	Action research
Experimental studies	Case studies
Longitudinal studies	Ethnography
Surveys	Construct elicitation
Models and simulation	Grounded theory
	Participative enquiry

A distinction between the quantitative and the qualitative research can be provided to justify the reliance on such approaches. The quantitative research handles the observation of an existing reality, and the researcher will approve the existence of this reality in association with its characteristics. However, qualitative research focuses on understanding and explaining the phenomena and the process (Abushaikha, 2014: Sweeny et al., 2015). ualitative research deals with reality as socially constructed research.

Antwi and Hamza (2015) argue that the researcher must get in contact with the research environment and the participants to study in qualitative research, the subjective dimensions of the research phenomena, and act as the data collection instrument instead of using standardised measuring instruments. This is particularly true when little is known about a research problem and very little published. That is applicable in this thesis, little is known, and therefore the application of case-studies by conducting semi-structured interviews, focus groups (FGs), and personally held observations on the Egyptian dairy producers, will enable the RQs to be answered.

The next subheadings provide a detailed explanation of the research philosophies whether, positivism, interpretivism, or pragmatism.

3.3.1 Positivism

The positivism research philosophy reflects the quantitative kind of research, known as the quantitative paradigm. Positivism under the management research aims at generating causal relationships in the organisations' operations. It allows management to work on a scientific basis and help managers control their environment and make better decisions. As positivists follow the causal relationships, hypothesis is utilised to reach these relationships. It works on a highly structured, narrow, and specific methodology and statistical analysis to permit its application on similar future research (Burgess et al., 2006).

It enables the researcher to handle the knowledge in a systematic and quantifiable way. It helps in creating a relationship between different parameters with a clear description of it (Lakatos, 1989). Quantitative research methods achieve generalizability by the provision of external validity, while the qualitative maximise and support the realism paradigm and enrich the internal validity (Burgess et al., 2006).

The positivist researcher usually works on an observational basis and believes that the result of the research can be generalised to similar research. Furthermore, for confirmation, positivism means that the researcher is independent of what they study and the final result of the research, including the selection of what to study, how to study it and the data collection tools and analysis (Burgess et al., 2006).

3.3.2 Interpretivism

Interpretivism is identified and known as social constructionism. It is related to the qualitative paradigm and identified by describing reality objectively by seeing the behaviour as determined by the phenomena of experience rather than by being externally away from it. Inductive research approach falls under the interpretivism paradigm (Boehme et al., 2011). Saunders et al. (2014) claim that interpretivism supports the understanding of the differences between humans as social actors.

The researcher under this paradigm sees reality as subjective and socially constructive based on people's experiences. The researcher focuses on creating meanings and interpretations based on people's thinking and feelings, individually and collectively. This means that the researcher values and opinion guide him/her through the interpretation of the results (Boehme et al., 2011).

This paradigm can be utilised in a holistic view rather than a reductionist view. Under such a paradigm, replication for the phenomenon would be difficult and problematic. Unlike the positivism paradigm, the statistical generalisation is less valuable in this paradigm. Since the reality of each phenomenon is unique and changing. Interpretivists seek to gain rich insights into human behaviours and experiences from a specific situation rather than focus on establishing replications and generalisation (Boehme et al., 2011).

Although most of the SC research adopts mainly the positivist nature of research, (Boehme et al., 2011) argues the need to shift to the adoption of the triangulation methodology in the logistics and SC field. Based on their studies which included some of thirty years' academic publications. Therefore, a noticeable trend appears in the following SC research to demonstrate interpretive research in the field of logistics and SC. They highlighted that interpretivism supports the clarification of the comprehensive SC environment in relation to the messy elements and the involvement of the human factor. Also, Mangan et al. (2004) encourage the logistics and SC researchers to explore and apply alternative research methodologies other than the quantitative if the research is exploratory and aims to gain knowledge. Sweeny et al. (2018) support the use of qualitative research in SC research, as it generates a deeper and richer understanding of the phenomenon.

This thesis follows the interpretive research paradigm because little is known about the research phenomena, which needs further exploration. It can be utilised to clarify what is optimum for the enterprise, to reach the best benefit that can be obtained, i.e., that can be perceived as a best practice. Therefore, high compatibility of this approach can be noticed in the application of the case-studies. This approach studies the ongoing practices of the studied cases, by utilising the analysis of each case-study's results. So, the researcher can find relations between the ongoing practices and how it affects its performance and later suggest solutions and improvements to these companies to benefit the Egyptian dairy sector.

This thesis explores the operational and SCP in the selected case-studies by conducting in-depth semi-structured interviews, observations, and FGs and acting as a part of the research environment. This enables identifying and validating the proposed framework constructs.

3.3.3 Pragmatism

Triangulation is one type of the mixed methods that provides a deeper understanding of a certain phenomenon, so adopting a mixed method in any research called the pragmatic research paradigm which interacts between both sides, the positivism and interpretivism (Venkatesh et al., 2013).

3.3.4 Choice of Research Philosophy and Paradigm

Understanding the research philosophy, approach and strategy and the relation between them is the core of any research. It clarifies the research design and helps to understand and recognize the suitable evidence required that best suit the selected research design, how it is collected and interpreted. Also, it enables the researcher to adapt and modify the research design in accordance with the constraints that might be faced during the research process (EL-Gazzar, 2013).

Starting with the application of the philosophy and the ontology of this thesis, it is rooted primarily in the interpretive paradigm from an epistemological philosophical position because little is known about the capabilities and KPIs in the Egyptian dairy producers. It has a subjective dimension exploring the research problem and research constructs. That is achieved by an in-depth investigation and understanding of the selected cases. It provides a deeper understanding of the phenomenon. A phenomenology or qualitative paradigm is the research methodology. This suits the research that needs to explore a phenomenon from different industry perspectives and geographical contexts. That can be achieved by exploring the practitioners' experiences and points of view in the researched area as a primary source of data. Based on Mason (2002), interpretive categories can be extracted from the data sets by reading beyond the literal text itself and imposing what the data implies and its context, either from interviews' transcriptions or observational field notes.

McCarthy et al. (2016) studied organisations and created theories in relation to them. The design and the implementation of this thesis follows the interpretive research paradigm in terms of methodology and data collection methods. This thesis matches McCarthy et al. (2016) in the use of semi-structured interviews to support the provision of a multi-case-study comparison. The generalisation can be achieved through the utilisation of a sufficient sample size to allow the researchers to reach appropriate conclusions and represent a wider population size where appropriate.

This thesis is highly exploratory, as it explores the already existing operational capabilities, CCPs, and the risks and challenges affecting their SCP to propose KPIs to optimise the dairy producers' operational performance. The RQs are mostly exploratory seeking to explore, understand, and characterise the operational practices in the Egyptian dairy sector. The study provides a theory development represented in the provision of improvement practices that can represent a best practice to the Egyptian dairy industry. This thesis is based on multiple data collection methods which will be explained under the following headings. The data sources address "what and how" kind of questions. The questions are mentioned previously under Section 4.2.

The exploratory study is based on the belief that a deeper and richer understanding of the phenomenon comes from people who are experiencing it. The inductive approach is based on the interpretivism philosophy, where limited or no-data is available and usually associated with the qualitative research method (EL-Gazzar, 2013). This thesis generates empirically practical insights toward the capabilities of the large Egyptian dairy producers by engaging with the key actors in their SC. It is supported by interviews, observations, and FGs to ensure the research reliability and achieve the framework's applicability on the entitled investigated sector. This is important because the Egyptian dairy producers are striving to enhance their operational and SCP to fulfil the market demand with safe dairy products as explained in Chapter One-Section 1.3.

3.3.5 Research Theory and Approach

According to Ridder (2017) there are three classifications for the theory continuum: building theory, developing a theory, or testing a theory. First, when building a theory, the researcher starts with a critical description of the research phenomena to build a theory. Second, developing a theory, in this case a preliminary theory exists, and the researcher develops, refine, or modify this theory. It is recognized by adding new components to an existing theory and explaining the measures. Last, testing theory is identified when the theory constructs, variables and relationships are well identified and measurable, it matches the quantitative hypothesis testing.

There are several organisational theories (OT) that exist in business and SC research. Thus, this thesis belongs to the second classification by extending to the three selected OTs; RBV theory, institutional theory, and network theory, as a lens through which to explore the research problem, not necessarily test, but to build and augment theory. Accordingly, this thesis contributes to the OT by taking those theories as a base to propose a best practice framework, which has been explored in this thesis.

According to Ridder (2017), logistics research is mostly affected by the economic and behavioural approaches to scientific research. Particularly, the area of logistics requires explanatory approaches through the adoption of multidisciplinary methodological pluralism. Besides, most of the logistics literature lacks orientation towards theory development and implementation. To overcome this lack of orientation, Ridder (2017) proposed a robust framework in the form of theory development. Moreover, Corley and Gioia (2011) highlighted that the theory must have a utility in terms of its applicability for both academic researchers and practising professional managers. A good theory should be practical, as it advances knowledge in a scientific discipline, guides the research towards specific questions, and enlightens the management profession. There must be an internal consistency of the good theory, which is usually achieved by carefully specifying and limiting the scope. Further, it is important to build your research based on a specific relevant theory contributing to the researched area. Thus, following a specific theory provides a clarification of the factors that are essential to the entitled research and the other factors to overlook. The goal is to identify where the theory is adequate and where it is lacking and needs further research (Rogers et al., 2006).

According to Sweeny et al. (2015), there is no specific unified theory of SCM or logistics. There is variation between theory and practice in the SCM field. Expansion of the research design to incorporate case-studies as research methodology has the potential to generate new SCM theory. That helps in facilitating a thorough understanding of the SCM phenomena. This insufficiency can be covered by a mix of three theories that reflect the SCM relations and measuring its performance to create a best practice for similar firms with similar structure. That is noted in the selected theories to formulate a compiled framework to present a best practice to the Egyptian dairy producers. The RBV theory identifies the operational capabilities and CCPs. Then, the network theory investigates the potential available risks and challenges residing between the SC members. This emphasises on identifying the SCOR model SC attributes. Last, applying the mimetic institutional theory has been utilised to create a best practice framework by comparing between the operational capabilities, CCPs, and KPIs of the selected six cases to reach the optimum state. Nevertheless, the researcher kept being open-minded in terms of what emerges from this qualitative study in terms of theory and insights.

The empirical work of this case-based thesis consists of three qualitative data collection methods to provide an in-depth understanding and analysis of the proposed framework. Those are: semi-structured interviews, observations, and FGs. While the context of this thesis is an empirical study in Egypt, the research findings and results could be generalizable to similar geographical areas with the same conditions referring to (Sweeny et al., 2015). That supports the theory development to assess and analyse the results which helps in describing and predicting the possible scenarios to improve the operational and SCP for the Egyptian dairy producers against potential risks and challenges. Accordingly, Egypt is chosen to be the core context of this thesis as it witnesses an increase in the dairy products consumption rate and a potential to re-open to the global market through increasing the dairy products exports (Euromonitor, 2017). Considering this potential, Egypt needs more investment and improvement in the operational phase of the dairy sector to increase the amount of production and the quality of products according to the global safety measures. Therefore, enhancing the operational capabilities of the large Egyptian dairy producers is required to enhance the production of safe and secure dairy products. That has been achieved by comparing the large Egyptian dairy producers' KPIs to (APICS, 2018: Moazzam et al., 2018) validated KPIs to dairy producers in New Zealand. Such producers in New Zealand are considered global market leaders in the dairy sector.

This thesis follows a comparative case-studies research approach. It answers the "what" and "how" RQs. The qualitative case-study is considered as a feasible research strategy where additional cases can be studied to benchmark the performance measurements. The case-study methodology enables the researcher to investigate the real-world with an in-depth investigation of the selected cases (Ridder, 2017). Moreover, the use of cross-case analysis allows the researcher to cover distinctive elements of the cases covered and obliges the researcher to look further over the initial impressions and responses, which improve the analysis of the data to create a more accurate and reliable theory. Comparing different cases to find a pattern, or a conflict generalises results and therefore makes the findings stronger (to Sekaran and Bougie, 2011: Mason, 2002).

A brief on the relationship between the research philosophy, approach and strategy is provided in Table 3.3.

Table 3.3: The Relationship Between Research Philosophy, Approach and Strategy- Source: (EL-Gazzar 2013:P.112)

Research Philosophy	Research Approach	Research Strategy
Positivism	Deductive	Quantitative
Interpretivism	Inductive	Qualitative

Also, Figure 3.3 illustrates the role of theory in both approaches. The deductive approach is related to testing an existing theory and inductive approach related to building a new theory or developing an existing theory (Haddad, 2016: Sweeny et al., 2015).

Figure 3.3: The Role of Theory in Inductive and Deductive Research- Source: (Haddad 2016:P.89)

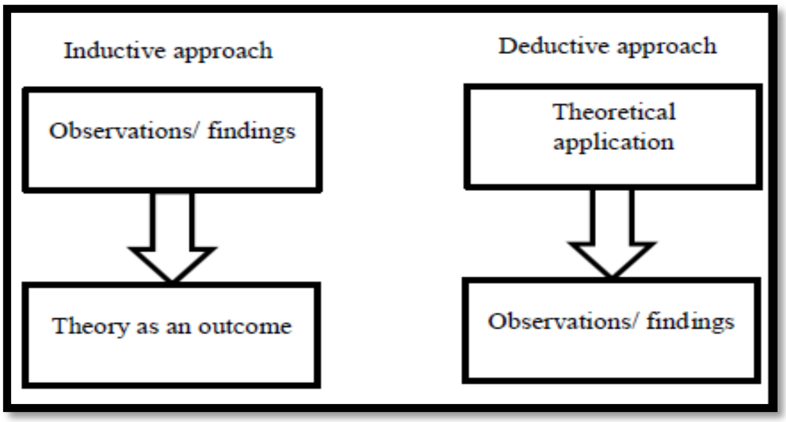


Table 3.4 summarises the main differences, then followed by separate subheadings explaining each approach in detail.

Table 3.4: Differences Between Inductive and Deductive Research Approaches- Source: (Haddad 2016:P.90)

Inductive Research	Deductive Research
-Gaining an understanding of the meaning humans attach to events. -A close understanding of the research context. -The collection of qualitative data. -A more flexible structure to permit changes of research emphasis as the research progresses. -A realization that the researcher is part of the research process. -Less concern with the need to generalize.	-The need to explain causal relationships between variables. -The collection of quantitative data. -The application of controls to ensure validity of data. -A highly structured approach. -Researcher independence of what is being searched. -The necessity to select samples of sufficient size to generalize conclusions.

In the deductive approach the research moves from the general view to the particular. It is characterised by the causal relationship, appropriate for both quantitative and qualitative data. Also, it is a structured methodology suitable for replication, and generalisation. It relies on existing theory and tests it by developing hypotheses and using quantitative data analysis (EL-Gazzar, 2013). In addition, it provides explanations and predictions to the theories. It is consistent with the positivism paradigm (Sekaran and Bougie, 2011).

Inductive research starts with the data collection, then analysing the data to create the theory based on it. It follows a more flexible structure to allow changes in the research focus and less concern on the generalisation issue. Usually, it works with qualitative data to obtain insights into the interpretation of an event. Also, it provides facts obtained through observation (Sekaran and Bougie, 2011). Therefore, qualitative studies are helpful in developing a thorough understanding of a phenomenon by capturing rich data (EL-Gazzar, 2013).

In summary, this thesis follows the inductive qualitative research approach, which better suits exploratory research. It has been conducted by using a mix of data collection methods including, in-depth semi-structured interviews, observations, and FGs to explore the research problem from different perspectives. According to (Saunders et al., 2009: Greener, 2008), the researcher moves through the research in three steps by following the inductive research approach. It starts with semi-structured interviews supported by observation, then FGs, to validate the framework's constructs to develop the theory. Relying on specific theory helps in clarifying the different theoretical perspectives that address a particular research problem. Also, it provides a lens that focuses on specific factors to be considered in the study and factors to overlook (Zsidisin et al., 2005).

3.4 Case-Study Research Design

There are many definitions of the case-study, it is defined by Easton (2010:119) as: "*a research method that involves investigating one or small number of social entities or situations about which data are collected using multiple sources of data and developing a holistic description through an iterative research process*". Another definition provided by Yin (2014:109) as *"an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident*".

Case-study is considered a powerful research methodological approach in developing concepts and theories in OM. Especially in exploring new areas of research, which contribute to building new theories or integrating new concepts in new contexts. Qualitative case-studies in OM involve both the human and the physical elements of the organisation. Most qualitative case-studies in the OM research adopted the inductive approach describing the phenomenon of single or multiple case-studies and analysing the data across the cases for comparison (EL-Gazzar, 2013). Besides, multiple cases allow replication between cases (Ridder, 2017). Further, according to EL-Gazzar (2013) multiple case-study design strengthens the validity of the research, which represents an addition in the OM research field.

Case-studies involves in-depth and contextual analyses of certain situations in organisations, and it provides a full view of the phenomenon. There is an argument that, one of its drawbacks is that it cannot be characterised as a problem-solving technique or used to make broad, thorough generalisations across the population, however it has a high level of internal validity. Some organisations also hesitate or refuse to reveal their weaknesses and problems. Also, sometimes it involves some participants who might disagree with the data interpretation, but they were considered to assure the data trustworthiness. Also, it requires a high level of commitment to manage extensive amounts of data (Mason, 2002).

Qualitative case-studies are recommended in solving problems in current situations by applying solutions based on past problem-solving experiences (Sekaran and Bougie, 2011). Therefore, extensive research and interviews with many experts directly involved in the research area might have to be undertaken to explore and understand the phenomenon.

Case-study research investigates a real-world phenomenon with in-depth investigation in the real-life context. The non-random sampling best suits the case-studies; however, it does not represent a larger population like the quantitative research. In order to provide detailed case description, the researcher needs to rely on triangulation data collection methods. Cross-case multiple analysis and within-case analysis requires the focus on interviews and observations with participants. Cross-case systematic analysis shows the similarities and the differences between the cases studied which may affect the findings (Ridder, 2017). Supporting that, Yin (2014) mentioned that the case-study provides a holistic investigation with detailed characteristics of the included cases with real-life events. Thus, this thesis conducts an individual and cross-case analysis approach by using semi-structured in-depth interviews, observations, and FGs within the selected cases to investigate the applicability of the proposed framework. Although it provides in-depth investigation with valuable raw data, it consumes lengthy periods of time to coordinate with the participants and get approval for participation in the research. Also, it resembles a source of bias in selecting the research participants and strict the researcher to the participants who are willing to participate and to the amount and type of data they can share. But, as this research is rarely investigated, therefore, this is the most appropriate methodology to qualify the researcher to collect the suitable data for the research aim.

According to Ridder (2017) there are four designs of case-studies that need to be reviewed; first, the *no theory first* concept in the exploratory research, the cases should be chosen according to its relevance to the phenomenon of interest and the deep insights related to this phenomenon. In this design, the RQ may get modified during the research and it avoids propositions regarding relationships. Qualitative data triangulation works best in this situation, represented in interviews, observations, and documents.

Second, the gaps and holes design, in contrast to the first design, focuses intensively on existing theory. It is based on specifying gaps in the previously existing theory and literature with the goal of advancing theoretical explanations for it. It includes the “how” and “why” questions. Afterwards, propositions or framework shall be developed to provide direction and guide the search for evidence and reflect the theoretical perspective (Ridder, 2017). Based on Yin (2014) the gaps and holes have RQ, built based on existing theory, propose propositions, and have a framework to be followed. It relies mainly on purposeful sampling and generates mainly qualitative data. The analysis primarily is based on pattern-matching, where the findings shall be consistent with the framework. The ‘gaps and holes’ is the case design followed in this thesis. The research is driven by the RBV theory, the network theory, and the institutional theory. It goes through two phases exploratory to develop the research constructs, then explanatory to validate the proposed framework. That was supported by non-probability purposive theoretical sampling to the selected dairy producers included in the comparative case-studies.

Third, the *social construction reality* is known by its philosophical assumption. There is no unique real-world existence independently away from any human interaction. There is no RQ, but the research is led by curiosity. In this case design, the researcher does not seek generalizable patterns. This scenario does not aim at building theory, however, it is directed and shaped by the interest of the case (Ridder, 2017: Creswell et al., 2007).

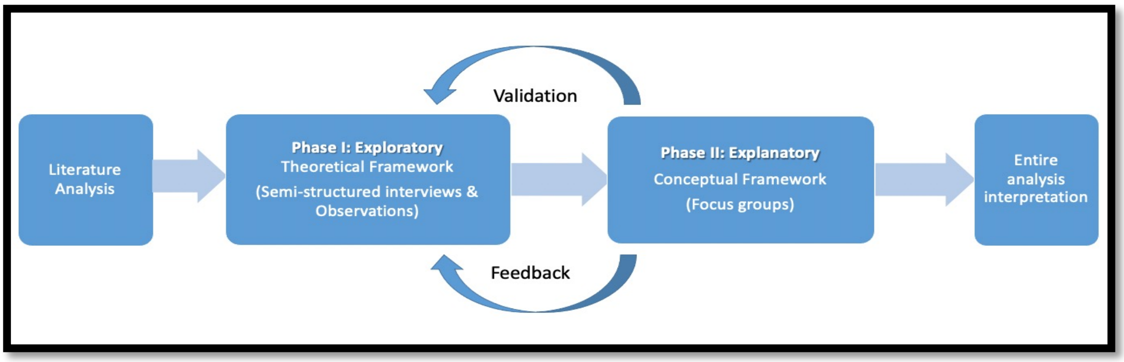
Fourth design, identifying *anomalies* for further research which is commonly used in management and organisation research. The RQ here cannot be explained by existing theory. Researchers focus on the interesting and surprising factors that cannot be proven by existing theory. Therefore, the theory is expected to be improved (Ridder, 2017).

Then, there are three phases of the theory continuum. Those are theory building, theory development, and theory testing. The first phase matches the no theory case design, where there is no theory explaining the phenomenon. The second phase matches the gaps and holes case design, where the theory exists but partially understood, so it is called theory driven. Third and last phase, theory testing, in both gaps and holes and the anomalies, the phenomenon is clear and understood with the availability of an extended theory (Creswell et al., 2007). In the case of creating a theory, it expands the relationships between the single case constructs (Sweeny et al., 2015). Linking the case-study design to the theory is necessary to be clarified. The exploratory case-study research design contributes towards the theory by facing a challenging role to refine, verify, or test theories. This thesis builds on the three theories: RBV, Institutional, and network theories by exploring them in the Egyptian dairy sector context.

Afterwards, case-study designs have two categories that suit two dimensions. Those categories are first, holistic case design suits the single unit of analysis dimension. Second, embedded case design suits utilising multiple cases' analysis design. The design of case-study research whether it is *holistic* or *embedded* case design, has four stages according to EL-Gazzar (2013): case design, data collection, case-study evidence analysis and writing the report. That leads to the fact that there are three types of case-studies that vary according to the research purpose: *intrinsic*, *instrumental,* and *collective* case-studies. First, intrinsic case-study, applied when the researcher needs to study and focus on a particular case not to gather general insights and understanding of different problems. Second, instrumental case-study, needed when the researcher understands or focuses on something else. Third, collective case-study, which applied in this current research. It is used when the researcher needs a general understanding of specific RQs and research problems by studying a particular case or multiple cases to reach a level of representation.

The fundamental aim of the thesis is investigating how to improve the operational and SCP of the Egyptian dairy producers to ensure the production of safe and secure products. Figure 3.4 illustrates visually the phases of the case-studies research design to answer the RQs.

Figure 3.4: Process Flow of the Case-Study Methodological Approach Design- Source: Author



While the literature review has helped to explore the research area, identify gaps, and develop a theoretical framework in relation to the RQs, empirical research is required. This thesis builds on the gaps in the literature by utilising key theories, RBV theory, institutional theory, and network theory to help develop a list of key operational and SC KPIs within a framework applicable to the Egyptian dairy sector.

The overall thesis methodological approach employed in this thesis is a case-study; the thesis uses cross and within case-studies and deploys interviews and FGs instruments, as part of these. This approach provides a deeper understanding and exploration of the phenomenon in what is a relatively scarcely understood area.

Supporting the implementation of the current case-study research, according to Wibowo and Sholeh (2015), the researcher should investigate the SC materials' procurement to research the possibilities of adopting the applicability of the SCOR model in the dairy industry by conducting a case-study. The first step in the SCP measurement is identifying the KPIs from the SCOR model. The proposed conceptual framework centred around the SCOR model attributes that is validated for application to the Egyptian dairy producers. The exploratory nature given to primary RQs attempts to be reflected in the semi-structured interview questions as part of the overall research design. The interview questions are structured around SCOR model 'make' attributes and operational capabilities affecting the SCP.

This thesis is divided into two key phases which comprises six cases (Figure 3.4). The first phase is exploratory by conducting semi-structured interviews and observations to validate the proposed theoretical framework for the selected cases, which was generated from the literature review process. This phase answers the first four RQs; 'what' and 'how' type of RQs. RQ1: to explore and identify the operational capabilities, including the CCPs. RQ2: identify the risks and challenges affecting the provision of safe and secure dairy products. RQ3: identify how dairy producers overcome the existing risks. RQ4: explore the existing KPIs in the included cases. The sampling strategy for this phase is non-probability theoretical sampling of the selected dairy producers, with a focus on within and cross-case analysis. The second phase is explanatory, involving conducting FGs to refine and validate a best practice framework. Explanatory research answers RQ5. It explains 'how' to improve the performance of the Egyptian dairy producers by introducing a best practice framework. Figure 1.5 illustrates how each RQ has been answered by positioning them on the framework's elements and highlighting the data collection methods and the interview's questions to answer them.

Explanatory analytical logic deals with the cases as a whole rather than parts (Mason, 2002). This has been achieved by providing explanations of the data analysed and comparing the cases. Multiple data collection methods including semi-structured interviews, observations, and FGs are used to enhance the construct validity and provide multiple measures for the phenomenon. This is because it helps the researcher to look at the same problem from different angles (Coyne, 1997).

This thesis adopts a case-study methodology, represented in empirical qualitative research. The reason behind the selection of the qualitative methodology to support the research is because previous research in the SC failed to cover different levels of gathering evidence from companies (Abushaikha, 2014). Assuring that, EL-Gazzar (2013) mentioned that the qualitative research explores a wide range of dimensions of a specific topic. This leads us to discuss the research sampling strategy and the data collection methods. Those are validity, confirmability, internal validity, external validity, and reliability.

3.4.1 Data Sampling

Sampling is the process of selecting a sufficient number of target populations (Carlile and Christensen, 2004). It is crucial when it comes to qualitative research (Robinson, 2014). The sampling process consists of five steps, starting with specifying the target population, then determining the sample frame, which leads us to the selection of the sample design, the sample size, and finally put this process in practice (Saunders et al., 2009). The sample strategy focuses heavily on the purposive theoretical sampling strategy to specify categories of participants to be included in the study.

The sample universe must match the research aim and questions; therefore, the researcher must face the trade-off between homogeneity/heterogeneity. As it leads the analysis and the results interpretation by defining who or what the study includes. Then, the sample size is determined based on both the theoretical and the practical considerations. There should be an inclusion and exclusion criteria to qualify or disqualify the cases for inclusion in the study. The more specific the criteria the more homogenous the sample universe (Robinson, 2014). Some obstacles may face the researcher in determining or reaching the sample. Those obstacles may include accessibility, availability of resources, and time constraints (EL-Gazzar, 2013).

Homogenous samples work best with interpretive phenomenology. On the other side, heterogeneous samples provide evidence that the findings can be applicable on different groups and achieves generalizability unlike the homogenous groups. Homogeneity can have many parameters: demographic, geographical, or history with common experience in the past (Robinson, 2014).

Inductive research most likely utilises a small sample size (Barnett et al., 2015), that might be more appropriate to focus on the context of events taking place in the research (Saunders et. al., 2009: Shaw, 2013). There are over 305 dairy private and the public factories in Egypt contributing to the Egyptian economy (Euromonitor, 2018). The focus in this thesis is on the processing stage in the large-scale companies, as they have the readiness and the necessary capabilities to qualify them to produce safe and secure products and engage in the global market. The sample frame is based on the top six large Egyptian dairy producers selected based on the most recent reports published by the Euromonitor (2018). Supporting the selection of six dairy producers, four of them are the most contributing companies in the local Egyptian dairy production were visited by Soliman and Mahhour (2011) and the top five dominating companies by Imam et. al. (2016). As a starting phase, twelve semi-structured interviews have been held with a diversified number of key informants to cover the scope of the interviews and validate the results. At least two interviews per company to be held to cover the scope of operations and supply side. That can be expanded to include more interviews if needed to reach saturation and ensure no new data is emerging. According to Haddad (2016), one to two informants is needed in each company as a source of information to provide the detailed information required and ensure continuity of information sharing with the researcher.

Those producers have the largest market share of the Egyptian dairy sector (Section 1.3) and yield the most profit which consequently contribute significantly to boosting the Egyptian economy. As, the sample design is non-probability purposive theoretical sampling. That leads us to determine the sample size represented in the number of interviews that have been held to reach the data saturation. They are located in the largest two cities Cairo and Alexandria in Egypt where they are the primary sources of daily fresh raw milk, and the largest number of factories are located near those big cities. Besides, those large dairy producers have better dairy products offerings, product quality, and the availability of refrigerators.

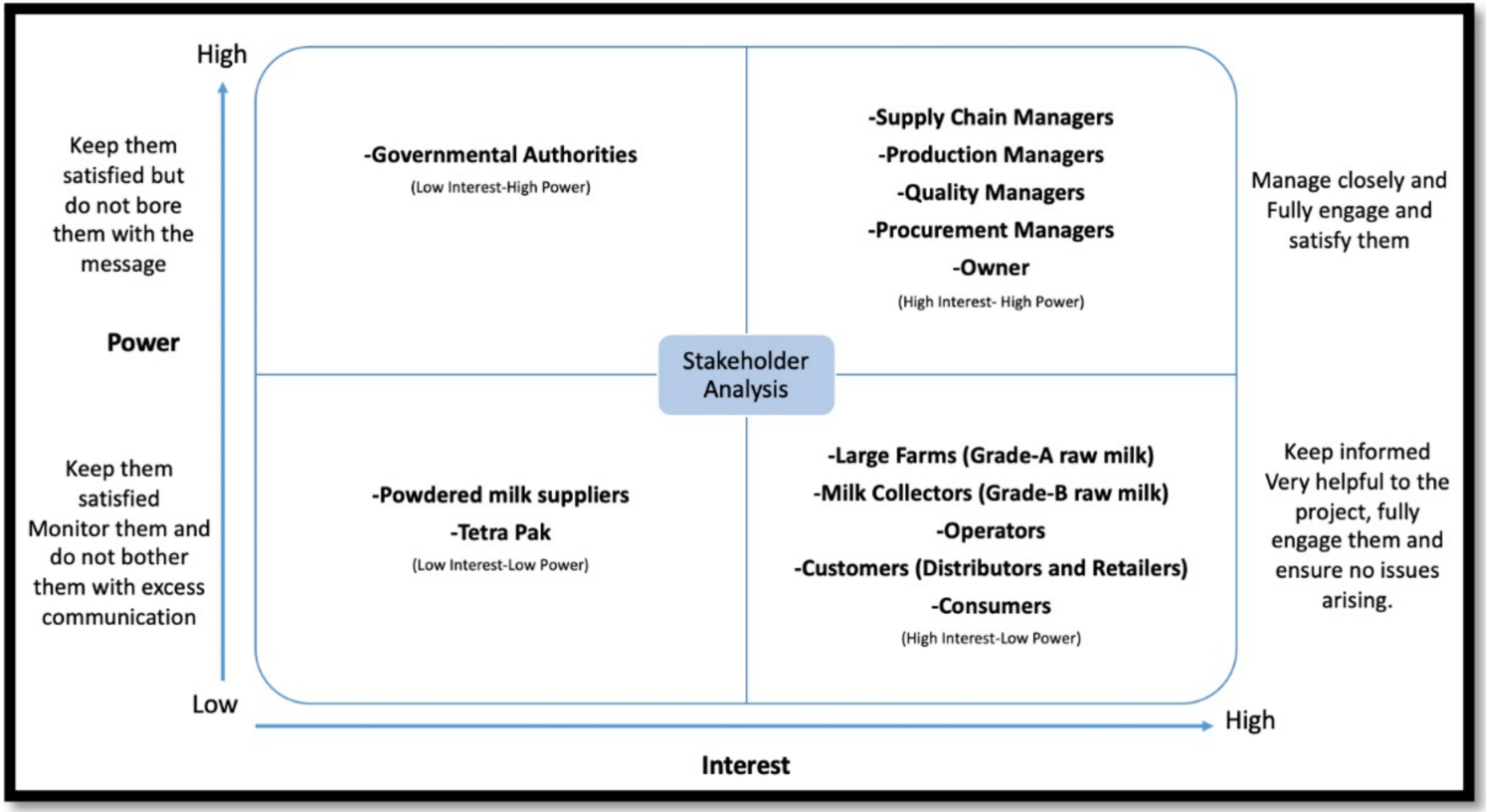
The sampling plan should direct the research to include a variety of participants to the thesis. They should have a thorough investigation of the phenomenon from different viewpoints and go through all the length and depth of the investigated area to gather rich data and ensure the data saturation. Those participants can link the researcher with a variety of key experts in the sector (Moser and Korstjens, 2018: Coyne, 1997).

The *theoretical sampling* strategy aims at reaching theoretical saturation by testing, elaborating, and refining the themes and categories for validity. It is a kind of non-probability purposeful selection for the participants to address the emerging theory (Saunders et al., 2009). The participants' selection happens simultaneously with the data collection phase. The guide to ensure that the researcher obtained enough in-depth data is to review the findings of the analysis until no new codes appear, and the existing codes keep repeating (Morse, 1995: Mason, 2010: Rijnsoever, 2017).

The saturation ensures qualitative research validity and displaces its subjectivity. Breen (2006) and Mason (2010) noted that theoretical saturation is normally reached after 10 to 12 interviews, depending on the research phenomena and if the informants share common characteristics and have homogeneity among the selected population. This will unfold throughout the data collection and analysis.

The key informants' selection is based on their high level of education, knowledge, and experience regarding the dairy production processes and the SC to understand the interview questions. They include managers in SC, production, quality, and procurement, who are aware of the operational processes within the companies, the key informants of this research problem within each case. At least one informant is selected operating within the factory and one or more key informants are selected covering the SC in general, including the suppliers and the quality control requirements for that company. Thus, that qualifies them to provide the information needed to validate the proposed framework and crucially answer the aforementioned RQs. A stakeholder analysis mapping exercise was completed (Figure 3.5) for the Egyptian dairy industry to ensure the researcher sampled the correct key informants. This determined the stakeholders (i.e., key informants) who have high power-(impact) and high interest-(influence) in the implementation of the proposed best practice framework. The researcher included other stakeholders (extending outside the dairy factory like; members from governmental authorities, packaging suppliers, and food safety authority) in 'Phase Two' to validate the framework constructs from the literature review and the interview process. This helped to increase the heterogeneity of the overall sample and test for theory saturation. As often, although these stakeholders are not directly working in the operation, they can have a significant impact on the operational processes themselves. This helps to increase the heterogeneity of the overall sample for the thesis and ensures the data theoretical saturation.

Figure 3.5: Key Informants (Stakeholder) Identification-Source: Author



There are two major types or techniques of sampling design, those are probability and non-probability sampling. The non-probability sampling techniques give the research the opportunity to select the sample purposively and reach members of the population who are difficult to identify (Saunders et al., 2009). The non-probability purposive sampling serves best at the multiple case-studies (Robinson, 2014). It is used here to collect specialised informants from the dairy SCs and their willingness to adopt the proposed framework. Consequently, the use of any other sampling design would not offer opportunities to obtain specialised information. As the purposive sampling is restricted to specific managers who can provide information related to the research (Sekaran and Bougie, 2011). The managers interviewed were highly aware and involved in the operations and SC processes of their companies. The precise type of professionals who can provide the needed information. That is because they conform with the research criteria and because they are the only knowledgeable ones in the researched area. The logic of selecting purposive sampling is based on the case strategy related to the RQ(s) and objective (Saunders et al., 2009).

In the purposive sampling, the homogeneous sampling provides an in-depth understanding of the studied cases by focusing on one specific sub-group similar in characteristics (Saunders et al., 2009). Therefore, this thesis focuses on a homogeneous sample of top-level managers who share common demographics. They have experience and expert knowledge, as they have gone through processes and the experiences themselves. Their selection might provide precise data and information to help the researcher. Generalizability of the findings is considered a challenging issue, due to relying only on the experts who are chosen by the researcher. However, it is the only suitable sample to obtain the needed information.

Theoretical sampling used to test, elaborate, and refine the themes and categories for validity. It is a kind of purposeful selection for the participants to address the emerging theory. Through the application of theoretical sampling, the researcher can confirm the importance and the meanings of all patterns and categories and explain the relation between them. It also reveals and compares the data analysis findings with new data and additional cases if required (Coyne, 1997).

Coyne (1997) argues that there is no difference between purposeful sampling and theoretical sampling. However, theoretical sampling is a rigorous tool to create a theory through qualitative data analysis. But some researchers mentioned that there is a difference between them. In purposive sampling, the researcher selects the most informative participants based on his/her judgment. Meanwhile in theoretical sampling, the researcher selects the participants simultaneously with the data analysis according to the emerging themes, patterns, and categories to ensure the adequate representation of the theoretical concepts until the researcher reaches the theoretical saturation (Moser and Korstjens, 2018).

Usually, the sample size is small in qualitative studies (Moser and Korstjens, 2018). It is determined based on the conceptual requirements of the study. As this thesis follows the purposive theoretical sampling, the participants are selected deliberately based on the predetermined selection criteria, as they hold the required knowledge to provide the needed data and insights that works on answering the RQs through the data analysis and comparing the results with the pre-designed framework and with previous literature findings (Baker and Edwards, 2012: Mason, 2010).

Case-studies are the most difficult types of qualitative research to classify. Several research articles concluded that there is no specific number of interviews determined in qualitative research (Ploutz-Snyder et al., 2014: Barnett et al., 2015). They specified a set of four to five interviews per case-study. One problem may emerge when the researcher specifies a range for the selected sample size, they may fail to justify the rationale behind this selection (Marshall et al., 2013). Although many researchers perceive that qualitative research cannot be generalised, however, it produces thorough investigation and generalizable applicability on research with similar scope, theories, or situations. This generalizability can be achieved through the theory not from the population by quoting statements from the large portion of interviews held in each case-study (Greener, 2008). Also, variation in the sample adequacy argument and participants with different specialisations under the same scope of research may overcome the lack of sample size, represented in the interviews held. Therefore, involving informants as a source of data enhances the construct validity of the case-study. Using the same procedure in all cases ensures external validity. Also, the sample of qualitative research approach is usually smaller than the quantitative because it is more about data saturation to sufficiently explore the research phenomenon (Moser and Korstjens, 2018). Therefore, this was considered in the FG design to extend the time of the FGs, send the questions in advance to the participants, ask the participants to interrupt and ask for clarifications or expand the questions if they feel confused about the answer. This ensures that the participants understand the questions and avoid misinterpretations or irrelevant answers and discussion (Nyumba et al., 2018). At least one to three FGs to be held on the investigated cases to validate the framework. The assigned participants for the FGs in this thesis are diversified stakeholders in the dairy chain including governmental authorities and ministries, suppliers, and practitioners from the dairy producers to validate the results of the interviews and the proposed framework's applicability in the Egyptian dairy sector. That should support the research data saturation.

The most used data collection tools to fulfil the data saturations are face-to-face in-depth interviews, observations, and FGs (Moser and Korstjens, 2018). Also, Mason (2010) mentioned that the sample size and the data saturation differ according to the research design, purpose, and questions. The goal of data sampling is to obtain rich and thorough information about the researched topic which consistently matches the research methodology and approach. So, the guide to ensure that the researcher obtained enough in-depth data is to review the findings of the analysis and compare it to the literature and support the arguments by quotes from the interviews, either supporting or contradicting the proposed framework (Moser and Korstjens, 2018).

According to Luborsky and Rubinstein (1995), good research needs a degree of flexibility to utilise multiple approaches in the conceptualization and the measurement for the phenomenon. There is no guide to a determined number of observations and/or interviews to be held. However, it is about the richness of the information provided and provide alternative interpretations of the data in the data analysis. By doing that, the researcher can achieve the credibility and validity of the findings. Therefore, the richness of the data achieves the data saturation rather than the large quantity of data. Morse (1995:147) referred to the data saturation as "data adequacy". The researcher should give the provided data an equal consideration and ensure that no data are ignored in the analysis.

According to Rijnsoever (2017) from an inductive qualitative research perspective, the theoretical saturation can be reached when all the themes, categories and codes are observed in the sample and the data starts to repeat itself. This means that no new themes are emerging, neither new meaning or explanations to the concepts/codes and the inter-relationship between them. Also, the saturation ensures qualitative research validity and displaces its subjectivity (Lakatos, 1989: Rijnsoever, 2017).

To fulfil the theoretical saturation, each theme and code should be observed at least once. Larger themes/codes require more sampling steps to investigate them all. Those themes are determined based on the predetermined research theoretical base in the literature. Mason

(2010) mentioned that the frequency of the theme or code occurrence is not critical in qualitative research rather than its explanation and its relevance to the framework analysis. So, it is a must to achieve theoretical saturation to ensure that the research phenomenon is fully explored, and the results are valid (Morse, 1995).

Most qualitative inductive research relies on the researcher's judgement; therefore, the researcher should have the following skills: flexible thinking, knowledge, experience, and tactical analysis (Rijnsoever, 2017: Mason, 2010). Such expertise can reduce the number of participants needed to obtain the required data and fulfil the data saturation (Mason, 2010). Accordingly, there are no rules for sample size in qualitative research other than practical reasoning. The sample size depends on "*what you want to know, the purpose of the inquiry, what's at stake, what will be useful, what will have credibility, and what can be done with available time and resources*" (Marshall et al., 2013:12). Therefore, the sampling must be representative, based on the sample design chosen. As the purpose of the study is exploratory and the sample selected is limited to predetermined selection criteria, that ensures the selection of purposive sampling as the most suitable for this thesis until the researcher reaches the data saturation.

Morse (1995) recommends that the more specific and cohesive the sample, the faster saturation can be achieved. Achieving theoretical saturation helps in developing a comprehensive framework. The concept originally evolved for grounded theory research but still can be applied to all qualitative research based on interviews as the data collection source (Saunders et al., 2009). The saturation concept can be reached when all the data needed are covered until nothing new is added and no data returns anymore (Saunders et al., 2009). Therefore, saturation is the key for qualitative research and estimating the sample size is directly correlated to the saturation concept (Marshall et al., 2013). As recommended by Saunder et al. (2009) and Breen (2006) when the research aims at understanding commonalities within a homogenous group of companies, twelve in-depth interviews are sufficient. In addition, the data saturation can be supported by personally held observations to the selected cases.

Also, Moser and Korstjens (2018) recommended an estimated minimum number of interviews which varies according to the research design either phenomenological, ethnographic, grounded theory or content analysis. This ranges between less than 10 interviews for the phenomenological to 50 interviews for ethnographic. Marshall et al. (2013) also mentioned that the minimum acceptable sample is 5 to 25 interviews for phenomenology research and 15 for all qualitative research. Besides that, Mason (2010) stated that 10 participants are enough to establish a reliable consensus. If they share common characteristics and have homogeneity among the selected population. Moreover, the researcher can achieve the quality assurance process when he/she uses the sample size proposed and determined in the design phase (Mason, 2010).

There are several factors besides the nature and the scope of the research that can affect the number of interviews needed to be held to achieve the saturation concept. So, data coverage is the key to determine the number of interviews per case. The responsibilities and level of involvement of the participant in the investigated cases vary according to the duties of each job position. Therefore, at least twelve interviews should be made to cover the main aspects of the study (Breen, 2006). Based on preliminary contact with the entitled companies, at least two experienced knowledgeable managers are responsible for the provision of all required information related to the proposed framework as key informants. Thus, two to three interviews with operations, quality, and/or SC managers who have sufficient information related to this thesis per case should be held among the six cases.

The selection of the key informants is based on their education, knowledge, and practical experiences in the field, to provide in-depth information about the dairy producers' operations and SCP. This number should be the minimum number of interviews to fulfil the predetermined framework with meaningful themes and useful interpretations of the findings until reaching the theoretical data saturation. Nevertheless, the researcher might face some constraints or challenges. Those are high resource-intensive, high time dedication and commitment, and mentally challenging (Marshall et al., 2013). Moreover, these interviews are supported by the industry and government reports and documents to enhance data saturation (Coyne, 1997).

The same cases are chosen for empirical contribution to the theory by investigating the conceptual framework. FG includes the same cases to examine the previously provided research constructs and reach the data saturation to contribute to developing/modifying the selected theories. That work on answering the RQs and the research objective sufficiently.

Based on that, the following chapter will include the detailed data analysis steps followed to reach the data saturation by using NVivo12 software. This detailed description will allow fellow researchers to replicate the analysis following the same procedures to fulfil the research reliability as one of the qualitative research quality tests.

3.4.2 Data Collection Methods

This section reviews the data collection methods used to gather all relevant data needed to accomplish this thesis. Multiple data collection methods contribute to the research accuracy (Haddad, 2016). So, the primary data for this thesis are collected in two phases with the six dairy producers. It includes semi-structured exploratory interviews with managers in the companies and observations in phase one, and FGs including different stakeholders from the dairy SC to validate the framework in phase two. The observations' narratives include process descriptions and illustrations of the cases. The interviews have been held on a face-to-face basis and telephone calls according to the practitioner's convenience. Then, supported by FGs as a final data collection phase to validate the data from the investigated cases. Therefore, key informants were selected to ensure construct validity. However, those informants might disagree with the results or the interpretation of the first exploratory phase, but they ensure the presented data are unbiased (Yin, 2003). The use of various data sources ensures that the problem is explored through more than one angle and allows multiple facts to be revealed (Sekaran and Bougie, 2011). That is to benchmark a performance measurement that can be applied by the Egyptian dairy sector.

Table 3.5 summarize the key advantages and disadvantages of the data collection methods utilised.

Table 3.5: Advantages and Disadvantages of Interviews, Observations and FGs- Source: (Sekaran and Bougie, 2011: PP.214-215)

Data Collection Method	Advantages	Disadvantages
Interviews	-Establish rapport and motivate respondents. -Clarify the questions, clear doubts, add new questions. -Nonverbal cues. -Use visual aids to clarify points. -Rich data can be obtained.	-Costs more when a wide geographic region is covered. -Respondents' concern about information confidentiality. -Can introduce interviewer bias. -Respondents can terminate the interview at any time.
Observations	-Reliable data free from respondents' bias. -Other factors was not considered before the observations may emerge and some meaningful patterns may get noticed.	-It is necessary for the researcher/observer to be present, takes long periods of time. -It is slow, tedious and expensive. - Researcher/observer bias in recording and interpreting the data.
Focus Groups	-Flexible in terms of location and time. -Genuine opinions, thoughts, feelings and ideas about the topic. -Relatively inexpensive. -Provide dependable information in short time. -Best suit the exploratory research.	-Provides only qualitative information. -Members are not selected scientifically to represent the populations' opinions to ensure its representativeness.

The data collection methods of this thesis will be explained as follows. The combination of the previously mentioned tools are used to validate the research results and strengthen its reliability. They are categorised to **Phase One- Exploratory:** ***Interviews*** and ***Observations and*** **Phase Two- Explanatory:** ***Focus Groups***

3.4.2.1 Interviews

Swetnam (2004) stated that interviewing is a method of collecting data that can stand on its own or be a follow-up process to another method. One comparatively short interview can take an hour to organise, an hour to carry out, and half an hour to reflect on. But it generates data which may not be feasibly obtained from any other data collection method (Mason, 2002). The basic choice is between structured or unstructured interviews. The structured interview uses standard predesigned questions which enable the responses of different individuals to be compared. A semi-structured approach may trigger spectacular and personal information that changes the entire development of work. Inevitably, the less the structure, the greater the skill is required for interpretation (Swetnam, 2004).

Another exploratory research by (Curkovic et al., 2013) studied how companies use the FMEA in managing their risks. Highlighting the high importance in managing risks through focusing on the supplier assessment and selection. Semi-structured interviews with the entitled SC managers, followed by a survey used to test the applicability of the FMEA for SCRM in the selected companies. The survey includes different kinds of questions varied between Likert scaled and open-ended questions. These questions represented in mentioning the kinds of risks that the company faced and what are the techniques or tools used to identify and mitigate those risks.

Two pre-testing interviews were held with two industry experts from two companies to ensure the clarity of the questions and their relevance to the respondents as a preliminary step before conducting the exploratory interviews. Then, the exploratory phase includes seventeen semi-structured individual interviews conducted across the six case-studies with operations, quality, and SC professionals. These interviews are supported by two in-depth observations held by the researcher at two dairy producers, who permitted access to their factories and one farm. Based on preliminary contact with the case companies, two to three experienced knowledgeable managers per case were identified as key informants and subject matter experts as participants in this thesis. Consent to interview was granted (Appendix One). Additionally, following up emails for the participants and phone calls were used to improve the response rate and gain access. However, few challenges occurred. Few participants kept rescheduling the meeting at short notice because of their busy schedules. Nevertheless, some of them connected the researcher with their replacements. Those replacements are their managers or a more experienced colleague who is more familiar with the information needed to answer the interview questions. This familiarity is identified based on the brief outline of the interview questions, which has been sent or communicated with the participants prior to the interview.

The interview protocol includes seventeen guiding open-ended questions, written in English (Appendix Two), covering all elements included in the proposed framework (Figure 1.5). Those are subdivided from the RQs to discuss each element of the framework. Followed by a Likert scale to comprehend their self-perception on their performance regarding the SCOR attributes. The interview process started with a brief introduction to the research aim, the purpose of the interviews, and confidentiality. Followed by capturing the interviewee's demographics, including his/her gender, age (if they are willing to share it), years of experience in the field, and details about the dairy producer and their SC partners.

The semi-structured interviews took an hour on average with managers and heads of operations, quality, and SC departments. They are selected for their knowledge, managerial roles, and their involvement in the operations and SC aspects that need to be explored in the entitled companies. However, some interviewees were more curious about the research topic and had postgraduate research experience. So, they felt comfortable to speak for longer, unprompted, and provide thorough details in answering the questions, which extended the interview duration to reach up to two hours. Most of the interviewees were males, except one female in the procurement department. Their ages ranged approximately between the late thirties to early fifties. Plus, their years of experience ranged between one year to nine years in the entitled dairy producer. Still, most of them had previous experience in other dairy producers. That reinforced their selection credibility.

This thesis followed the contractarian business ethics approach, focusing on its strong compatibility with empirical research especially when it comes to studying companies' performance (Cudd and Seena, 2018). Accordingly, establishing trust is crucial with interviewees and assure them that the information are used for research purposes only and are kept confidential and anonymous throughout the research journey (Appendix Three and Four). So, the key was to ensure the confidentiality and protection of the data and interviewee by the researcher and engage in a reflexive research practice.

At least one interviewee from each dairy producer volunteered to sign the consent form on behalf of the other participants to represent the dairy producer's acceptance to participate in this research (Appendix One). Most of the interviewees accepted to have their interview audio recorded to ease the transcription only, however, some were uncomfortable with this audio being shared further to preserve the anonymity of their identity. Thus, the full transcriptions of the interviews were kept available for analysis, but the audio deleted thereafter. At the same time, most of them agreed to maintain contact after the interview to obtain any further information for the research if needed. A copy of the transcription was sent shortly right after the interview to the interviewee so that they could review it to ensure it reflected the accurate meaning of the contents. Table 3.6 consist of the interviews' details held.

Table 3.6: Completed Interviews

Interview no.	Company	Interviewee position	Date	Face to Face or Call
1	A	Corporate Quality Manager	31-Jul-19	Face to Face
2	A	Production Department Research and Development and New Projects	2-Sep-20	Call
3	A	Production Engineer	8-Sep-20	Call
4	B	Supply Planning Manager	29-Aug-19	Face to Face
5	B	Quality Assurance Head	12-Sep-20	Call
6	B	CEO Secretary and Operations Supervisor	22-Dec-19	Call
7	C	Manufacturing, Planning and Control	3-Sep-19	Face to Face
8	C	Continuous Improvement Team Leader	13-Sep-20	Call
9	E	Quality Manager	14-Feb-21	Call
10	D	Projects, Health and Safety Environment (HSE) & Maintenance Manager to the Manufacturing Sector	25-Aug-2019 +2-Sep-2020	Face to Face + Call
11	D	Group Procurement Manager	8-Sep-19	Face to Face
12	D	Milk Purchasing Manager	8-Sep-19	Face to Face
13	E	Plant & Operation Manager	4-Sep-2019 + 2-Sep-2020	Face to Face + Call
14	E	Foreign Procurement Manager & Supply Chain Planning	14-Sep-20	Call
15	F	Planning and Material Management Manager	7-Feb-21	Call
16	F	Supply Chain Manager	11-Feb-21	Call
17	F	Quality and R&D Manager	15-Feb-21	Call

These interviews are semi-structured. It is conducted face to face and on phone calls individually with the interviewee to ensure the accuracy of the information and to avoid overlapping information from different interviewees at the same time. They are selected based on the non-probability purposive sampling for their high relevance to the researched area, further explanation of the sample in Section 3.4.1. These interviews were held with specialised managers after contacting them with a previous arrangement for the appointment and follow-up calls as needed. The interview duration ranged from one hour to one hour and a half.

Arguably, the most critical aspect of research is its quality or validity (Sekaran and Bougie, 2011). Thus, in this thesis, semi-structured interviews were held supported by observations to identify the current KPIs in the large-sized Egyptian dairy producers using the proposed theoretical framework. Then, the FGs propose a validated version of the framework, including the KPIs to those producers in the form a best practice framework.

3.4.2.2 Observations

Observations are another valuable source of data collection method that is utilised in this thesis. They are necessary for exploring intangible practices. Literal reading of visual data and documented texts reflect reality (the ontology). They were held by the researcher for the entitled dairy producers. Evidence of the collected information is discussed with the interviewed managers for confirmation. It is documented in written notes. One of the benefits of using in-depth observations as a data collection method is its nature for covering a real-time event, and they are needed to investigate the internal processes within the organisation (Haddad, 2016). Observations support the qualitative research by allowing the researcher to become fully immersed in the study, either as an overt or covert participant researcher. In this case, the researcher was an overt participant observer held on a direct partially participating base where the researcher focuses on organisational subjects and takes part in the interactions (Ciesielska and Bostrom, 2018: Moser and Korstjens, 2018). The observer keeps his/her identity as an outsider to the environment and gets an opportunity to get closer to the research field without obstructing and interfering with their operations, stay aside, and take notes. According to Mason (2002), the researcher can ask the participants to read and comment on the documents. All these documents support answering the RQs. Fundamentally, observations helped the researcher to understand the environment in which the interviewees worked, and this helped to validate and underpin the interview process.

Observations have advantages and disadvantages. It provides access to silent knowledge (i.e., body language, team interactions) and facilitates gathering narrative data for a given situation (Ciesielska and Bostrom, 2018), generate diagrams to describe processes (Mason, 2002), and obtain reliable data free of bias (Sekaran and Bougie, 2011). The observation narratives include process descriptions and illustrative diagrams for the selected cases. Subsequently, copies of the diagrams were discussed with a key informant from the entitled case for accuracy check. All these documents support answering the RQs (Mason, 2002). The disadvantages are represented in the extensive time and effort needed by the researcher as an observer (Sekaran and Bougie, 2011). Thus, partial participation was held to avoid risks related to the location and the inability to participate as one of the operators and farmers in the dairy farms and factories.

Bias in observational studies should be avoided. It may be represented in recording errors, memory lapses, or errors in interpreting activities. The validity of the results of the observational study can be threatened by the respondents' bias. To ensure the data validity, it should be collected over a long period of time to ensure that the respondents behave normally, and their behaviour remains the same and has not been changing over the time (Sekaran and Bougie, 2011). That is what was achieved in this research.

Observations in general can include similarities and differences between what is mentioned in the interviews and what is happening in the actual field. It may include taste, smell, and touch, not just observing and hearing. It might include specifying distinctive odours or temperature of a certain place. Each field is different from the other. Detailed field notes should be transcribed into narrative if a recording was not possible due to any distractions or noise. Field notes are essential to record and analyse the observed settings and interactions within (Ciesielska and Bostrom, 2018). It is essential to focus on the framework being explored and observed and to focus on how and why you are observing it. As, the researcher can be selective in what is included in the observation and omit what is irrelevant (Mason, 2002).

3.4.2.3 Focus Groups

Focus group is an effective tool that can be used as a supporting tool to improve the research credibility and achieve industrial relevance. It can be considered as a group interview and belong to the interpretive research paradigm. When it is well managed it can provide useful qualitative data that can supplement the quantitative data and refine a conceptual framework. Also, it is used to explore the experts' opinions, previous experiences, and future expectations of the participants. Additionally, it helps in refining a conceptual model and providing further validation for it (Robinson, 1999). Therefore, it is used in this exploratory thesis as a secondary method supporting another empirical research method. Also, it is used to assess a detailed causal relationship provided by other methods i.e., interviews, to provide more depth of the investigated area and generalise the findings (Rodrigues et al., 2009).

It is an open-ended group discussion to explore a predetermined set of issues held for about one to two hours with five to eight or ten members with a moderator who leads the discussion on the topic (Sekaran and Bougie, 2011: Shaw, 2013). However, Rodrigues et al. (2009) determined that six to thirteen members per group should be balanced in terms of similarities and differences between them, to ensure the continuity of the group discussion. The participating members are chosen based on their education and experience. The FGs aim to notice and record the members' impressions, interpretation, and opinions regarding the discussed topic. The moderator is responsible for guiding the FG and keep directing the members on the intended purpose. He/she is also responsible for ensuring that all members participate in the discussion and expressing their own opinions and it's not dominated by only one member (EL-Gazzar, 2013: Sekaran and Bougie, 2011). Once the researcher reaches the theory saturation, he/ she can stop the process of collecting further data (Rodrigues et al., 2009).

FGs serve the best when the researcher needs to collect exploratory data for the research. It provides more critical comments than interviews. The success of this approach represented the quality of the outcome rather than the quantity (Robinson, 1999). It may be held by video conferencing if there are regional variations in responses and several FGs are needed. In this case, if the FG is not held by the researcher him/herself, trained and experienced moderators can manage each panel separately (Sekaran and Bougie, 2011).

In summary, applying FGs have both advantages and limitations. Starting with the advantages; cost-effective data collection method, provide the researcher with a high degree of flexibility in the research design, held with small group of experts that represent a huge population, group interaction provides the researcher with quality data, focus on the most important topics, participants enjoy the experience, and it is considered as a tool for solving business problems. Moving to the limitations; researcher have less control than the semi-structured interviews, considered as a time-consuming tool, requires a high level of skills from the researcher or the moderator, different views of opinions between the participants, suits the identification of major themes not the micro-details, participants' confidentiality between each other, its results alone cannot be generalised, and limited time to hear all the participants' opinions (Robinson, 1999: Rodrigues et al., 2009).

In summary, the interpretive approach seeks understanding the business or a particular phenomenon rather than measuring or predicting it. Consequently, qualitative research approaches assume that the phenomenon can only be understood and explained from someone directly involved in the activities related to the investigated phenomenon. Therefore, semi-structured interviews on a one-to-one basis or FGs are a flexible data collection method, which makes interaction with the participants generate more in-depth data and perfectly serve the purpose of this thesis (Robinson, 1999: Rodrigues et. al., 2009). So, relying on a triangulation methodology helps in avoiding overlapping weaknesses.

For this thesis, the FGs have taken the semi-structured interview form with open-ended questions, linked back to answer the RQs. The FGs' duration ranged between one and a half hours to two hours to allow the respondents to get to know each other and familiarise themselves with the topic and the setting to ensure a comfortable atmosphere of smooth flow of discussion between them. One to two FGs are held for the explanatory phase as a final data collection phase to validate the identified elements and sub-elements of the framework from the first phase. Each group meeting included five members on average with a moderator or the researcher to lead the discussion on the topic (Sekaran and Bougie, 2011: Shaw, 2013). At least one key informant from each case was considered to ensure construct validity. Some external stakeholders were included in the FG to add further insights to the explored framework, such as suppliers, governmental authorities, or customers. Nyumba, et al. (2018) noted that FGs can be composed of two to five participants who share a high level of experience (mini focus group). Those participants might disagree with the results or the interpretation of the first exploratory phase, but they ensure the unbiasedness of the presented data (Yin, 2003). As, they have an influence and impact on the dairy producer process, and they add heterogeneity to the overall sample and improve internal and external validity.

The venue location is considered one of the critical factors determining the success of the FGs (Shaw, 2013). It was selected to suit the participants' convenience and ensure it is neutral and unbiased to any of the participants. Therefore, it was online via Zoom software due to the COVID19 pandemic and health safety restrictions.

A Zoom video recording was kept, upon the consent of the participants. Also, the researcher has taken notes during the FG. It included the participants' reactions, responses to key questions, consistency in their answers, themes and subthemes in their responses, and the overall mood of the discussion. The researcher controlled the FG discussion and managed the time-division equally among the topics to be covered and not lose track of time. That was achieved by having pre-planned open-ended questions to guide the discussion and ended with a sum up question to summarise the group discussion (Yin, 2003: Shaw, 2013). Following that, a full transcription was prepared from the recording and the researcher's notes. The transcripts were sent to the participants, as in the first phase, to ensure it summarises the discussion adequately and includes all the points raised during the discussion (Breen, 2006: Al-Amer et al., 2016).

The FG data analysed by conducting content analysis using NVivo12, just as the first phase. The content analysis included listing all the capabilities, CCPs, and the KPIs mentioned during the meeting and focusing on the most frequently used keywords by the participants to represent a unified list of KPIs within a best practice framework, also looking for any new themes or measures to emerge. That can be achieved by running word frequencies and reporting the word counts of each operational capability, CCP, and KPI mentioned by the participants.

The use of various data sources ensures that the problem is explored from more than one angle and allows multiple facts to be revealed (Coyne, 1997: Sekaran and Bougie, 2011). That is to benchmark a performance measurement among the selected cases that can be applied by the Egyptian dairy producers. In addition to confirming the data obtained from the interviews, the FGs are only generalised on the sample selected and other producers of the same selection criteria (Breen, 2006).

In the second phase of this thesis, two FGs were held online using Zoom software on 24th April 2021 and 2nd May 2021. They were recorded on the cloud and moderated by the researcher. The FGs were held at 9:30PM each day. The recordings of the FGs were treated with confidentiality by the researcher on the cloud. The researcher mentioned the position of the participants only in the transcriptions of the FG for future use in the research and to maintain confidentiality.

Table 3.7 includes the details of the FG participants, including their position and the sector they belong to in the SC. All ten participants are males of leading positions in different governmental authorities, ministries, suppliers, and major companies in the Egyptian dairy sector. The sampling strategy for the FGs is to choose at least one participant from each entitled stakeholder who has interest and power in the dairy SC success. For instance, that is achieved by including the head of the national food safety authority-NFSA and ministry of agriculture, (Figure 3.5-stakeholder identification). That increases the diversity of the sample and improves the overall reliability of the study, beyond just the interviews.

Table 3.7: FG Participants

Participant Code	Position	Sector
FG1: 24th April 2021		
Participant 1:	The head of the national food safety authority in Egypt (NFSA)	Government
Participant 2:	An inspector from NFSA	Government
Participant 3:	Project manager in Mansour group and the food safety manager, Company D	Dairy Company
Participant 4:	Quality assurance section head, Company B	Dairy Company
Participant 5:	Continuous improvement and planning manager, Company C	Dairy Company
FG2: 2nd May 2021		
Participant 6:	The Head of the Livestock Development in the Ministry of Agriculture	Government
Participant 7:	Project Manager at TetraPak	Packaging Supplier
Participant 8:	General Manager at Sakr Group-Dairy producer and Fonterra Agent in Egypt	Powdered milk Supplier
Participant 9:	Milk Collection Center Coordinator at Ministry of Agriculture	Government
Participant 10:	Director of Technical Support and Quality Systems in The Ministry of Trade for Food Systems and Professor in The National Planning Institute	Government

It was challenging to arrange with the participants to compose a successful homogeneous FG. That was due to conducting the FGs during the COVID19 pandemic and the increasing surge of infected cases with Coronavirus in Egypt and ran across Ramadan, the holy month, where the daytime is limited during the long fasting hours. Therefore, arranging for the FG to be held online via Zoom software was the most convenient solution for the participants. They preferred the evening time to suit their different working schedules. Six participants from both cities Cairo and Alexandria were invited to FG1, however, one of the participants and the moderator excused themselves before the first FG for a few hours. The FGs participants were sampled for their power and interest in sustaining and enhancing the Egyptian dairy sector according to the stakeholder analysis held in Chapter Three. The researcher approached the same managers from phase one along with the governmental authorities and suppliers to validate the findings of their contribution towards the research. Three of them were committed to attend FG1 together with two participants from NFSA. Then, five participants were invited and committed to attend and participate in the second focus group. Each FG took approximately an hour. Although the moderator excused at the last moment, the researcher managed the FG and investigated detailed areas of the topic.

The FGs started with an introductory phase to allow the researcher to introduce the participants and get to know each other. Then, being the researcher and the moderator at the same time, the researcher gave them a brief on the research and setting the rules to moderate the FG and the time dedicated for each question and each participant to give a fair opportunity for all participants to express their answers for each question. The FG protocol contained five questions and a summary table of phase one findings (Appendix Five). The questions explore solutions to overcome the risks and ways to improve the dairy sector. Also, it ensures that the interviews' findings are sufficient and checks if any of the framework's elements are still missing to ensure that the RQs are answered. The researcher allocated approximate time for each section of the meeting to avoid losing track of time, five minutes for briefing, twenty-five minutes for answering the questions and five minutes to review the findings of the interviews from phase one. Then provide their comments in relation to the framework's core constructs which emerged from phase one themes.

3.4.3 Data Analysis

Qualitative research design is flexible to leave space for exploring the phenomenon. Thus, the researcher shall continuously keep in mind the analytical phase that will be followed. A researcher should ask the following question to understand the analysis approach: "*what is the question doing here, and how do we propose to analyse it later?*" (Shaw, 2013:162). Thus, it is not easy to analyse case-studies, as there is no precise procedure to analyse the data during this phase. A key challenge is that qualitative methods yield a large volume and variety of data which needs to be analysed. NVivo12 was used in both phases to help analyse and code the data to display and reduce it for interpretation.

The assessment of the qualitative research findings relies on the provision of different meanings and explanations to the provided data and the critical interpretations of the theoretical foundation of the study (Luborsky and Rubinstein, 1995). Following the epistemological position, the researcher needs an extensive reading of the data to analyse the qualitative data obtained from interviews, observations and FGs. Accordingly, the researcher has an active role in generating the data, exploring them, and interpreting them (Mason, 2002). Thus, the analysis under the interpretive paradigm works simultaneously with the data collection, after the first interview or observation held (Moser and Korstjens, 2018). That enables the researcher to detect if new themes or categories are still emerging and if there is a need for further interviews or observations until no new data appears and reach the data saturation (Moser and Korstjens, 2018).

It is important that the researcher keeps a log of each data collection method to ensure a successful qualitative data content analysis and to facilitate the transcription throughout the research. The data reduction and display are an iterative process among all the cases included in the thesis (Shaw, 2013). As the researcher will need the details of the dialogue to reduce the data by coding it into themes. Then, the data display and followed by verifying the data and drawing conclusions of it.

According to Williams and Moser (2019) there is a process for qualitative coding strategy to construct a meaning of the collected data and ensure the cyclical data loop through the coding methods. Those are, open, axial, and selective strategy. It starts from open coding by managing many pages of texts and going through the axial, represented in classified codes, then being selective by reducing the codes to a specific number of themes. This will be reflected in the application of the thematic analysis phases in the current research by Braun and Clarke (2006).

According to Yin (2009), the researcher should utilise his/her knowledge and experience in conducting case-study research. Therefore, objectivity can be achieved by utilising all available evidence and demonstrates interpretations that address the major aspects of the case-study. Analytical techniques are used as tools to fulfil the internal and external validity in conducting case-studies. These techniques are pattern matching, explanation building, time-series analysis, logic model and cross-case synthesis.

Validity and reliability are of an important element in any research that should be considered. Both validity and reliability tests are done to ensure the research design quality (EL-Gazzar, 2013). Halldorsson and Aastrup (2003) and Rodrigues et al. (2009) judged the quality of the qualitative research. It requires investigation over time to publish reliable results. Accordingly, the quality criteria or the trustworthiness of a research is determined based on four criteria: internal validity, external validity, reliability, and objectivity. Also, Marshall et al. (2013) noted that citing recommendations provided by previous qualitative methodology scholars act as an external justification for the interviews’ sample size. Table 3.8 summarizes a description of each criterion.

Table 3.8: Qualitative Research Methods Criteria- Source: Author based on (Halldorsson and Aastrup, 2003: Rodrigues et al., 2009)

Criteria	Description
Internal validity (Credibility)	-Reflects the variations in the research outcome. -Measured by testing the theory saturation and making the research participants review and comment on the research findings.
External validity (Transferability)	-Reflects the generalizability of the research outcome. -Collecting a wider scope of specialists' opinions can effectively reflect generalizability of the results and overcome the focus groups limitation. -Relating the findings to the literature determine the transferability as well.
Reliability (Dependability)	-Means the research instrument is consistent and predictable which reflects its accuracy. -Documenting the data collection tool, starting from the design to analysis and feedback.
Objectivity (Confirmability)	-Means the research is free of bias. -Triangulation methodology help achieves the confirmability criteria. -Enables the researcher to cross-check the results.

According to Mason (2002:39): "*If your research is valid, it means that you are observing, identifying or 'measuring' what you say you are*". Multiple data collection methods are considered to enhance the construct validity and provide multiple measures for the same phenomenon. Ten companies representing the large dairy producers in Egypt. The selection criteria among the cases are the top six Egyptian dairy producers of milk products, their factory size larger than 300sqm, and they contribute to over ninety percent of the dairy market share (Euromonitor, 2018). They will be considered for sampling of this thesis.

Establishing and enhancing construct validity can reduce the subjectivity of the case-study, by maintaining a chain of evidence. Internal validity is related to causal relationships in the explanatory research. External validity is related to the generalizability of the research findings. Finally, reliability means repeating the same research procedures and reaching the same research findings (EL-Gazzar, 2013). The goal of reliability in case-studies is to minimise the percentage of error and eliminate the bias (Sekaran and Bougie, 2011). This can be done when other researchers can imitate this current research and reach the same results and conclusions by using the same data.

The research strategy refers to analysing the data from the interviews, FGs, and observations held by the researcher (Wibowo and Sholeh, 2015). Valid research is about the appropriateness of the choices the researcher makes in terms of the research strategy, data collection, and analysis techniques used, and it relates to how the empirical data from interviews, observations, and FGs are gathered and analysed. Linking the results of the study to the already existing literature can enhance the internal validity of the research. However, the external validity is obtained when the findings of this thesis can be generalised in another context (Biggam, 2008).

Sekaran and Bougie (2011) defined the validity of a research as a test of how well the developed instrument is. The validity can be achieved by obtaining more data and the researcher skills in analysing it (Greener, 2008). Also, validity can be achieved when collecting data from multiple sources. Thus, strengthening the validity of the research can be achieved by covering the research problem from many perspectives using multiple data sources.

The research could be valid but unreliable, as suggested by Biggam (2008) to use data collection techniques that are considered relevant by the researcher (e.g., interviews), and to apply a suitable means of analysing the collected data, yet the work may be untrustworthy. The issue of bias may also impact the reliability of the research. Consequently, it is essential to keep a record of evidence of what you did in preparing the research in a fair and objective way. The trustworthiness can be achieved when the RQ is clear, the design of the case-study is clearly connected to the RQ, ensuring the appropriate sampling is used, systematic data collection tools, the steps were unified on all cases, and the data is analysed correctly (Sekaran and Bougie, 2011). A copy of the transcribed interviews were sent and discussed with the interviewees right after the interviews to fulfil the construct validity and confirm the transcription reflects the meanings they intended to deliver.

According to (EL-Gazzar, 2013: Liu et al., 2019) the empirical studies are essential in the development and validation of the operations and SCM models. Therefore, to ensure the theory's internal validity, it must be clear and understood by all readers or researchers with the same explanation of its reasons and conditions. The following conditions must be achieved: 1) its conclusions must be derived from its structure, and 2) the researcher identified all relevant and possible alternatives that might link the phenomena with the outcomes. Therefore, the theory's internal validity must be examined through different relevant perspectives of the organization. That result in better decision making in the organizations (Carlile and Christensen, 2004).

Then, the theory's external validity is the extent of the relationship between the observed phenomena and the outcomes. Can be achievable in different contexts and may be tested on different datasets. So, you can achieve better results through the utilisation of a larger sample size (Carlile and Christensen, 2004).

Table 3.9 summarises the approaches used in this thesis at each phase of the research to answer the predetermined RQs.

Table 3.9: Case-Study Tactics for the Designs Tests- Source: Author based on (Haddad, 2016: Yin, 2009)

Tests	Case study tactics	Phase of research in which tactic occurs	Case study phase	
			Exploratory	Explanatory
Construct Validity	-Use of multiple sources of evidence. -Establish chain and track of evidence. -Ensure the review of the case study reports by key informants.	Data collection	√	√
Content Validity	Practitioners and clarity of the statements and questions	Data collection Exploratory Phase (Semi-structured Interviews)	√	
Face Validity	Academic experts to ensure the clarity and the coverage of the content added	Data collection (Semi-structured Interviews, Observations & Focus Groups)	√	√
Internal Validity	-Explanation building	Data analysis	√	√
External Validity	-Use of replication in multiple case studies.	Research design	√	√
Reliability	-Following the case study protocol. -Develop case studies database with evidence.	Data collection and analysis	√	√

This thesis uses the pattern-matching technique to analyse the data. It enables further data analysis techniques; whether explanation building or cross-case synthesis. Additionally, it is suitable for analytical generalisation between the six selected cases. As, the researcher can compare the empirical results with the initially proposed ones. That results in modification of the existing theory or extending it. The analysis should be backed up with all relevant evidence, including all interpretations and address all aspects of the case-study. Supporting that, the researcher's expertise plays a vital role in the data interpretation and linking it to the research objectives and providing accurate analysis (EL-Gazzar, 2013).

Table 3.10 summarises the analysis process of both empirical phases held. The interviews were analysed qualitatively by using the pattern matching technique among the six cases. Two stages of analysis in the exploratory phase were held, those are within-case and cross-case analysis.

Table 3.10: Analysis Process Summary-Source: Author

Steps	Method	Purpose
Phase One: Exploratory		
1	Documentation of Qualitative Data -17 Interviews' transcriptions -2 Observations narratives and process diagrams	-Provide an overview of the selected cases and identify general themes recorded during the fieldwork and review it with the participants and academic expert for language validation and accuracy check.
2	**Stage One: Within case analysis using NVivo12**	- Content analysis explore the general themes recorded from the interviews and the codes accompanying it. - Thematic analysis identify the relations between the variables. Work as a base to generate themes and codes within each case and facilitate the cross-case comparison.
3	**Stage Two: Cross-case analysis using NVivo12**	-Case comparison, detect the relationship between the themes and concepts and compare them between the cases.
Phase Two: Explanatory		
1	Focus group transcription	-Full transcriptions of the participants' dialogue. -Review the transcriptions by the participants.
2	Data reduction using NVivo12	-Content analysis, create transcriptions' summaries including themes and codes following the focus group protocol.
3	Data Presentation using NVivo12	-Develop word cloud, maps, and tables of the proposed framework's elements and sub-elements represented in themes and codes.

This thesis follows the inductive analysis, where the inductive codes relevant to the RQs appear by going through the transcriptions (Moser and Korstjens, 2018). The first stage- Within case analysis using NVivo12, content analysis indicates the coding process to extract the themes and categories in each case representing a within-case analysis. It is a repetitive and unified consecutive step followed among the seventeen interviews held. The codes stem from the data transcriptions by following the inductive methodological research approach. It records the existence and the frequency of concepts that appeared in the text (Krippendorff, 2004).

According to Mason (2002), there are two options to index the data sets: the variables and the unfinished resources. The 'unfinished resources' are applied in this thesis and more appropriate with the qualitative research. It enables the researcher to treat the data sets 'such as variables', where themes emerge from the data sets. Normally, this type of research extends to further data analysis to identify the content of each theme. This was achieved by conducting FGs in the second phase.

Creating a case classification portfolio on NVivo12 for each case was a starting point to organise and compile all the primary and secondary data of each case separately for analysis. Then, moving to the analysis, as the researcher asks the same questions to all participants, this works as a systematic approach to ease reporting code frequencies, tabulation, and interpretation (Morris, 2008). The code creation starts with extracting the general themes detected among the collected data by following the interviews' open-ended questions protocol and focusing on the key terms and phrases recorded repetitively and consistently by the participants. This ensures the data consistency and accuracy. Thus, assigning each theme to a separate node eases classifying the related codes and categories to each theme (Morris, 2018). It has been supported by conducting a thematic analysis. That aims at identifying the relations between the variables (Cox, 2018). This enabled running queries including conceptual maps, project maps to represent the relation between the extracted themes. These queries emphasise the patterns among the codes and the relationship between them. The researcher can achieve the reliability for other coders to replicate the same coding process by providing a detailed code definition and description along with generating a codebook to be added to the appendix section of the research.

The second stage- Cross-case analysis using NVivo12 aims at finding the relation between the emerging themes and codes and comparing them between the cases (i.e., cross-case analysis). Comparing different cases to find a pattern or a conflict, will generalise results and make the findings stronger (Yin, 1989). Therefore, this stage demonstrates the similarities and the differences of the identified operational capabilities, CCPs, and KPIs between the six selected cases and detect the common themes from the data (Mills et al., 2012). The researcher can confirm the importance and the meanings of all patterns and categories and explain the relation between them to ensure the adequate representation of the theoretical concepts until the researcher reaches the theoretical saturation (Coyne, 1997: Moser and Korstjens, 2018: Marshall et al., 2013).

Repetitive codes strengthen the theoretical data saturation and work against any misinformation. That can be achieved by observing the same code multiple times and will be noted in the analysis chapter by providing multiple quotes supporting the same code. If the code appeared only once in the data collection exploration, then, it means its occurrence is just rare, not necessarily it means that it is wrong or irrelevant to the study (Krippendorff, 2004: Mason, 2002). That can be supported by referring to the original theories which the research is extending on (RBV, institutional, and network theories).

The interview questions were written in English. The participants were able to understand and communicate in English. But they felt more comfortable that the researcher is capable of understanding and communicating in both languages (Arabic and English), which left them comfortable to express their thoughts in the language they want for clarity. They spoke mostly in Arabic and used the professional terminologies in English as it is during the conversation, given their reliance on English as a professional language. According to Aichhorn and Puck (2017), English is widely used in professional communication as a global business language.

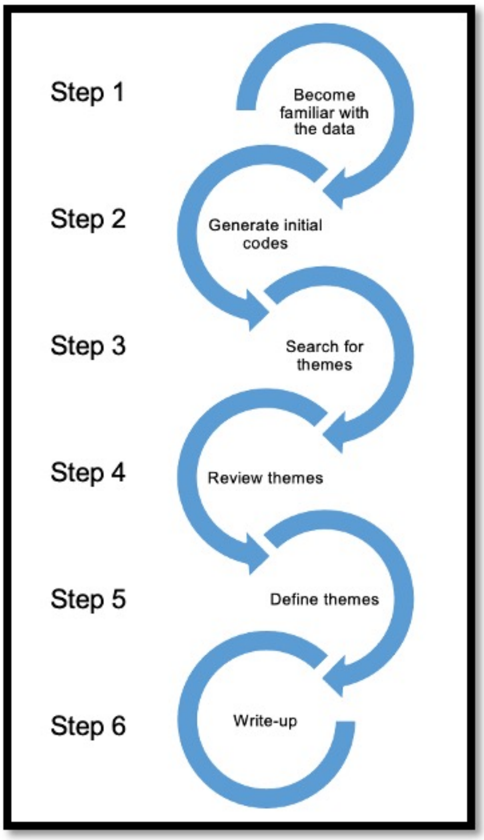
The interviews were semi-structured. So, the ordering of the questions may be irrelevant because the interviewees may provide further explanations or provide answers to future questions that have not been asked yet and would take place at a later stage. Therefore, consistency in writing the script and the interview's findings is the responsibility of the researcher to set the outcome of the interviews in accordance with the research framework.

The researcher audio-recorded the interviews, transcribed them, and translated them directly from the audio right after the interview. The purpose of this direct translation is to provide an accurate meaning to the original data and keep the translation close to the meaning they intended (Lee, 2019). Then, a copy of the transcribed interviews was sent to the interviewees and discussed with them shortly after the interviews to fulfil the construct validity and confirm the transcription reflects the meanings they intended to deliver, and all the terminologies and names spelled correctly. Some of them clarified the spelling of some processes and the naming of some authorities. That is to achieve credibility and trustworthiness in qualitative bilingual research (cross-language research). That enhances the trustworthiness of the data translation and the construct validity of data analysis significantly (Al-Amer et al., 2016: Loubere, 2017). Therefore, being the researcher and the translator at the same time allows us to analyze the data on an ongoing basis and enhance the understanding of the data.

Data analysis for this thesis was accomplished with the assistance of Nvivo12, a qualitative analysis software. The NVivo v.12 project database systematically housed all documents related to the thesis and remained separated from the study reported findings. It enables the analysis of a significant amount of data. Database was searchable and reported all of the evidence in a system readied for pattern analysis, pattern contrast, or proposition linked to data. Database contained the case-study chain of evidence documentation such as researcher notes, theory-supporting documents, interview respondent narratives with answers to the open-ended RQs, citations, informed consent documents, research acceptance letters, and conclusions. Purpose of the organisational records were to verify whether a sufficient amount of data has been collected for triangulation to occur to represent a cross-case analysis among the six selected dairy producers. NVivo12 software application feature includes a matrix coding query that demonstrates a prevalence of a theme occurring over the different sources of documents (Putnam, 2019).

The NVivo12 was relied upon to obtain answers to the RQ by performing thematic analysis. One of the key advantages of thematic analysis is that it enjoys theoretical freedom and can be practical through a wide range of theoretical, epistemological, and ontological methods (Braun and Claeke, 2006). Therefore, thematic analysis provides a practical and flexible tool for qualitative data analysis that can provide a comprehensive and complex narrative of data (Boyatzis, 1998). After creating the themes from the written data, the researcher proceeds to explain and interpret the data. The researcher also provides dialogue related to each topic to support increased reliability through a detailed description of the results (Alam, 2020). This study followed six phases of thematic analysis proposed by Braun and Clarke (2006) which is a useful framework for conducting this kind of analysis (Figure 3.6).

Figure 3.6: Phases of Thematic Analysis



Step 1: Become familiar with the data: After collecting data from the interview as audio files, the researcher transcribed these audio files and preserved them as MS word files. These transcribed files were later imported into NVivo12. All the seventeen interviews and two observations are organised accordingly.

Step 2: Generate initial codes: After importing the interview data into NVivo, all the responses were extracted and compiled together. These responses were the first attempt to look over the data.

Step 3: Search for themes: After compiling these responses, the researcher went through the data carefully.

Step 4: Review themes: Arranging the interviews' transcriptions for each company. This allowed the researcher to conduct within-case analysis by using the thematic analysis to reach the research findings. The content analysis is used to extract the codes from the interviews held with each company. Accordingly, codes are determined by checking similar nodes and gathering them under separate codes. In the same way, themes are determined by checking similar codes and gathering them under separate themes. For this process to take place, the researcher followed some procedures. The first, to carefully read the transcripts written for the number of interviews at hand, which is an important process in extracting the emerging codes out of the text in the transcripts. Then, gather similar codes together and different ones are kept separate from each other. This step is useful to interpret codes and relate them to each other under one theme if they are similar and under separate themes if they are different from each other.

Then, the researcher counted the code frequencies to sum them up for emerging themes, which is useful for identifying the relative importance of each emerging theme of the study. This helped the researcher to move to thematic analysis and identify relevant quotes by relating quotes of evidence related to each theme extracted in the study. This step of analysis using thematic technique was useful in observing the different patterns and figures.

Step 5: Define themes: Identify the themes emerged from the data to answer the RQs.

Step 6: Write-up: Represent the findings of data analysis and categorise it to themes by highlighting the commonalities and differences in the cross-case analysis.

These steps were supported by the ending Likert scale question. Likert scale was used as a continuation step to the seventeen exploratory semi-structured interviews as an ending question.

‘On a scale from 1 to 5, rank your supply chain performance in terms of a safe and secure supply of milk products, where (1) is very low performance and (5) very high performance.’

Its purpose is to provide a subjective self-perspective from the participants on their assessment of their current performance according to the SCOR model attributes (reliability-RL, responsive-RS, agility-AG, cost-CO, and asset management-AM). The participants ranked each of the five attributes on a five-point Likert scale (Likert, 1932) where (1) was ‘Very Low Performance’ and (5) was ‘Very High Performance’.

The results should evaluate the performance of the selected six cases and identify the SCP attribute that will need further enhancement and recommendation for development with

'Moderate' and which attributes are achieving an optimum level with 'Very High Performance'. That should qualify the six companies to create a best practice for the Egyptian dairy sector. The responses should range between 1 and 5 based on the given participants' responses. Likert (1932) clarified the ranges of each scale as summarised in the following table. Table 3.11 acts as a reference for the following averaging analysis results and interpretations.

Table 3.11: Likert Scale Descriptive Analysis

Scale	Range	Response and Verbal Interpretation
5	4.21- 5.00	Very High Performance
4	3.41- 4.20	High Performance
3	2.61- 3.40	Moderate
2	1.81- 2.60	Low Performance
1	1.00- 1.80	Very Low Performance

The five-point Likert scale with (3) as a middle scale would be sufficient and suitable to support the exploratory phase with the semi-structured interviews in this thesis. Likert scale analysis can be analysed using descriptive statistics like average, mean, variance, standard deviation, and multivariate analysis techniques (Shaw, 2013). The descriptive statistics analysis applied in this thesis generates the frequency counts of ranking each of the SCOR attributes and the average to their responses to provide a score to the performance of each company.

The five-point Likert scale is developed to assess the familiarity of the interviewees about the SCOR attributes and its degree of applicability in the entitled companies. It tests their understanding of SCP measures. Such scale enhances the research validity and reliability by generating insights to their self-assessment which supports the qualitative data analysis findings.

3.5 Research Ethics

This part of the research investigates the application of the ethical approaches' consideration during the sampling strategy and the data collection phase in the Egyptian dairy producers visited. This thesis focused on contractarian business ethics, focusing on its strong compatibility with empirical research. Especially when it comes to studying companies' performance. A noticeable trend in the business and SCM research is directed towards the contractarian ethics (Dunfee and Donaldson, 1995). The contractarian business approach tries to provide solutions to problems. It reflects the relationship between the company and its community in terms of social contract terminologies used by the interviewed managers in describing their current practices (Wempe, 2008: Mathenge, 2012).

In the process of collecting the primary data, the researcher abided with following the code of ethics documented in ethics in social research technical report by the UK government as a guide in the preparation of this thesis. The report deals with the research participants in terms of; approaching the participants, their consent and refusal, the sampling, conducting the interviews and the analysis (Kim et al., 2016: Graham et al., 2007).

The researcher planned to use all available supporting documents from the university that are available in addition to the supervisors' approval to strength the researcher's situation. These documents indicated that the researcher is an Egyptian native Ph.D. student who is keen on getting the Ph.D. degree from University of Hull in the UK. That strengthened his/her position as a researcher to contribute to enhancing the dairy sector in Egypt (Appendix Three and Four). Based on the researcher's understanding to the Egyptian community, being an assistant lecturer in the Arab Academy for Science, Technology and Maritime Transport, a reputable diplomatic organization, besides being a Ph.D. researcher that strengthens his/her position with the interviewees. The researcher business cards including all contact information were provided to the participants to ensure that future contact can be easily achieved.

Using the previously mentioned techniques to obtain and maintain the trust with the participants captured their interest in participating in this thesis. A brief introduction about the research problem and how this thesis will benefit their organization and improve its' performance was mentioned verbally and written with the list of questions which were sent to the participants in advance by e-mail if needed. Confirming the participants' approval is a must, by signing a consent form (Appendix One). That enriched their trust and willingness to keep future participation and maintain a good relationship with them.

Interviews and observations have been held personally by the researcher to avoid any misinterpretation to the participants' views. The researcher ensured the integrity in writing and reflecting the responses in the academic context of the research, a copy of the research results and contributions can be shared with the companies participated in this thesis upon their request and their interest in the research.

3.6 Summary

In summary, there was a need to intensively investigate the literature regarding the concepts, theories, and possible practices related to the topic. Collecting the appropriate data supporting the development of the proposed framework was needed. Thus, the thesis employs an inductive approach where observations and facts are clustered together with seventeen semi-structured interviews and two FGs and then analysed to develop the three selected theories. Diversity in the literature chapter in terms of references and sources assist formulating a conceptual framework.

This chapter started with restating the research aim, the RQs that were answered throughout the research implementation, and the framework of this thesis. Explaining the data collection methods; interviews, observations, and FGs that have been used to gather reliable data to support the research and fill the gaps missed in the literature. Then explaining the research philosophy and the methodology used. The methodology applied in this thesis is case-study following the qualitative approach by interviewing managers at the large-size Egyptian dairy producers in both cities Cairo and Alexandria in Egypt.

A clear explanation of the purposive sampling applied in this thesis was provided, supported by the reasoning behind this selection. Followed by explaining and discussing the research validity and reliability. Then, all the details regarding the ethical considerations and approval in conducting this thesis were discussed.

Chapter 4 Phase One-Exploratory Semi-Structured Interviews and Observations Analysis and Results

4.1 Introduction

This thesis aims to determine the basic elements of operational capabilities, CCPs, and performance measures, which affect the quality and safety of Egyptian dairy products. That is, the thesis seeks to provide dairy producers with practical guidance when implementing the developed SCP measurement framework to ensure the company has product produced safely and sustainably. Correspondingly, seventeen interviews are conducted in six Egyptian large dairy producers, to discuss the role of suppliers in companies, as well as the types of measurements that companies apply to measure their SCP, as well as the various cleanliness measures, they use to ensure the raw milk quality. In addition to discussing the certifications that dairy companies obtain when ensuring quality and safety security in the companies. And how do some health and authorities help to ensure the quality of final products in companies. Last, the interviews inform us about some plans to increase the efficiency of SCP and thus are presented by the research to provide solutions to dairy companies to ensure product quality and SCP.

This chapter describes the qualitative analysis of the data, including the practical steps involved in the analysis. The participants in the interviews are seventeen members (Table 3.6), preselected from the following departments: quality, production, research, and development (R&D), planning and control, projects and health and safety environment (HSE) and maintenance, procurement, plant and operation manager, and supply chain. In the interview session, a discussion is handled to answer the same questions, in which the participants are asked to participate with their views, perspectives and opinions based on their knowledge and experience. Data collected is then analysed into generative themes, which were described individually how these themes overlapped then cascaded to categories and codes.

Data collected from interviews and observations was analysed by applying the thematic analysis using NVivo12. The findings of the study are presented in this chapter with the purpose of introducing a qualitative analysis of operational capabilities, CCPs, risks affecting operation and SCP, overcoming SC challenges and operational risks, performance measures, and improving the Egyptian dairy producers' performance. This analysis is presented in the form of thematic analysis to present the results in themes and codes. Under the sample of this study and according to the responses received from the participants during seventeen interviews, held with seventeen participants, presenting the heads of departments and two observations of six large Egyptian dairy companies, the study findings had been found and illustrated each in a separate section. The age of all participants ranges between early thirties to late fifties. All of them are men except one procurement manager is a female. Accordingly, this chapter is divided into five main sections, where the first one is represented in the current introduction for the chapter. The second section provides a brief overview on the selected companies. It includes secondary data from the companies' website, archives, and governmental reports. Supported with the observations. The third section presents pieces of evidence for the process handled for the interviews and observations' data analysis. The interviews' themes development procedure is described in the fourth section along with the coding process to present the quotes from each company related to each theme to present a within-case analysis. The fifth section presents cross-case classification results displayed in the analysis, while the sixth section is based on deriving a conclusion for the analysis results obtained in the study.

4.2 Cases Overview and Observations

This thesis focuses on six large dairy producers, who produce packaged milk products and following international quality standards. They dominate the Egyptian dairy sector, based on their capabilities and qualification of providing the basic international hygiene standards in the provision of safe and secure products. Also, they are of the major contributors in the Egyptian dairy sector, compete globally, and always looking for areas of development (Geijer et al. 2017: Imam et al. 2016: Soliman and Mahhour 2011: Euromonitor, 2018). Those local producers showed interest in participating in this thesis and were eager to reach the findings to be shared with them. Those producers are in the largest two cities: Cairo and Alexandria in Egypt (Figure 1.1). Both cities are known with the maximum number of dairy production factories among the country and their favourable weather for dairy farms and cows' welfare and productivity. Those locations are considered central locations between the dairy farms and the market. They serve as primary sources of daily fresh milk and reachable to cover most of the local dairy demand. In addition, the large size dairy producers have a wide variety of dairy products' offerings with high quality, use advanced production equipment, follow the international safety and hygiene requirements, have refrigerators and transportation fleet that ensure the sustainable delivery of safe and secure dairy products to the local and global markets.

Table 4.1 includes the case classification, which helps in providing the basic characteristics of each company to make the reader familiar with the companies selected and ease the following up with the analysis. Company-B, D, and F have only one factory managing all their dairy products. On the other side, Company-A and E have two dairy factories and C has three dairy factories. As the number of dairy factories, production lines, and suppliers varies from one company to another, this is essential in determining the company's performance and the number of product offerings to the market. That depends on the number of production lines and product offerings. Also, it is noted that three companies own their farm(s) (i.e., vertically integrated), two of them rely on external farms besides their own to fulfil the supply deficiency in the raw milk supplies.

Table 4.1: Egyptian Dairy Producers Case Classifications

Dairy Producers	Farms	Number of Factories	Number of Production Lines	Number of Suppliers	Plant Location	Plant Size	Fresh Milk	UHT Milk	Skimmed Milk Powder
Company A	Outsourced	2	Over 10	Over 100	Cairo-Alexandria Dessert Road	Large Plant- More than 300 sqm	Not Produced	Produced	Not Produced
Company B	Both	1	4	3	Cairo-Alexandria Dessert Road	Large Plant- More than 300 sqm	Not Produced	Produced	Not Produced
Company C	Both	3	Over 10	30	Cairo	Large Plant- More than 300 sqm	Not Produced	Produced	Not Produced
Company D	Outsourced	1	4	25	Alexandria	Large Plant- More than 300 sqm	Produced	Produced	Not Produced
Company E	Outsourced	2	Over 10	Over 100	Cairo	Large Plant- More than 300 sqm	Not Applicable	Produced	Not Produced
Company F	Owned	1	2	Over 100	Cairo-Alexandria Dessert Road	Large Plant- More than 300 sqm	Produced	Not Produced	Produced

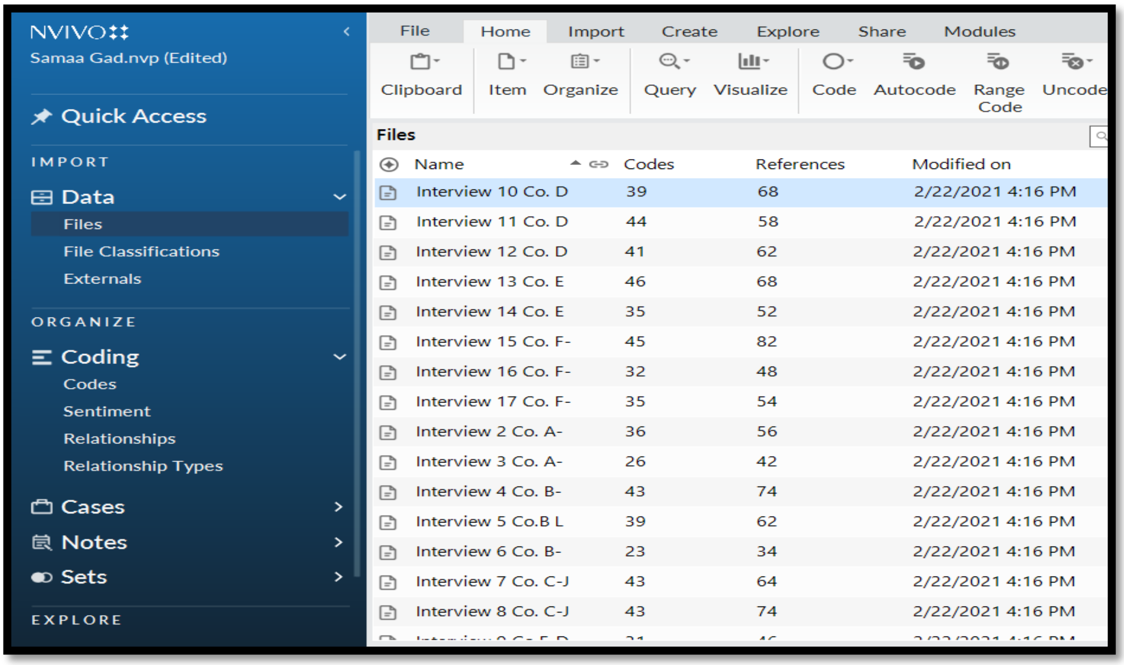
4.3 Process of Interviews Data Analysis

Thematic and content analyses are used in the analysis of the data collected through seventeen interviews to extract the codes from the word frequencies used in the interviews collected and handled by the researcher with key informants of seventeen experts of Egyptian dairy companies. Accordingly, the codes and themes of the developed framework are obtained through the restructure of the words and quotes used by the heads of departments of each company to identify the quotes of each case to resemble within case analysis.

Data gathering was done from July 2019 till February 2021, where seventeen individuals were interviewed in the interviews. These individuals were personally approached and were sent the questions before joining the interview and consent to join as they were informed that they will not be accused of their answers and the interviews will not cause them any harm in their jobs or personal life (Appendix Four). They were guaranteed anonymity throughout the interview process. The semi-structured interviews setting was informal, to enable the interviewees to feel at ease and talk openly around the questions asked.

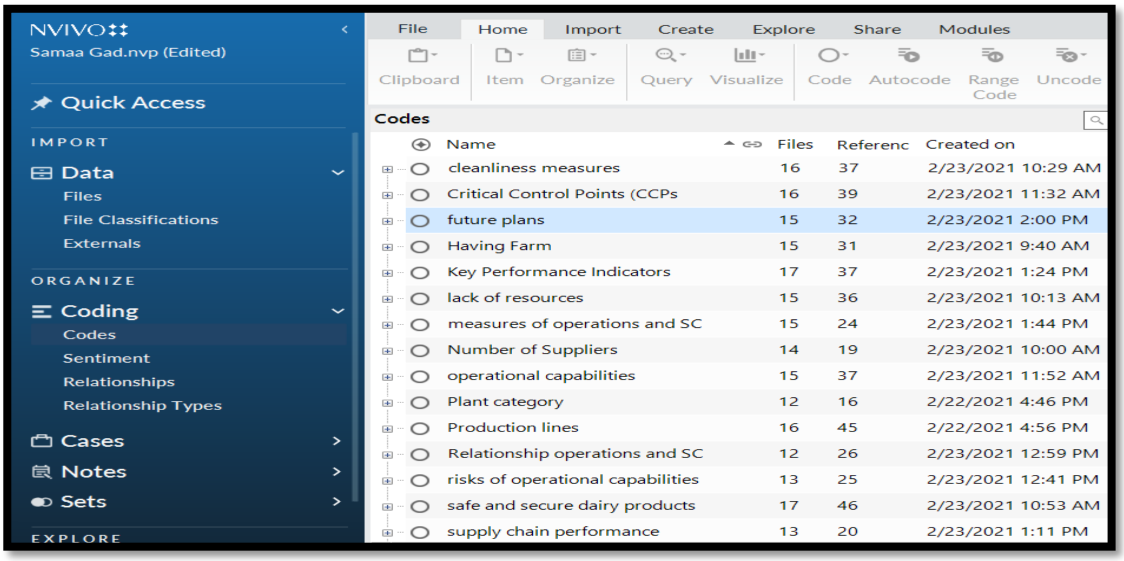
The data analysis and themes extraction have been conducted by following the six phases of thematic analysis explained in Chapter Three (Figure 3.6). In brief, it started with transcribing the interviews' audio files to word documents, then imported them to NVivo12 along with the written observations (Figure 4.1).

Figure 4.1: Imported File into NVivo12



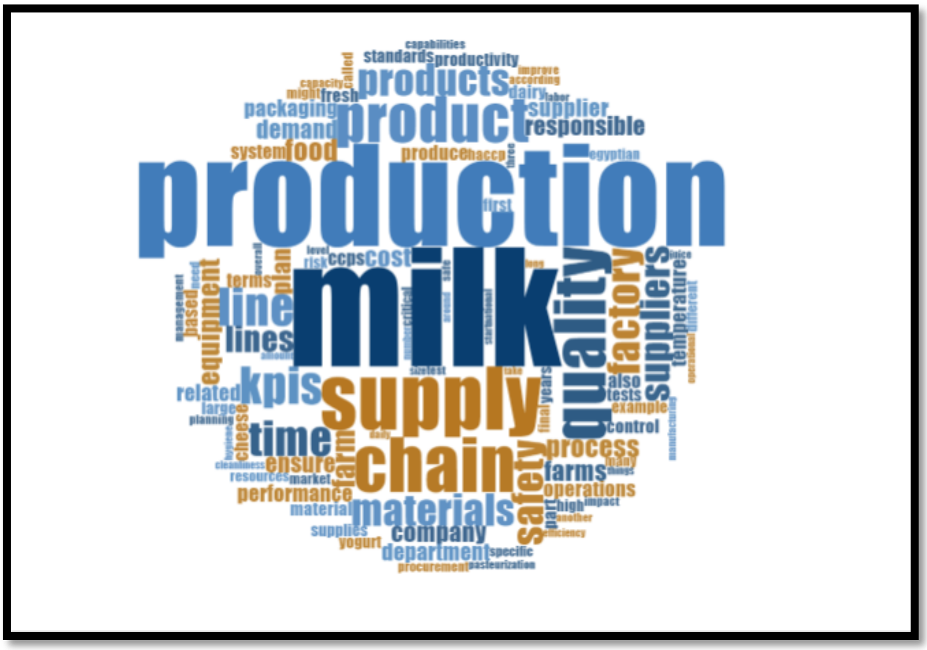
Then, review the transcriptions carefully to compile and extract responses to search for codes. After that, assorted the similar codes together. That enabled the search for theme among the compiled responses (Figure 4.2). Followed by reviewing the themes by arranging the transcriptions for each company to facilitate conducting within case analysis and search for similarities and differences among the six cases. That facilitated the themes review among the cases.

Figure 4.2: Extracted Responses from NVivo12



After this, the researcher counted the codes and word frequencies (Appendix Six) to create the following word cloud (Figure 4.3) as an extraction of the most frequent words from the seventeen interviews, which helped initially to develop themes. Accordingly, primarily the researcher set four themes from the word cloud such as milk, production, supply chain, and quality. But it needed further exploration by going through the assorted codes again to search for more detailed themes.

Figure 4.3: Word Cloud Extracted from the 17 Interviews using NVivo12



Building on the fourth step of the thematic analysis, where the data collected from interviews were then arranged and transcribed for each company to present within-case analysis. The researcher used thematic analysis to ascertain the research interview results and findings.

The details of extracting each theme out of the interviews collected are documented in the following subsections by using the word frequency table illustrated in Appendix Six. It shows the words most frequently used in the seventeen interviews included in the analysis.

In summary, an initial four themes were formed after reviewing the emerging codes from the transcriptions (Figure 4.2). Those were aligned with the RQs such as strategy, improvement, performance, and measurement. From the research objectives the researcher picked five themes for getting answers to the RQs for example Operational Capabilities and CCPs, Risks Affect Operation and Supply Chain Performance, Overcoming Supply Chain Challenges and Operational Risks, Performance Measures, and Improving the Egyptian Dairy Producers' Performance.

These themes emerged slowly by going through the full interviews transcriptions several times (Appendix Seven and Eight) and after reviewing the word cloud, word frequencies, creating mind maps, and using text search queries. The researcher stepped back from the data for a week after the coding process and then settled on the creation and the phrasing of these five themes and sub-themes.

These five major themes are categorised to different sub-themes to answer the RQs (Table 4.2). Under steps and process of exploring the developed framework, dairy producers' most essential need is to set performance improvement plans than other themes.

Table 4.2: Defining Themes and Sub-themes from Interviews

Major Themes	Sub-themes	Reference	Total
Operational Capabilities & CCPs	Number of Production Lines	13	167
	Lines Classifications	19	
	Production Lines	13	
	Safe and Secure Dairy Products	20	
	Measures and Certificates of Quality and Safety Security	26	
	Critical Control Points (CCPS)	17	
	Kinds of Critical Control Points	22	
	Operational Capabilities	37	
Risks Affect Operation and Supply Chain Performance	Source of Raw Materials	31	56
	Operational Risk	2	
	Raw Materials Risk	5	
	Cleaning and Breakdown Risk	7	
	Production Risk	2	
	Energy Risk	3	
	Machines performance Risk	1	
	Malfunction Risk	2	
	Prices Risk	3	
Overcoming Supply Chain Challenges and Operational Risks	Number of Suppliers	19	118
	Supply Chain Risks	15	
	Lack of Materials	21	
	Cleanliness Measures Toward Quality	37	
	Supply Chain and Operations	19	
	SCOR Model	2	
	Research and Development	1	
	SAP System	4	
Performance Measures	Measuring the Supply Chain Performance	7	91
	Supply Chain Performance	13	
	Key Performance Indicators (KPIs)	37	
	Supply Chain KPIS	25	
	Delivery Time and Cost	9	
Improving Egyptian Dairy Producers' Performance	Feeding Programs	1	32
	Reduce the Emissions and Waste	2	
	Increase Productivity	7	
	Improve Suppliers	7	
	Implementing KPIs	5	
	Increase Sales	2	
	New Technology and Training	8	

The following section is assigned for development of interview themes and finding the commonalities and differences among the six cases and reaching a cross-case analysis summary at the end of the chapter.

4.4 Development of Interviews Themes using Thematic Analysis

Using thematic analysis, the seventeen interviews were collected and analysed, and the respondents' answers were investigated. In this section, the researcher evaluates the responses of the seventeen interviews for each question proposed in the interviews to demonstrate how these themes and sub-those were determined.

These interviews enable the researcher to analyse the current situation and the future of dairy producers. The interviews focused mainly on the problems their company faces, the systems used by the company to measure their performance followed by their opinion regarding the developed framework and how it can be used in dairy producers. The following big dominant themes combine the emerged sub-themes.

Five major themes emerged from interview analysis process:

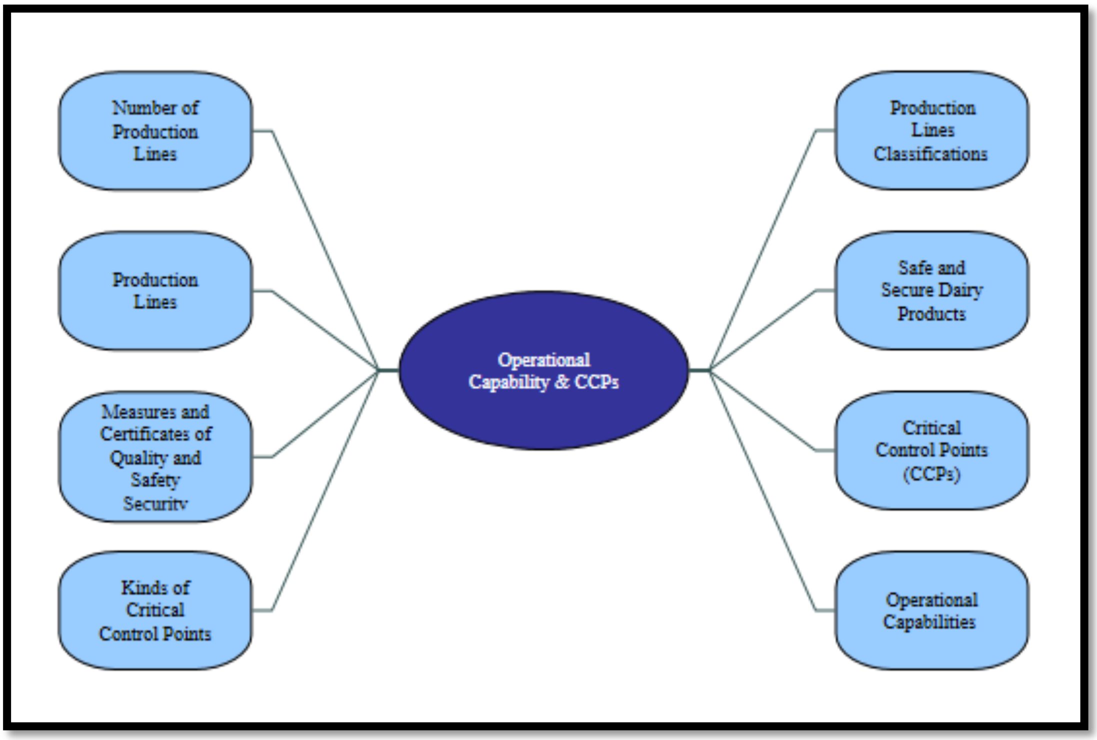
1. Operational Capabilities and Critical Control Points
2. Risks Affect Operation and Supply Chain Performance
3. Overcoming Supply Chain Challenges and Operational Risks
4. Performance Measures
5. Egyptian Dairy Producers' Performance Improvement

The detailed explanation of each theme and the details of extracting them out of the interviews collected are documented in the following subsections.

4.4.1 Sub-Themes of Operational Capabilities and Critical Control Points

For defining operations and increasing the SCP in dairy companies, the Operational Capabilities and CCPs sub-themes that emerged from the data could be expressed into several codes, which are: Number of Production Lines, Production Lines Classifications, Production Lines, Safe and Secure Dairy Products, Measures and Certificates of Quality and Safety Security, Critical Control Points (CCPs), Kinds of Critical Control Points, Operational Capabilities. These codes are illustrated in Figure 4.4, where the codes are presented for the theme of operational capabilities and critical control points.

Figure 4.4: Sub-Themes of Operational Capabilities and Critical Control Points (NVivo12)



4.4.1.1 Number of Production Lines

In this part, several codes are covered that indicate the number of production lines present in the companies that were addressed by the interviews, and this is due to the fact that the difference in the number of production lines in the companies is the reason for the differences in strategies in the dairy companies to ensure the quality of products and to provide safe and secure products to consumers. In addition, the different numbers of production lines lead to choosing different cleanliness measures and utilisation of the raw materials used in manufacturing. As well as adopting different plans to ensure the SCP, and this in turn leads to differences in the operational capabilities and CCPs in companies.

The number of production lines in the companies targeted by the interviews differed. The following evidence noted that the more the production lines the higher the products' offerings of different kinds of products with more amounts to fulfil the market. Also, the second interview clarified the number of production lines in Company-A, through the following evidence: *"We have 4 categories for the production of milk".* While in interview number three dealt with a different number of production lines in the same company, with the following evidence: *"Company-A has around 16 production lines".*

In addition, the interviews numbered four, five and six for directors from different departments in Company-B. In what follows they will present some evidence in interviews four, five and six about the number of production lines. The evidence is as follows: *"We have two production lines for two sizes. 1-litre and 230ml", "4 Production lines"* and *"At the 5th step the raw milk splits into the 2 production lines depending on the pack size".* Also, interviews number seven and eight differed on the number of production lines with Company-C officials in various departments. Evidence from the interviews is illustrated as follows: *"Company-C has two production lines for milk and one for cheese"* and *"It is around 13".*

As for interview ten did not specify a specific number of production lines in Company-D, and this is what is explained in the following evidence: *"But as production lines, we have many production lines producing standardised capacity".* However, the twelfth interview with the milk purchasing manager in Company-D revealed an approximate number of production lines in the companies, and this is shown in the following evidence: *"We have 4 production lines".*

The thirteenth interview dealt with the number of production lines for cheese in the Company-E only, while it did not discuss the number of production lines for dairy, and this is explained in the following evidence: *"Mainly we have three categories of cheese".* The fourteenth interview discussed the number of production lines in the company as a whole from those used in milk, cheese, juice and other products of Company-E, and this is evident in the following evidence: *"Almost 22 production lines".*

Finally, interviews fifteen and sixteen dealt with the number of production lines present in the Company-F. Interviews fifteen explained the number of milk production lines only, and this is evident in the following evidence: *"We have one production line for milk and another line for yoghurt... but first we have the pasteurisation process and then w direct the milk to the mixing according to the flavour if we are going to produce flavoured milk"*. While the sixth interview dealt with the number of production lines of Company-F as a whole, the number of products in the company and how production lines are distributed in it, this is evident in the following evidence: *"5 production lines. 2 of them for milk".*

So, production lines as a topic dominated the interviews, it indicated differing sizes, and capacity of production and variety of products produced in the large sized dairy producers.

4.4.1.2 Production Lines Classifications

The different strategies used in companies depended on the diversity and classification of companies for production lines, and this is based on the difference in quality measures and cleanliness of the raw materials and milk received from suppliers as well as from their farms, and this is to ensure the final product's safety. The classification of production lines is due to their division into the products of the companies and the different products produced by the companies. This leads to a diversification and increase in the number of production lines in the dairy industry.

There is evidence that appeared in the second and third interviews, including how Company-A classifies its production lines on the products that the company produces from dairy, cheese, and other products, and this evidence is as follows: "*We can use any production line of it. We produce UHT milk, yoghurt, rayeb milk, flavoured milk, and juice*", "*We have 2 startups, one for dairy and one for juice. You are interested in the dairy*", "*Starts with raw milk or sometimes it is called Fresh and UHT. Both get into the pasteurisation then splits into 2 lines one for milk and one for yoghurt*" and "*DAIRY ONLY, including all its types; full cream, half fat, skimmed… The production line can be used to produce juice, but we direct it to produce milk only*".

There is evidence that appeared in the fourth and fifth interviews, including how Company-B classifies its production lines as follows: "*I have two UHTs. I can make one produce milk and the other produce juice. Or I can produce milk...Or split them between 1-litre and 230ml*", "*We have two; 1-litre production lines and one 230ml. And I have the flexibility to work with both milk and juice*" and "*2 production line for the 1Litre size and 1 production line for 130ml and 1 production line for 200ml*''. Thus, production line flexibility links to SCOR by providing better reliability, responsiveness, and agility.

More evidences appeared in the seventh and eighth interviews, including how the Company-C classifies its production lines, as follows: "*Producing 10 milk products, i.e. stock keeping units (SKUs) produced by 20 production lines*", "*4 production lines for the small size yoghurt, 4 production lines for the bigger size…2 production lines for the drinkable yoghurt...1 for the milk, so the total is 11*" and "*1 production line for McDonald's products. It is a B2B business. The milk shakes and the Sunday ice-cream*".

Evidences that appeared in the tenth, eleventh and twelfth interviews, including how Company-D classifies its production lines as follows: "*We have fresh and UHT products*", "*raw milk is directed to either one production line for the fresh pasteurised milk product with short shelf life…Or three production lines depending on the product and the packaging for the UHT milk product*", "One for the fresh pasteurised milk and three for the UHT milk. The difference between the UHT milk production lines is the packaging material and size" and "*fresh pasteurised milk (7 days' shelf life) and UHT milk (up to 6 months' shelf life), yoghurt, ghee and butter*".

In addition, evidence that appeared in interview thirteen, including how Company-E classifies its production lines as follows: "*Soft Cheese: two production lines differ based on the packaging material specifically. They are divided into plastic cups packaging…and TetraPak packaging", "Processed Cheese: one production line includes the mixing and filling production processes",* and *"Mozzarella Cheese: one production line*".

Moreover, there is evidence that appeared in the fourteenth, fifteenth and sixteenth interviews, including how Company-F classifies its production lines as follows: "*It is around 10 products: we produce cheese, yoghurt, flavoured milk, skimmed milk. The flavoured milk, we have it with chocolate, strawberry, cocoa, coffee. Besides, rayeb, juice…all this produced with the same production line. It operates for milk and juice*", "*both are pasteurised milk, which is fresh milk with 7 days' shelf life. And fermented milk stays for 14 days' shelf life same as yoghurt*" and "*We have the first production line- the old production line- for skimmed milk powder and butter... Second, we have a production line for yoghurt. Third, the production line for cheese; white cheese, gouda, and edam. Fourth production line-PET for milk and juice*". Such changeover in the production lines to produce different varieties of products reflects operational efficiency and better management to their operational capabilities.

4.4.1.3 Production Lines

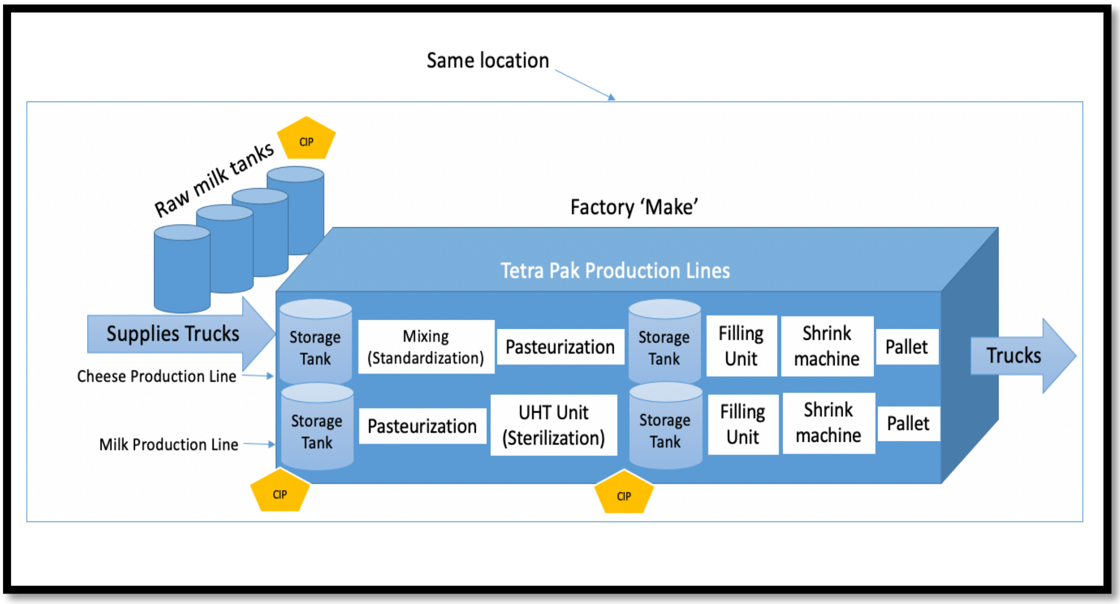
It was previously discussed that the difference and multiplicity of production lines lead to the adoption of different strategies in Egyptian dairy companies, to ensure the quality of the final products, in addition to following different systems in the SCs to ensure their performance and efficiency in the delivery of materials and raw milk from farms to factories in the desired conditions. Also, each production line has different stages in production, for example milk production lines differ from cheese production lines as well as juice production lines due to the different stages and production processes in each production line.

There is evidence in the interviews that explain the different stages of production in the different production lines, for example in interview one, the steps of production lines in Company-A are shown and this through the following evidence: *"Some of the previously mentioned products have common lines and it splits in the middle either at the packing stage or at the phase of additives added to the fillers", "If you are going to consider those 3 products, they are passing in* *the same production line",* and *"The production line of yoghurt differs from the production line of milk. All depends on the product type, the technology and the criticality of the product itself".*

While interview four, five and six the steps of production lines in Company-B are shown through the following evidence: "*production lines are categorised based on package size", "I can convert the 1Litre production line to 750ml or 500 ml*" and "*The production line is functioning and withdrawing milk according to its operating schedule*". In addition, interview seven in Company-C showed the following evidence: "*The production line in Egyfood produces in 1-Litre and 0.5-Litre sizes. Juhayna only produces the small 125ml*".

Moreover, interview twelve in Company-D showed steps of production lines through the following evidence: "*each production line works with full capacity*". While interview fourteen in Company-E showed the following evidence: "*Milk now is a new project. It will be a production line for 1Litre and the 250ml*'' and "*we have a production line for; soft cheese, processed cheese and TetraPak*''. Furthermore, interview fifteen in Company-F showed the following evidence: "*It is the same production line; we do the washing and then changeover according to the product we want to produce*". Figure 4.5 illustrates the 'make' processes and the production lines' processes in Company-E based on field visit observation held by the researcher to one of their factories.

Figure 4.5: Company-E 'Make'- Source: Author



Based on observations and field notes, the researcher noted that dairy producers set their plan of cleaning process in the most efficient way to overcome any arising issues in the production line which might affect the product quality. This happens by starting with the processing of skimmed milk before the full cream. The operators can skip washing cycle in such process. As, it will not affect the fat percentage of any of both products. But this cannot be inverted. Because it will affect the percent of fat in the skimmed milk which should be approximately 0.1% and 3% for the full cream milk. That's how the dairy producers are being efficient in the changeovers during the production process.

4.4.1.4 Safe and Secure Dairy Products

One of the most important goals of dairy companies is to ensure and maintain the production of safe products that are manufactured in the selected cases. This is what this thesis deals with and focuses on is how to ensure the safety of the raw products that enter the production of dairy products in the selected cases. As well as the basic concepts agreed upon by dairy companies in Egypt regarding the concept of safety and health for dairy products.

Interviews one and two were held with two managers in Company-A. The interviews covered these basic concepts that managers in different departments have about safe and secure dairy products, and here some of this evidence: "*you understand the phrasing of safe and secure dairy products with the hygiene*", and "*all Company-A's products are wholesome and with no preservatives added or any harmful ingredients".*

Interviews four and six were held with two managers in Company-B. The interviews covered these basic concepts about safe and secure dairy products and provided these evidence: *"The quality of Company-B milk product relies on two elements, the quality of raw milk used, and the technology used in processing the milk"* and *"However, we apply higher quality standards represented in accepting raw milk with maximum 20.000 bacterial counts to ensure the ultimate quality of introducing safe and secure milk products to the final consumer".* Interviews seven and eight were held in Company-C presented this evidence: *"There's currently an unannounced audit in the factory on OHSAS"* and *"we fulfil anything related to ISO, the Egyptian national health ministry, the Egyptian Food Safety Authority-NFSA, and if we are a supplier to other producers, we should pass his test".*

Interviews eleven and twelve in Company-D presented these evidence about safe and secure dairy products: *"We do quality tests for each shipment of supplies getting in the factory before passing through to the production lines", "We are whitelisted by the national health and safety authorities", "The safe and secure dairy product should have passed through the laboratory tests before getting out of the factory with zero bacteria level and the good nutrition facts in terms of* *protein, fat, lactose, and for sure in a well protective package with all the detailed labelling information of manufacturing and expiry date and product's specifications"* and *"We perform quality audits for the hygiene and safety in our factories and to our farms periodically".*

Interviews nine, thirteen and fourteen were held with three managers in Company-E in different departments, and here some of their evidence about safe and secure dairy products: *"Our products have to be free of Pathogenic bacteria to be safe for human consumption", "we get a reference from the International Food Standard CODEX Alimentarius, FDA, the Egyptian National Food Safety Authority (NFSA). Based on that, we apply it on ourselves and our subcontractors"* and *"we test the product (material) before we buy it".*

Interviews fifteen and sixteen were held with three managers in Company-F in different departments and provided this evidence about safe and secure dairy products: *"On a farm level, we work on a B2B base where we sell to other companies like Company-C, Company-A, and Company-B. They take our milk and pasteurise it on high temperature to produce UHT milk", "But the nature of this product can be stored in such conditions unlike my product. So, the main issues we face are related to the cold chain", "the criteria of safe and secure dairy product is the storage condition, the transparent package you ensure your product is safe. Then the cold chain and cold storage"* and *"In terms of quality, it is the responsibility of the quality team. They have a process to check the physical product and the microbiology (tests) to ensure that the milk product is within the upper and lower limits of quality".*

4.4.1.5 Measures and Certificates of Quality and Safety Security

In this section, the standards and measurements used by dairy companies to ensure the safety of raw materials used in the dairy industries will be discussed. Also, the certificates obtained by the dairy producers targeted in the research will be discussed for the correct application of safety standards for them by national health institutions or international organisations that aim to ensure the safety of dairy products and how companies work to obtain these certificates in order to reach international standards in quality and safety.

Now, evidence will be presented from interviews one, two and three for Company-A about measures and certificates that companies use and obtain due to quality and safety security assurance. The evidence is as follows: *"any producer should have HACCP, then the national food safety authority (NFSA) does inspections on food safety programs to ensure the food safety... All exports should have basic food safety certification", "Food safety management system (FSMS), HACCP and ISO are the building blocks of any food factory", "OHSAS 18001, ISO 14001 for environment and safety. If we are talking about the food safety, we have the FSSC 22000, ISO9001, and the HACCP part of the FSSC22000",* and *"ISO22000-food safety, ISO14000-*

Environment, ISO18000-Human safety, AIB- American Institute of Baking, it is a certificate for food safety and hygiene. The most important for us are the AIB and ISO22000".

Some evidence will be presented from interviews four and five for Company-B about measures and quality and safety certificates, these are: *"we have FSSC 22000. And ISO22000. OHSAS 18001. Whitelisted by the Egyptian National Health and Safety Authority", "If we are focusing on food safety, its base is the GMP and it goes up to 5S, then HACCP, then the first standard of the food safety which is the ISO22000, then the FSSC…those are the basics of food safety", "Yes, FSSC, ISO22000, and ISO18001"* and *"Of course, HACCP, GMP, and everything related to food safety are included in the ISO22000".*

Some evidence will be presented from interviews seven and eight for Company-C about measures and certificates that companies use are as follows: *We also have the FSSC 22000", "We have ISO22000, ISO14001. And we're currently working on 50001 which is an Energy Management System to enhance the energy efficiency"* and *"HACCP, ISO, everything…we are suppliers for McDonald's, so we should pass all McDonald's standards".*

Some evidence will be presented from interviews ten and twelve and their published profile on their website for Company-D about measures and certificates that companies use and obtain due to quality and safety security assurance, these are: *"Our factories carry ISO 2005/2000, OHSAS 2007/18001, ISO 2004/14001, ISO 2008/9001, ISO 2005/17025, and BH OHSAS 18001:2207 certifications. Additionally, they have quality marks from EOS in UHT Milk, and Processed Cheese"* and *"Company-D recently attained the following certifications: HACCP & ISO 9001, FSMS, OHSAS 18001, ISO22000, ISO 17025, ISO 14000 system and the quality mark from the Egyptian Organization for Standardisation and Quality Control (EOS) in producing UHT Milk and Processed Cheese".*

Some evidence will be presented from interviews nine, thirteen and fourteen for Company-E are as follows: *"We apply the HACCP and for sure the ISO. ISO22000, ISO18001, each product has a separate HACCP plan, we follow the OPRP, we also have HALAL certificate", "to be certified by: Food and Agriculture Organization (FAO), ISO 9001, FSSC 22000-HACCP, ISO14001, Halal, OHSAS 18001",* and *"ISO, HACCP, HALAL, and all certificates related to them".*

Some evidence from interviews fifteen and seventeen for Company-F are as follows: *"The packaging specs, ensure the cap safety, the bottle thickness and resilience during the transportation against any damage", "A safe product is determined based on their chemical tests to match the CODEX international and Egyptian standards", "the total bacterial count should not be more than 1000 and I do not exceed the 100 here in Company-F. Also, to be free of any* *coliform bacteria and yeast mould"* and *"Our factory has ISO22000, the food safety in 2018. We also have ISO9001 for laboratories in 2015, ISO45001-Occupational Health and Safety (OHSAS), and ISO14001 for the environment".*

So, adopting the inclusive guide of food safety FSSC2000, which includes GMP, ISO22000, HACCP, and BRC, should be adopted to make them eligible for exports to the Gulf and European countries. Besides dealing with whitelisted farms for the raw milk. That is the recommendation of the NFSA.

4.4.1.6 Critical Control Points (CCPs)

In this part, the concepts of the dairy companies about the CCPs in Egypt will be discussed, whether the dairy companies implement this system correctly or not. One of the most important features of the CCPs is to ensure the quality and safety of dairy products. Moreover, CCPs are the most critical elements in SCs that affect production.

There is some evidence in interviews one, two and three, respectively, discussing the CCPs in Company-A. These are: *"The CCP is the process parameter that guarantee achieving the end result consistently each time without the need to test it", "The CCPs is an expression we use to describe the food safety control parameters within the operations per each product line", "Keep the CCPs for the food safety system- it is subsidiary of the food safety system", and "if we have pathogenic microorganism, if it passed through the pasteurisation, theoretically speaking, the pasteurisation minimum heat treatment should kill all these pathogens…so this critical point is eliminated, and it is called CCP".*

There is some evidence in interview four on the concept of CCPs in Company-B: *"CCPs: Operational Prerequisite Program (PRP), Raw milk temperature, Raw milk bacterial level".* Moreover, there is some evidence in interviews eleven and twelve in Company-D are represented in: *"The CCPs differ from one product to another"* and *"Each production line has its own CCPs".* In addition to, two pieces of evidence in interviews nine and thirteen in Company-E as follows: *"Critical control points…are applied on the mozzarella production line"*, and *"CCPs vary from one product to another"*.

Moreover, there is some evidence in interviews fifteen and sixteen describing the concept of a CCP in Company-F as follows: *"Quality is the core of our factory"*, *"there is a huge difference in the production of raw milk between summer and winter. This difference also appears in the fat* *percentages between both seasons"* and *"The pasteurisation processes. We have a filling line process ensures the goodness of the process".*

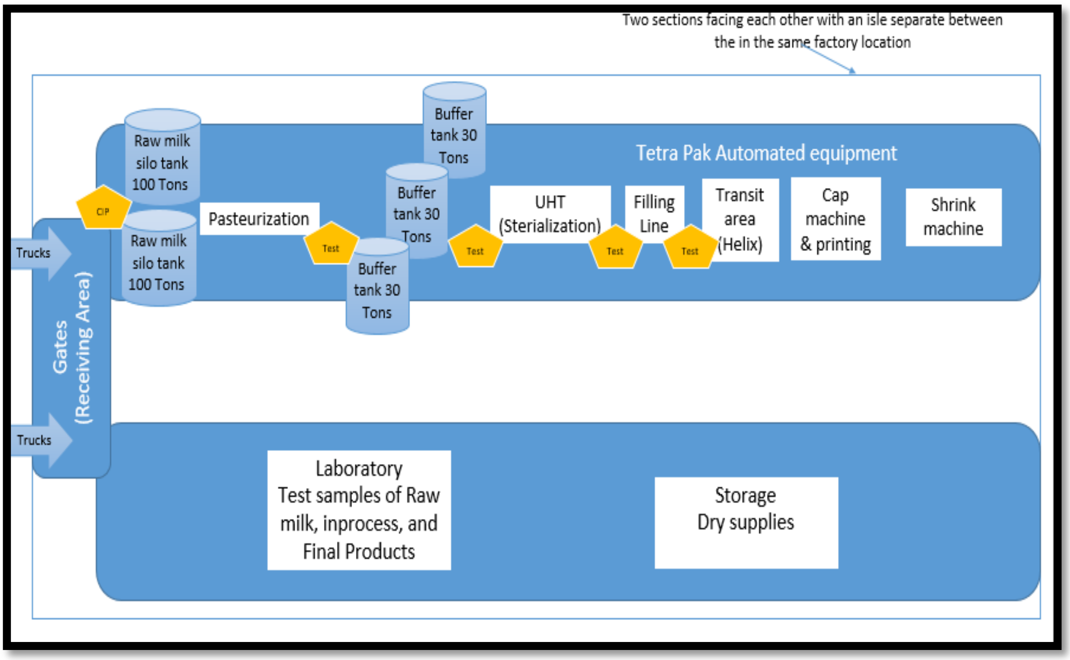
4.4.1.7 Kinds of Critical Control Points

The types of CCPs differ in dairy companies in Egypt. This is what was proven by the interviews. The interviews of the dairy companies targeted in the research proved that the types of CCPs are different, as well as their scale in the companies, due to the production regulations and the priorities of all companies in production, as well as the different stages of manufacturing in different companies. Also, supply chains differ in companies, and this leads to different types of CCPs in the Egyptian dairy companies.

Some evidence addressed in interviews one and two of the types of CCPs followed in Company-A. will be presented are represented by some of the statements that were clarified in the interviews as follows: *"Milk CCPs are Antibiotic residues, UHT filters. UHT high heating time and flow", "using the HACCP gets you the CCPs"* and *"The pasteurisation temperature and the UHT temperature".*

Furthermore, some evidence are addressed in interviews four and five of the kinds of CCPs followed and used in Company-B as follows: *"There are 9 CCPs", "Under the same UHT CCP checkpoint, we have CCP for milk, and another CCP for juice, and CCP for almond milk", "The UHT temperature is the first CCP", "It is called packaging integrity; the package welding should not allow any leakage. That's why I need to check it every 15 minutes. Of course, the equipment does this check", "Hydrogen peroxide in the 230ml equipment…All other equipment has sensors that read the level of Hydrogen peroxide. The equipment which does not have this sensor needs to have a CCP checkpoint every two hours.", "3 CCPs for the cows' milk products"* and *"the other 4 CCPs are for non-dairy products".* The following figure illustrates the critical points representing the CCPs of Company-B. This illustration is created based on personal observation held to their factory and reviewed with one of their participants.

Figure 4.6: Company-B 'Make' Factory Layout-Source: Author



In addition to, some of the evidence addressed in interviews seven and eight of the kinds of CCPs followed in Company-C as follows: *"the pasteurisation point and the holding time. Those are the main CCPs for milk processing"* and *"During the production, right after the CIP, we do sample tests for the equipment itself from different areas during the production and last the GMP which is one kind of quality audit to the hygiene and cleanliness of the place, the production line, the operators and everything…all this together controls the process".*

Three evidence addressed in interviews ten, eleven and twelve, respectively, of the kinds of CCPs followed in Company-D as follows: *"Holding time, Bacteria total count, Temperature control, Production line efficiency", "Some of the CCPs in the UHT milk is; temperature, microbiological tests to assess the quality of raw milk-bacteria total count, holding time, and package sealing"* and *"PH level which changes over time".*

Moreover, one evidence addressed in interview thirteen of the kinds of CCPs followed in Company-E will be presented as follows: *"The most generic common CCPs are: Chemical concentrate test, the microbiological test should be zero contamination, temperature control with a range of minimum and maximum temperature-vary according to the product".*

While the evidence addressed in interviews nine, sixteen and seventeen of the kinds of CCPs followed in Company-F are as follows: *"The first CCP is the pasteurisation stage, second the pasteurisation heat temperature, and then adding the preservatives", "the CCPs here are: The*

Hydrogen peroxide concentration should not be less than 35%. If the oxygen level decreased below the 35% the equipment stops", "it is three spots; the raw milk, the pasteuriser, and the filling line", and *"The critical control points for milk are the milk temperature should be appropriate, the filters should be available in the milk processing for safety to remove any impurities in the raw milk...Third, the storage temperature".*

The CCPs differ in number and nature according to the product produced. Those CCPs differ in temperature degree and percentage of chemical and bacterial concentrate. The CCPs are spotted as tests on the production line in Figure 4.6. The fewer the CCPs the better. This means that the production process is controlled and monitored carefully from the beginning. Once the CCP test check is fulfilled successfully, this means the process is successful.

4.4.1.8 Operational Capabilities

Operational capabilities differ in Egyptian dairy companies. As each company has its own criteria and elements that set priorities for division and work on them. For example, there are companies that rely on their farms only to obtain raw milk, while there are other companies that do not have private farms and depend on suppliers, and there are companies that depend on their farms as well as suppliers. The operating capabilities of the companies are divided into several sections, including Production Line, Sales and Marketing, Demand Plan, System, Packaging, Cheese Processing, Milk Processing, Resources, Labour Competency, and Lead Time.

Firstly, production lines companies pay great attention to their production lines and place them at the forefront of their interest in distributing their operational capabilities as this guarantees the quality of products. This is the evidence from interview one for Company-A, and it becomes clear as follows: *"The production run length depends on the design and the filler capability*". Moreover, this is what showed the evidence from the interview seven for Company-C: *"Mainly the efficiency of the production lines. It's measured with something called OEE (Overall Equipment Effectiveness). So, the OEE of the production line is the main factor when deciding whether the production line performance is good or bad".* Interviews ten, eleven and twelve of Company-D supported that as follows: *"Let's start with the equipment…As we are part of Mansour Group, we have the most recent production lines for yoghurt, fresh pasteurised milk or processing of milk or processed cheese", "in terms of production, we are part of Group…it gives us the privilege"* and *"Our production lines are equipped with the most advanced equipment to ensure the effective safe and secure productivity of milk products. We have flexibility to introduce new milk products using the same production lines, by doing this we can reduce the cost of production".* Also, interview four and five in Company-B mentioned: "*I can produce for 30* *minutes and then switch to skimmed right away...So that we can produce on the same production line*.", "*I can convert the 1Litre production line to 750ml or 500ml*". This is also supported the evidence from the interview thirteen for Company-E as follows: *"flexibility determined based on the product nature and the required equipment and supplies needed to produce the product".*

Furthermore, this is also what showed the evidence from interview nine for Company-E, fifteen, sixteen and seventeen for Company-F, and it becomes clear as follows: *"We have cheese with olives, istanbolly, baramily, all these products can be produced by the same production line", "We produce powdered milk. Sometimes we have excess raw milk from our farm instead of disposing this milk, we process it to produce butter and powdered milk", "We are working based on product layout at the factory…The product layout means every production line produces group of products with similar attributes and/or characteristics", "The production line composed of 10 workstations with almost 4 fillers, followed by labeller, then shrink. We have 2 production lines for each workstation with different capacities", "We have an annual plan which is the ultimate goal we aim at, and a daily production plan. All production factories work on this base. We set this ultimate annual plan according to our capabilities and the capacity of our pasteurisers and the equipment's productivity in terms of filling how many bottles per hour"* and *"Because the consumer wants the product with the date of today, and I distribute my product on a daily basis. Take care, the UHT milk producers do not change the date daily. They change the date every week or every 10 days. So, they use the same date for the production of many batches".*

Second, sales and marketing, some companies explain that their operational capacity depends heavily on sales. This is evident from interview three for Company-A as follows: "*We have a massive storage capacity... It is located at the factory and absorbs the sales 2 weeks in advance, even if the factory did not produce at all. The available stocks can cover two weeks".* And so, agreed to interview four of the company-B and this is shown by the following evidence: *"We get it from sales and marketing"* and *"it starts with marketing".*

This is evident from interview seven for Company-C: *"you will always face this challenge, shall I drop two to three days for maintenance, these days will impact the sales badly to fulfil the market and the machines are on hold".* And so, agreed to interview twelve of Company-D and this is shown by the following evidence: *"We are a market leader in the fresh pasteurised milk product with short shelf life and our products are used by the international cafés and restaurants".* In addition to the evidence from interview seventeen for Company-F: *"I might have a very large capacity at the factory and do everything, but the marketing cannot sell this product. Especially the fresh milk product".*

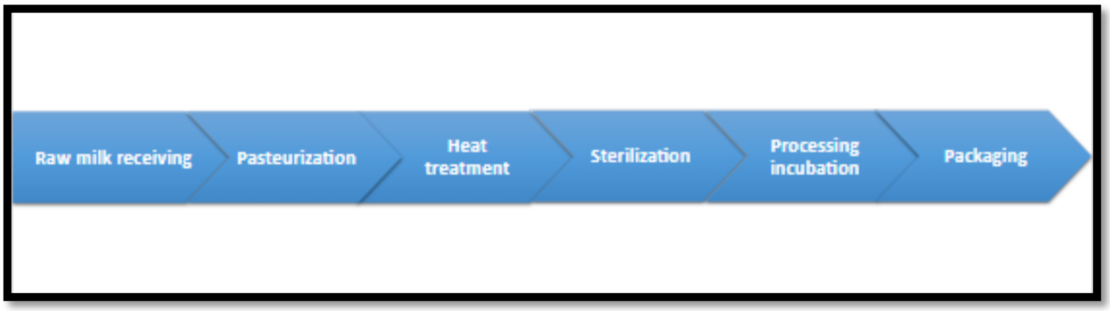
Third, demand plan, many companies rely on the demand plan to clarify their operational capabilities plans and be the main driver for them in their production plans and setting the company's priorities. That is related to the pull strategy, which enhance the SC agility. This was shown from interview four with Company-B by the following evidence: *"We have a demand plan"* and *"It gets renewed for the next month every time. So, we always have a 12-month demand plan present for us. There's also a five-year plan for general purposes, to calculate any warehouse capacities, production capacities and all supply capacities such as trucks and distribution centres".* In addition to, some evidence was shown from interview eleven for Company-D as follows: *"Our production lines are capable in fulfilling double the amounts in the high demand season with minimum rest time to the equipment, but with the proper maintenance"* and *"We never ran out of stocks or lost orders in terms of dependability. As we always balance our production through managing our demand plans around the year. We fully utilise our production lines with 100% capacity during the summer season and we underutilised them during winter, in both ways we have enough safety stock to feed the market".* All this support and strengthen the SC agility.

Fourth, system operating capacity systems differ in dairy companies. This was clarified by interview five of a quality assurance head at Company-B. This is evident in the following evidence: *"I want to tell you that I have established a system for the factory that includes 23 procedures, from farm to table. These 23 procedures make around 2250 documents. Each document might include 1 to 300 papers. So, guide me with a list of capabilities".* Interviewee twelve agreed on that for Company-D and Company-F, and this is clear from the following evidence respectively: *"We have our own fleet in collaboration with the suppliers' fleet. Those trucks are supported with GPS connected with the factory's information system to track the supplies"* and *"I have created a report including the amount of supplies I am receiving from each supplier".*

Fifth, packaging, one of the most important operational capabilities that dairy companies are interested in is packaging and this is because improper packaging can lead to contamination, so companies must ensure the quality of their products by placing good packaging as a priority in operational capabilities. This is what was agreed upon in interview eight of Company-C, with the evidence: *"For the factory resources, all the raw materials, the packaging materials, the manpower or the overheads, the equipment and time".* Also, one of the directors of Company-D agreed in interview eleven on the importance of packaging in the company and this is what is shown in the following evidence: *"The cost of production can be managed also by looking for local suppliers instead of international ones. We did that by changing the packaging materials after the currency devaluation and we ensured that the local package provided the same protective conditions to our products".*

Sixth, cheese processing, the operating capabilities of the company are divided into its products, for example there are operational capabilities for milk processing, yoghurt processing or cheese processing. There are some clues in interview number nine of Company-F. This is evident by: *"the white cheese is one product. But we have different specifications of it. For example, we have white cheese with natural fat and white cheese with vegetables fat. Both can be produced by using the same production line"* and *"if I am going to produce these two products, I should start with the plain feta cheese then followed by the olives because it has a flavour".* Such evidence can be visually supported by Figure 4.5 for Company-E's illustration of their production lines, either for milk processing or cheese processing.

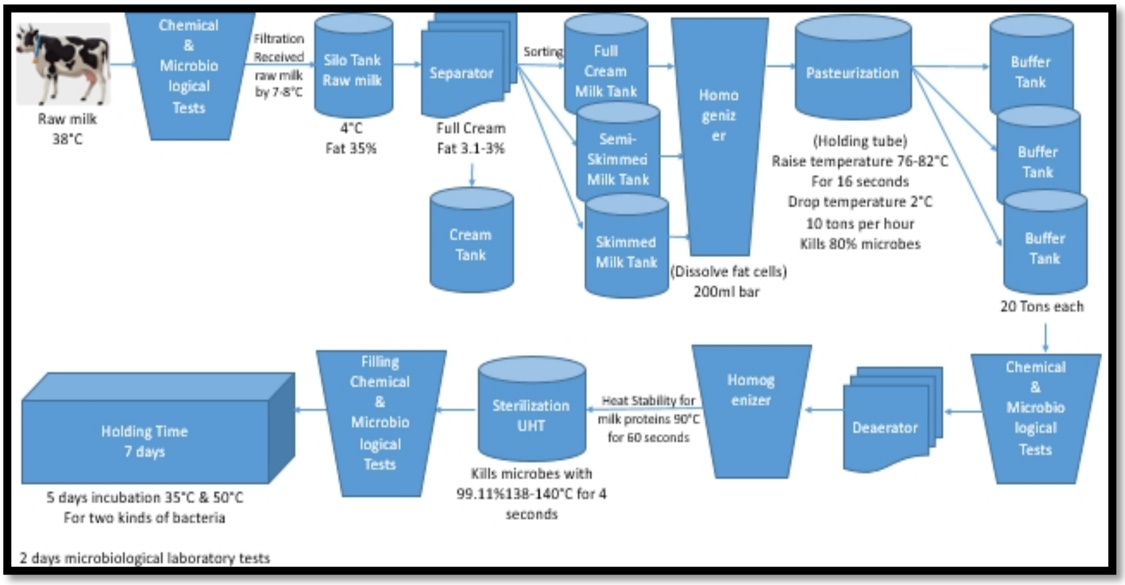
Figure 4.7: Milk Processing Steps- Source: Author



In parallel, the milk processing flow should be explained to help the reader visualise the dairy production process. Figure 4.7 provides a brief visualisation of a unified milk processing step that must be held starting from the farm until it is ready for consumption. Evidence from Company-A interview one is: "*I should maintain the milk's sterility...In the pasteurised milk, it is only killing the pathogenic microbes, but the milk still has bacteria*", "*Received a raw milk and packed it as milk product passing through the pasteurisation processing. If I want to produce skimmed milk, I will remove fat from it and then pack it and move the fat to the production of other products. Using the same process with the same equipment."*.

It is also supported by Interview nine for Company-E and Interview five for Company-B with evidence mentioned respectively: "*We used to have heat treatment to products such as the milk or dairy in general, we should start with heat treatment, the UHT-Ultra Heat Treatment, sterilisation...We used to have an engineer to adjust the pasteuriser on 72 Celsius degrees for timing of 15 seconds. Then, he keeps monitoring the temperature to ensure it does not gets below the 72 degrees"* And *"When I receive the milk, the 20 tons tank get pasteurised in 2 hours and I withdraw samples for chemical and microbiological tests, again. If the chemical test is okay for me, I will withdraw the milk and push it to the UHT equipment and start with a preliminary* *heat process at 75 degrees, then go to the deaerator…followed by a heat stability phase, where I heat the milk at 90 degrees for 60 seconds".* This detailed extracted description is illustrated visually in Figure 4.8.

Figure 4.8: Company-B Milk Processing- Source: Author



Seventh, resources, in addition to that, companies rely on clarifying their operational capabilities plans on the resources they own, whether these resources are self-contained, from their own farms and factories, or resources obtained from suppliers or from other dairy companies. In interview ten of Company-D, the following clues were clarified with this: *"The capabilities reflect all the available resources needed to produce the product. However, the activities are the utilisation of those capabilities".* Interview thirteen also agreed on this in Company-E, and this is evident by: *"We always have different suppliers for the same raw material and other alternatives to cover any problems".*

Eighth, labour competency, the operational capabilities of the companies increase by increasing the labour competency in them. This is due to the fact that labour competency means raising awareness among workers and using correct methods of production, which increases the efficiency of dairy products by increasing their quality. This is what will be proven through interview ten of Company-D from the following evidence: *"labour, it's one of our capabilities. As we looked after our human resources for over 20 years until it shifted from the public sector to the private sector and was acquired by Mansour Group".* Besides evidence from interview fourteen of Company-D: *"On the operators' level, or the operations in general, we give them courses, send them external experts to explain to them their role and its impact on the production* *process. We provide them with safety courses, hygiene courses, personal skills courses with their colleagues"* and interview two of Company-A: *"We invest in the labour competency".*

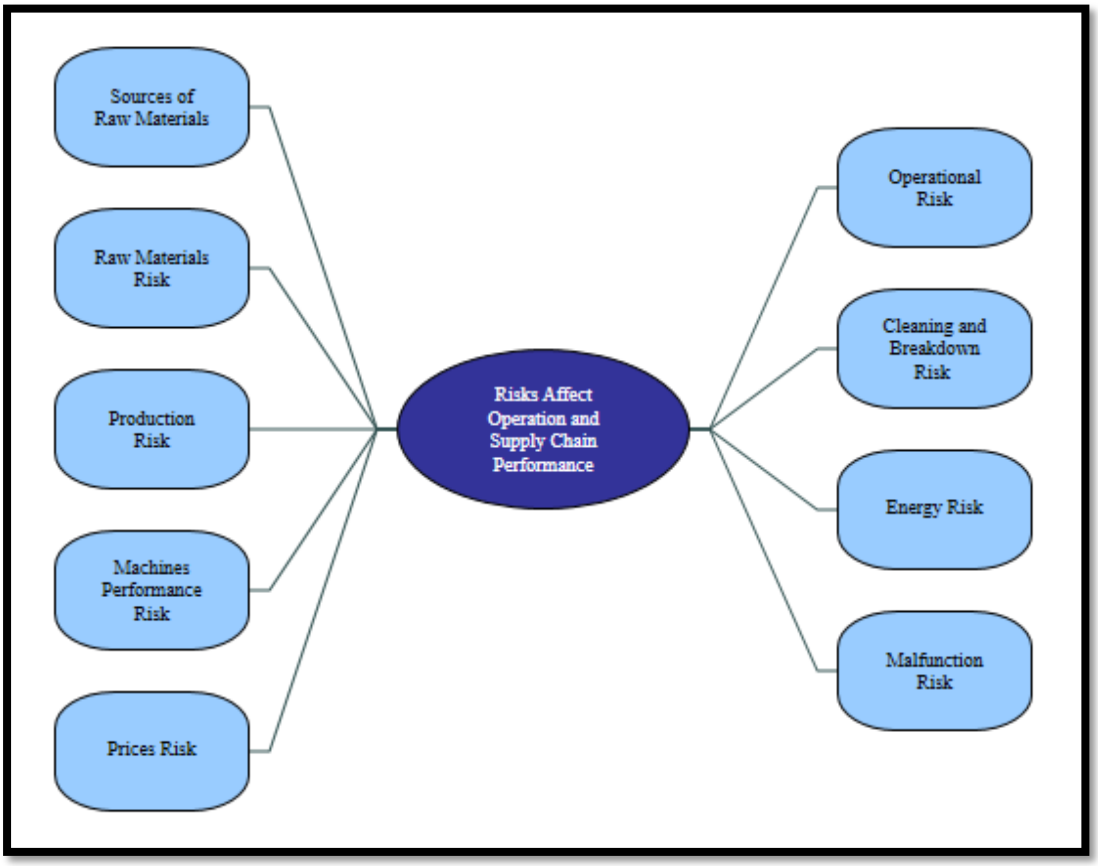
Ninth, lead time, determining the operational capabilities of the Egyptian dairy companies depends on the lead time in delivery or production. This indicates that lead times have a strong impact on companies' operational capabilities and plans. This is evident in the following from the evidence found in interviews thirteen and fourteen of Company-E's managers: *"release time or holding time for the quality control tests before it is delivered to the final consumer"* and *"the speed of the production time, the lead time of importing the resources".* Also, interview one of Company-A mentioned: "*We call it service level agreement in the operations. Each activity has a lead time".* Interviewee ten of Company-D stated*: "The speed or lead time of producing the fresh pasteurised milk product inside the factory is 24 hours in addition to another 20 more hours specified for the release time and the checkout of the product and ensuring its quality tests are safe and meeting the standards.".*

To summarize, 1) vertically integrated SC represented in managing their capital and functioning in a group. That provides better transparency and enables them to be more efficient. 2) there is a different number of CCPs according to the product type and different interpretations for it, 3) investments in production line technology are essential to increasing capacity and agility while not affecting quality, only the large dairy producers can afford this. 4) Working on a demand-driven SC, based on the updated customer demand, 5) Line flexibility, agility, speed, and capacity of production are key, and it appears that many of these players do changeovers frequently with lots of products. That reflects its efficiency. Some companies have better production schedules than others according to their demand plan accuracy. 6) The large dairy producers adopt the ISO standards on different disciplines like food quality and the environment. Applying these standards is a must to qualify them for exports.

4.4.2 Theme of Risks Affecting Operation and Supply Chain Performance

For defining operations and increase the SCP in dairy companies, the risks affect operation and SCP that emerged from the data could be expressed into several codes, which are: Source of Raw Materials, Operational Risk, Raw Materials Risk, Cleaning and Breakdown Risk, Production Risk, Energy Risk, Machines Performance Risk, Malfunction Risk and Prices Risk. These codes are illustrated in Figure 4.9.

Figure 4.9: Theme of Risks Affect Operation and Supply Chain Performance



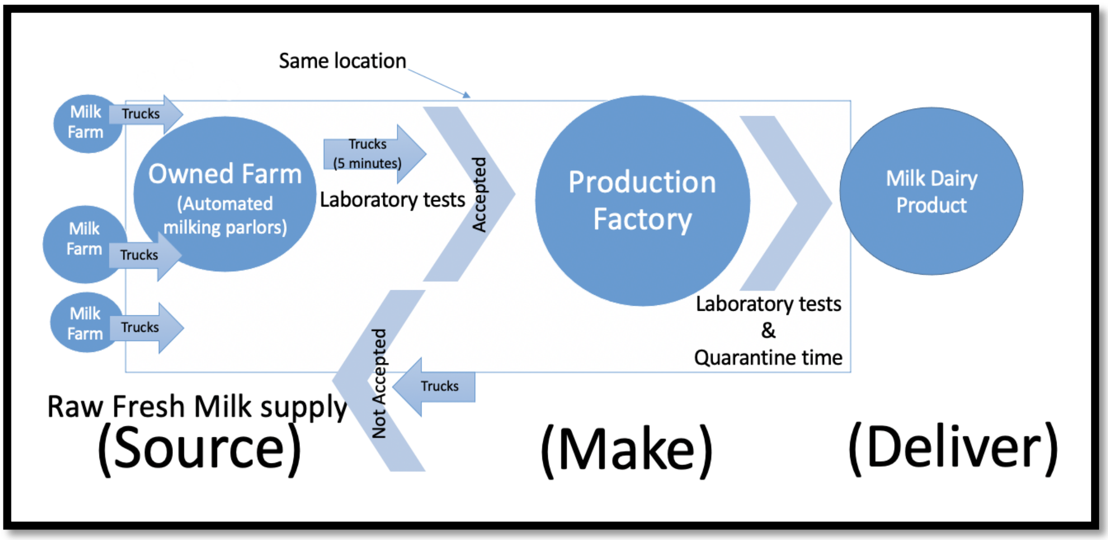
4.4.2.1 Sources of Raw Materials

Dairy companies depend on many farms to obtain raw milk or even raw materials, so there are companies that rely on their own farms only to supply raw milk to them, and others do not have any disputes, so they depend on external farms and obtaining milk from suppliers or competitor farms. There is also a third type of company that owns many production lines, so this type is not only satisfied with the raw milk produced from its farms, and it needs to obtain a percentage of the raw milk from suppliers and other farms.

In this part, some evidence from interviews in different dairy companies in Egypt will be discussed, indicating that even companies that own farms do not rely only on the products of their farms for their production, but also deal with suppliers. In interviews one, two and three in Company-A, some evidence will be presented that clarifies the above: *"I am investigating the sources of raw milk supplies for the MCCs…to ensure the raw milk sources and practices to ensure the quality", "Is it feasible to establish my own farm or outsource? Shall I pay high prices for the milk or pay to build long term relations with MCCs to bring me cheaper prices of milk from the* *farms?", "We buy only from approved suppliers",* and *"I have multiple suppliers, all of them are approved, but with different approval criteria for the dry materials or wet materials".*

In interviews four, five and six in Company-B, some evidence will be presented: *"we ensure the same quality and it's exactly one source supplier", "the farm is only 5 minutes away from here (the factory)", "Company-B's farm is known for its top quality of raw milk. Because you use imported cows' herd", "But our farm fulfils our supply with 60-70%.",* and *"We provide fully integrated milk process at one place".* Figure 4.10 shows a simple visualisation of Company-B's integration between its own farm and relying on other supporting farms for raw milk. This visualisation was created based on an observational field visit to their factory.

Figure 4.10: Company-B 'Source' to 'Make'- Source: Author



Moreover, interview seven and eight in Company-C presented the following: *"We have our own farm…it supplies around 15% of the dairy supply"* and *"Our farm does not cover our productivity".* Also, interview ten, eleven and twelve in Company-D presented more evidence: *"We do not have our own farms, but we rely on long term contracts with authorised farms and MCCs by the Egyptian National Food Safety Authority (NFSA)", "We have two categories: Grade A milk is collected directly from the farms (contracted farms) and Grade B milk collected from the collecting centres",* and *"We have our own MCC in Damanhur and we contracted with small and large farms, in addition to the international suppliers for the powdered milk and other materials".*

Furthermore, interview thirteen in Company-E presented some evidence: *"we do not have our own farms. We rely only on suppliers and MCCs specially for the fresh milk".* Moreover, some evidence supported this from interview fifteen, sixteen and seventeen in Company-F: *"We rely totally on the farm. Our company…is concerned with the farm's development of the output from the farming process and ensuring the product safety to the end customer", "the raw milk we get only from our farm. We do not buy a single drop of raw milk from an outsider farm, even the powdered milk. It is also produced at our factory"* and *"We deal with many suppliers."*

Thus, companies rely on different sources of supplies, some companies are vertically integrated, other companies own their farms, others are single sourced from a supplier, some from a range of suppliers. All these approaches will impact risk in different ways. It will help to reduce risk, single-sourced is risky, multiple sourcing helps to spread risk. The key is to maintain a steady flow of raw milk to keep the production going.

4.4.2.2 Operational Risk

The first risk that could lead to a shortage in the SCP is the operational risk. Firstly, the production lines and the quality of the products, as well as the operational risks can greatly affect the SCP. Some operational risks can be wrong planning or wrong choices for SC systems, which in turn can lead to the adoption of SC systems that do not fit with the company's strategies or production lines.

This was explained in the interviews and discussed on the extent of the impact of operational risks on the SCP in dairy companies. Interview fourteen also agreed on the extent to which operational risks affect the SCP for Company-E in the following evidence: *"If I could not make the raw material available at the right time, I will not be able to put the production in practice".*

The continuous improvement team leader at interview eight of Company-C also supported this by mentioning: *"I get affected by the supply chain from the supply side where they provide me with the raw material and the packaging materials. At the same time, I impact the supply chain on the demand side. Because if I did not produce, he would not deliver. So, the supply chain impacts me and feeds me with input. My output is based on him and his output is also based on me".* This reflects factors which cause production stoppage like unreliable suppliers or production line's breakdown. That will impact the overall SCP in delivering products to the market.

4.4.2.3 Raw Materials Risk

Lack of raw materials can lead to significant risks affecting the operation of dairy companies as well as the performance of the dairy producer's SC. Risks of raw materials may occur due to their shortage or the use of raw materials that are not suitable for industry and do not meet the quality standards. These raw materials can be the raw milk used in the production, packaging materials, flavouring materials and other raw materials that maintain the quality of dairy products.

Egyptian dairy producers consider raw material risks as one of the most vital risks that seriously affect the SCP and their operating performance. This was clarified in the interviews that were conducted for the study. Interview two for Company-A clarified some evidence as follows: *"Bottlenecks may occur and hinder the production if they did not empty the existing silos periodically, which may result in blocking the entry of the coming raw milk".* Company-D also agreed in interviews eleven and twelve on that and explains that in the following evidence: *"Seasonality of raw milk and demand fluctuations"* and *"Currency devaluation is considered a critical challenge to obtain the raw materials and manage our production variable cost".* Moreover, Company-F also agreed on that in interviews fifteen and sixteen as follows: *"you might face shortage of materials you need to fulfil your demand. Materials of caps, flavours or any other raw materials"* and *"Our location resembles a real challenge to the workers as one of the resources…resembles an issue and a challenge to hire the talented calibres of them most of the time. This happens on both levels of the workers and the higher rank. The destination might be a bit far from some supportive industries, which may raise the prices due to the increasing cost of transportation to reach our destination".* Company-D interview ten also included the evidence: *"We have the most strict receiving policy…We refuse many batches to retain the name of Mansour company.".*

Company-B interview five provided this supporting evidence: *"the lack of following the specifications. This is the main issue facing the manufacturers who want to provide Grade A products. We are surprised that many suppliers and multinational companies apply a very fragile system, which is not applied…That is why we reject them...It takes a month to audit 1 to 3 suppliers to select one good supplier.".* Also, Interview eight of Company-C supported this by mentioning: *"the received milk is not compatible or inaccurate amounts, or the milk truck is not clean, or the driver is not committed with the hygiene rules".* Thus, quality and consistency of supply is absolute key to production.

4.4.2.4 Cleaning and Breakdown Risk

Hygiene risks are among the most important risks that affect the SCP, as well as the operation of dairy companies, as there are many institutions that in turn monitor the operations of cleaning, quality, and safety of dairy products in companies, and they report periodically to the Ministry of Health, and NFSA. Therefore, cleaning risks greatly affect dairy companies in Egypt. In addition, the risk of faults in factories comes, which in turn may lead to stopping the operation of industries for some time, and this can lead to great financial loss for companies. Therefore, the risk of faults is an important element in the chain that affects the operation of companies.

Therefore, attention to the risks of breakdowns and cleaning is very essential for dairy producers to maintain the efficient SCP and operations. This is clear in interview number two from Company-A, as follows: *"Filler's cleaning are the major operational challenges. In case of breakdown or cleaning happening, this makes a difference in the production process which requires flexibility in the production or the cleaning decision".* Company-E and Company-F broadly agreed on this, as these risks were discussed in interview nine of Company-E with the evidence: *"If the Hydrogen peroxide is not 35% and the paper gets in, it will cause contamination to the product…it will cause harm and risk to the consumer. If the preservative is added with less percentage, it will cause microbiological risk"*, and interviews fifteen and seventeen of Company-F revealed the following evidence: *"If the vets found out this kind of disease it will recommend killing the cows in this station. That is a risk on your farm and the nearby farms",* and *"Corona Virus which impacted everyone".* Thus, the frequency of production line cleaning (CIP) and sterilisation is critical. It happens every 24 hours in milk production lines. A simple wash is held when shifting the production from skimmed milk to full cream milk. That will not affect the fat percentage in milk production with a higher fat percentage, But the opposite scenario is not the same and requires CIP.

4.4.2.5 Production Risk

Production risks have a negative impact on the operations of dairy companies in Egypt. Productivity risks can also affect the SCP. As production risks can come in the production stages without any plans or expectations for them. Production risks also occur for several reasons, including, for example, a shortage of raw materials, a malfunction in the machinery used in the industry, or a weakness in production lines. Therefore, production risks are an unexpected risk that may include any other risks.

This is what was clarified by interview three with Company-A, where it drew attention to the production risks that could be the result of any of the other risks that companies face. Some evidence of this will be presented from the interview as follows: *"As long as we are working at a factory, we are always at risk in all production phases".* Interview eleven of Company-D dealt with this concept also about production risks that affect the SCP with the following evidence: *"The size of the farm impacts the production at the factory. The production lines depend on the amount of raw milk supplied to the factory".*

4.4.2.6 Energy Risk

Certain energies are used in the production stages of dairy products, as each product needs different temperatures from the other to get produced and preserved, for example, the temperature and energy used in the production of milk differs from that used in the production of cheese and others from the production of yoghurt. Same applies on the farms' cooling system to sustain the cows' health and welfare and the factories' refrigerators and the cooling temperature to avoid the spoilage of raw milk or final dairy products. Also, power cut-offs and electricity instability affect the operability of the equipment. Therefore, energy risks can lead to product spoilage, and this affects the operation of companies, as well as preserving raw materials with a certain energy so that they are not destroyed, and this affects the SCP.

Energy and heat risks are discussed in the interviews. Company-C paid attention to energy risks and placed it as the main risk that affects its operations as well as the SCP, and this is explained in interviews seven and eight through the following evidence: "*Heat Wave. It's also called Three-Days Fever", "The Three-Days Fever affects cows in the summer in intense heat waves. And it makes them sick for three days and unable to produce milk. So, if it happens for a whole farm, it's a disaster"* and *"Power fluctuations. If there's any kind of power fluctuation it causes fluctuations in pasteurisation machines, so it completely ruins the batch and it gets drained"* and *"there is risk related to the energy, all these production lines operate with electricity. If the energy is unstable, it will destroy everything. If there was a power cut at the factory it takes a very long time to put the factory back to work. If there is product at the filling lines, it should be expelled".* Another evidence from interview three of Company-A is: *"electricity shut down"*. The power cut-offs and instability represent a major risk affecting the industrial areas in Egypt. That affects the factory and the farms equally. It causes the production lines to stop at the factory and impact the cooling systems for the cows. Thus, energy and power instability threaten the whole manufacturing sector and the dairy sector specifically.

4.4.2.7 Machines Performance Risk

The performance of the machinery used in such industry is a risk threatening the operations, as the use of industrial machines that do not conform to the specifications set by the Ministry of Health and the institutions whose role is to pay attention to food safety may lead to harmful and unhealthy dairy products of poor quality and this in turn may lead to large losses and could reach the closure of these companies by government institutions. This was discussed in interview seven and eight of Company-C as follows: *"The performance of the machines is the most crucial for us. We always regularly tackle that issue"* and *"if the break-down exceeds an hour, you will lose 3 hours of production, because you need to do CIP in those 3 hours, and you lose all the milk and yoghurt amounts".* Another evidence from interview ten of Company-D: *"If I had machine breakdown for 5 to 6 hours, so I have lost 500.000 cups of yoghurt I cannot recover it".* Also, interview thirteen and fourteen of Company-E included: *"The productivity of the machine is reduced when there is maintenance, which will increase the cost. Because it will produce defective products"* and *"if an equipment or production plan went through breakdown it resembles a huge problem. I will not be able to fulfil my demand and consequently I will lose benefits and profit".* Besides that, interview three of Company-A also provided evidence related to this risk which is: *"Once the equipment stops it means all the amounts inside will be considered defected and wasted. The equipment will reject it…which are around 300 packages nearly".* Interview four and five of Company-B also mentioned: *"Machine breakdowns happen"* and *"When there is equipment breakdown, this equipment should go for CIP-Clean in Place and SIP-Sanitize in Place again…it takes at least 5 hours out of the 20 hours".*

4.4.2.8 Malfunction Risk

Malfunction risk affects the operation of companies and affects the SCP, and this is due to the fact that malfunction risk may be caused by suppliers during the supply of raw materials, destroyed by them due to a malfunction in heat equipment, or it can also be malfunction risk resulting from the production itself in the company. Accordingly, the cause of the malfunction risk is at the same time affected by it.

The interviews dealt with evidence that malfunction risk negatively affects the operation of dairy producers in Egypt. It also addresses that it affects the SCP in these companies. This was clarified in interview one and three of Company-A with: *"I might have many quantities of raw milk, but I have a malfunction in the production lines"* and *"this waste does not count on the production department but is reported to equipment malfunction. For example, the equipment's safety lock opens mistakenly by itself. So, we report this waste to the abnormal issue with the equipment"*.

Also, interview six of Company-B included: *"in case there is equipment malfunction, the technician should fix it in 3 to 4 minutes' maximum"*. Interview eight of Company-C, provided another evidence: *"there is risk related to the malfunction, if I have a malfunction which I cannot fix in an hour, I will reject all the products inside the equipment and do a CIP cycle for 3 hours"*. In addition, interviewer eleven for Company-D explained this also using some of the following evidence: *"Equipment malfunction or breakdown".* Moreover, Company-E in interview thirteen and fourteen stated: *"If we face any malfunction in any equipment or production line this will slow the supply chain agility and responsiveness" and "challenges related to the equipment's spare parts and avoid any malfunction".*

4.4.2.9 Prices Risk

In recent times, especially after the Egyptian pound floated, companies have encountered many problems in prices, either the prices of raw materials or the machinery and the prices of their products. Therefore, a new risk threatening the dairy companies in Egypt has emerged, which is the price risk. The companies discovered that this risk has an impact on the company's operation and SCP. The rise in the prices of raw materials as well as the increase in the prices of machinery used in production has led to an increase in the prices of the raw products produced by the company, which in turn led to a decrease in the sales and profitability of companies recently in Egypt.

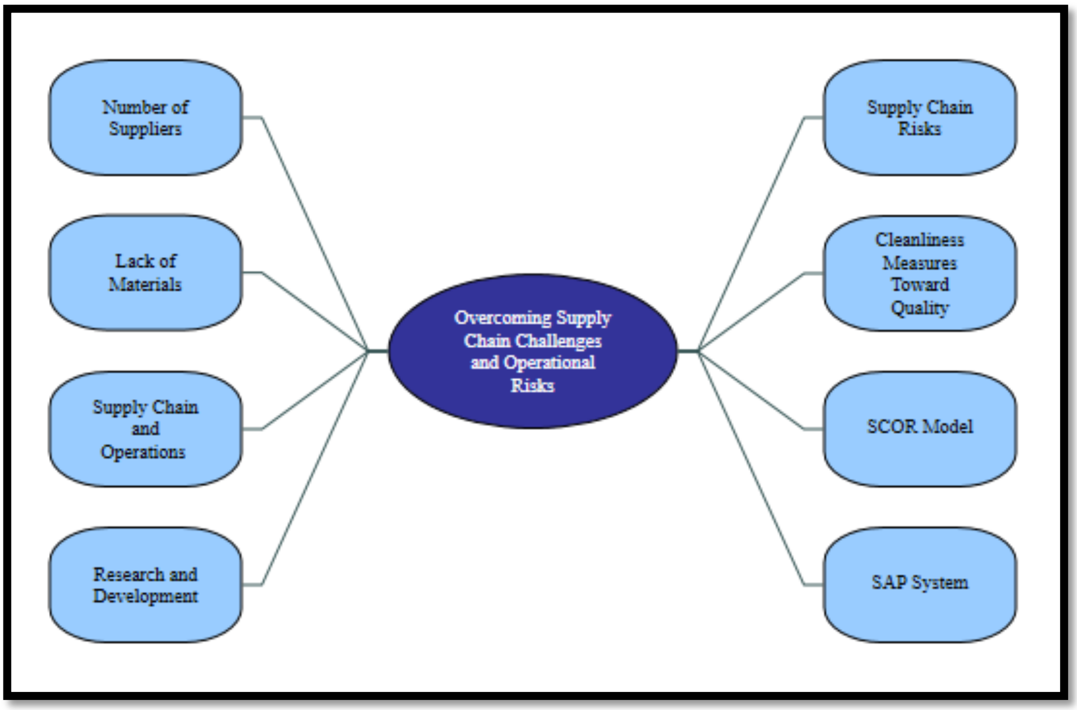
This was discussed in interviews ten, eleven and twelve of Company-D, and the interviews revealed some evidence that price risks greatly affect the company's operations, and this is evident in the following: *"the most critical issue in the factory is the variable cost, which is the raw material's price and the packaging materials price", "Imported packaging material high prices"* and *"after the currency devaluation, the final products cost of production doubled".* Company-E also agreed on this, and this is evidenced by the evidence in interview thirteen, and it is clear as follows: *"High prices of powdered milk, Delay in the customs clearance, Packaging materials shortage".* Thus, the increasing prices of supplies lead to increase in the production cost and higher final product's prices, which keeps the SCP vulnerable.

4.4.3 Theme of Overcoming Supply Chain Challenges and Operational Risks

For defining operations and increase the SCP in dairy companies, overcoming the SC challenges and operational risks that emerged from the data could be expressed into several codes, which are: Number of Suppliers, Supply Chain Risks, Lack of Materials, Cleanliness Measures Toward

Quality, Supply Chain, and operations, SCOR Model, Research and Development, and SAP System. These codes are illustrated in Figure 4.11.

Figure 4.11: Theme of Overcoming Supply Chain Challenges and Operational Risks



4.4.3.1 Number of Suppliers

The company's dependence on suppliers varies from one company to another. This is because dairy companies that have their own farm(s) do not deal with the same number of suppliers like the other companies that do not own any farms. Those who do not have their own farms, their primary dependence is on suppliers only to obtain raw milk. While there are dairy companies in Egypt that have farms and rely on them 100% and do not deal with any raw milk suppliers (see Table 4.1).

Some evidence from companies will be presented on the number of suppliers that are dealt with in the targeted companies in the study. Interview number two and three in Company-A revealed some evidence, including: *"120 different farms for milk only and MCCs-Milk Collection Centres."* and *"Our suppliers for the straw are a company called Tawfikia Plastics and Baron".* Interviews four and five in Company-B, revealed some evidence, including: *"you have only one supplier you trust"* and *"3 farms in addition to our farm".* Interviews number seven and eight in Company-C, revealed some evidence, including: *"They're around 30 farms"* and *"A lot…We have a special department responsible for managing them; it is called 'the farms' improvement department".*

Moreover, interview ten, eleven and twelve in Company-D, revealed some evidence, including: *"Company-D source their fresh raw milk from 25 local suppliers including large farms and MCCs", "25 local farms and our MCC. In addition to different collectors, we rely on them in the low supply season, i.e., summer" and "25 farms".* Interviews nine, thirteen and fourteen in Company-E, revealed some evidence, including: *"We have around 20 to 25 farms", "190 suppliers include both local farms, local packaging materials, producers and international powdered milk suppliers and in collaboration and partnership with TetraPak", "I should have many suppliers in case any drop happened for any reason"* and *"If we are speaking about the skimmed milk powder, we can have 15 to 20 suppliers".*

Furthermore, interview fifteen and seventeen in Company-F, revealed some evidence, including: *"We have a maximum of two suppliers for the packaging in terms of the bottle and the cap"* and *"we have many suppliers, starting from the empty bottles, the caps".*

4.4.3.2 Supply Chain Risks

There are multiple risks threatening companies in terms of SC systems. This section covers how SC overcomes risks. As the risks of SCs can lead to paralysis in the operation of dairy companies, and this is due to the fact that the SCP has an impact on the quality of production and the safety of final products and this is because the risks of SCs are formed in the form of raw materials used in production, if raw materials are used in poor quality, this will lead to the production of products that are not in compliance with international and local quality regulations and systems.

There are some evidence that were collected from interviews one and three from managers of different departments in Company-A as follows: *"The raw side with all the risks", "the product might be prone to risk at the preparation phase, during the storage at the warehouses, or during the production process", "We have risk assessment at each phase…the product should not remain in the tanks more than a specific period of time, the raw milk should not remain in the tanks more than a specific time to avoid being adulterated",* and *"There is another risk we face; the straw equipment might stop working".*

Moreover, there is some evidence that was collected from interviews four and five from managers of different departments in Company-B, and this evidence is explained as follows: *"There's a risk that the supplier might send you something that does not conform with your* *standards"* and *"we take 3 months to shift to another supplier. That's why we have long lead times…It impacts the quality assurance time in general besides the procurement time".* There is evidence that was collected from interview seven from managers of different departments in Company-C, and this evidence is explained as follows: *"Mainly fluctuation in powder prices. So that forces us to buy extra in certain periods of time...So, we're always dealing with that risk" and "Then we try to delay it until we watch the auction for the powder when it gets lower prices".*

Furthermore, there is some evidences that was collected from interviews ten and eleven in Company-D, and this evidence is explained as follows: *"The increasing price of Grade A milk than Grade B from the MCCs, which require the factories to add more processes to their production to improve the quality of Grade B milk", "Increasing the price of the imported powdered milk or the late deliveries of it"* and *"Increasing the governmental customs and regulations on the imported materials".* Also, interview seventeen from Company-F included this evidence which is explained as follows: *"The main risk we face in the production of fresh milk is time. Why? Because today is the 15th of February and I want to produce the fresh milk products by the 16th of February. So, I have to finish this production before 11:00 PM to be released for distribution on 15th".*

Company-D explained the difference between raw milk Grad A and B and how it represents a risk to the dairy company: "*The difference between Grade A and B is Grade A-cooled down in refrigerators once it got produced from the cow. Grade B-might remain from 10-12 hours until it gets into refrigerators…might increase the potential of growing bacteria and/or contamination*".

4.4.3.3 Lack of Materials

Dairy companies in Egypt suffer from different operational risks, due to the suppliers and due to the lack of materials that are used in production. This shortage of materials, such as flavours, powdered milk, stabilisers, or packaging materials can cause many operational risks because it reduces the production of companies and leads to an increase in unfulfilled demand, which leads to increasing the price of the product. Thus, in turn can lead to consumers heading to the products of competitors in the market. Accordingly, companies suffer huge losses due to material shortages and SC risks.

The lack of materials was discussed by most of the interviews, and all the companies targeted for the study dealt with it. First, interviews one, two and three for Company-A evidenced the following: *"If I target the economy segment, so I should provide them with a competitive price…I will use different packaging materials cheaper than the usual", "The delay happens. We have traders. Some materials are site specific or recipe specific. Not all the stabilisers are unified for* *all producers", "we do not have any other option except securing the supply"* and *"By having minimum stock levels, coverage, crisis management".*

Second, interviews four and five for Company-B indicated the following evidence in the interviews: *"If the supplier itself has a lack of resources…If they do not supply the dictated amount there are other terms that take place", "Fluctuations in demand can affect our stock. And if anything goes wrong in the farm it can lower my milk supply"* and *"We do not rely on a sole supplier for specific material. We have a main supplier supplying us with 70% of the material".*

Third, interview seven for Company-C, evident this as follows: *"I will have lack of resources".* Fourth, interviews ten, eleven and twelve for Company-D evident the following: *"we have lack of fresh raw milk during the summer", "devaluation is considered a critical challenge to obtain the raw materials", "Limited imported materials and constraints to entry by the national authorities, especially the customs clearance"* and *"Cow's productivity of raw milk decreases by 30 to 40% in the summer".*

Fifth, interviews nine, thirteen and fourteen for Company-E provided the following evidence: *"The lack of resources usually represented in the raw milk…Lack of TetraPak packaging materials", "which will reflect in increasing the production cost, or get it in large amounts and keep it in stock but this will also increase the overall supply chain cost", "You should have safety stock to cover your production up to 3 months in advance, to avoid running out of stock",* and *"We can accept it with compensation if we can mix it with another product (material) with good quality, so it might be accepted. But if it is totally unacceptable, we return it"*.

Finally, interviews fifteen and sixteen for Company-F evidenced the following: *"We Import the flavours. Sometimes we face delays and issues with the customs recently…we call it delay of delivery due to the regulations"* and *"Mostly in the peak period. Usually at the summer season. We have plans with the farms and issues related to the pricing".*

4.4.3.4 Cleanliness Measures Toward Quality

Egypt dairy companies rely on setting different cleanliness measures to ensure the quality of the raw materials that are received from suppliers or their farms. These raw materials go through many stages in the stage of treatment of harmful bacteria. The companies follow various cleanliness measures and cleaning of production lines, which in turn ensure the quality of raw materials and the quality of the final products.

The various cleanliness measures in the dairy companies are discussed in the interviews conducted for the thesis. First, interviews one, two and three for Company-A, from which some evidence was reached on the cleanliness measures it uses, and this is explained as follows: *"The quality is checked by the PH and doing a milk analysis gap. This analysis includes checks for potential adulteration (i.e., bad quality raw milk)", "There's a full system for the HACCP includes many things happen…including the sources coming from where, the cleanliness, the number of risks, the types of risks, the degree and level of risks. All monitored by a cross-functional team", "they do audits for the farms...They are responsible for the procurement together with the quality engineers who do the audit",* and *"Adulteration test by using water, adulteration test by chloroform, test for antibiotic, physical test for impurities-if there is unfamiliar ingredient other than the milk, the PH, the density, the fat".*

Second, interviews four, five and six were held with managers in Company-B, from which some evidence was reached on the cleanliness measures it uses, those are: *"When I audit a raw milk farm, I start monitoring their CIP system, GMP, HACCP, isolation systems", "The GMP reflects the labour's cleanliness, the place's cleanliness, the equipment's cleanliness",* and *"we apply higher quality standards represented in accepting raw milk with maximum 20.000 bacterial counts to ensure the ultimate quality of introducing safe and secure milk products to the final consumer".*

Third, interviews seven and eight were held with managers in Company-C, from which some evidence was reached on the cleanliness measures it uses, and this is explained in the following: *"It has veterinary doctors. Their role is going on periodical visits on all the farms to make sure that all the procedures are according to the guidelines. For example, that there are not any acid additives or antibiotic additions. That the cows are being treated properly. To also make sure that the tools are sterilised and clean",* and *"We test all the milk trucks before getting into the production line".*

Fourth, interviews ten, eleven and twelve were held with managers in Company-D, explained some evidence on the cleanliness measures it uses: *"Farms providing Grade A raw milk, use automatic milking equipment", "They follow all the national and international instructions to ensure their farm's cleanliness and hygiene level to provide raw milk free of any contamination", "The raw milk transferred from the automated milking parlour direct to the sudden cooling refrigerators then the raw milk filled into the tank without any exposure to air which ensure the raw milk is free of any contamination and maintained its total bacterial count",* and *"Grade A raw milk is the best quality milk with the best nutrition facts, usually it comes with high price".*

Fifth, interviews nine, thirteen and fourteen of Company-E explained the following: "*So the quality department responsibility is not limited to checking the final product, but its role extended to collaborate with the production department…control the process from the raw materials until the final product", "We support the milk suppliers by sending them our engineers from the quality control department and from the production to guide them with the hygiene process and tools", "Cleanliness of the milking equipment-sanitisation, Milking practises hygiene system",* and *"All the 6 points we included it Feeding, Housing and animal health"* and *"There is percentage of humidity, percentage of recomposition, percentage of protein".*

Finally, interviews fifteen and seventeen were held with managers in Company-F explained the following evidence: *"we should start with heat treatment, the UHT-Ultra Heat Treatment, sterilisation, slow and fast pasteurisation- in the old ages. We used to have an engineer to adjust the pasteuriser on 72 Celsius degrees…Meanwhile the equipment comes with a diversion valve to adjust the temperate as I entered to the equipment and it does closed circulation to adjust the temperature or give a sound and light alerts and return the milk back for pasteurisation", "There is milking protocol with the timings and everything to control the process", "The aflatoxins depend on controlling the cow's feeding within the acceptable input tolerance to get you the desired output", "we agreed that the somatic cells depend on the CIP, the cleanliness of the cow's fore udder" and "We are one of the largest dairy farms in the Middle East in terms of productivity and the cleanliness. That's why we maintain the raw milk quality".*

4.4.3.5 Supply Chain and Operations

The SC starts from the supplier 'Source' to the consumer 'Deliver', (Figure 4.8). So, SCs are seen as "in and out". The operations 'Make' that companies undertake are an integral part of a company's SC. There are many concepts linking SCs and companies' operations. These concepts were addressed in the interviews by presenting the respondents with different understandings of the relationship between the SCs in dairy companies and their operations.

First, evidence will be shown from interview one in Company-A as follows: *"The supplier already knows the amount of supplies required by each producer. Also, he calculated his cows' productivity and managed accordingly. Therefore, any constraint from the supply chain will impact the whole chain", "operations are an integral part of the supply chain…This is the supply chain-in and out. The operations cover the part related to the equipment, labour, manufacturing overheads, the conversion cost, utility cost", "I cannot separate between the supply chain and operation. I deal with it as one unit"* and *"This is the supply chain of the farm, which impacts the supply chain of the operations".*

Second, evidence will be shown from interviews four and five in Company-B as follows: *"We adapt to problems in the supply chain. Or the supply chain adapts to problems in the factory", "It is reciprocal relation"* and *"we in the production or the research and development- R&D. We need new materials; we send an order to the procurement department. Based on that, the procurement department starts to look for suppliers".* Third, evidence will be shown from interviews seven and eight in Company-C as follows: *"there's a relation between operations and supply chain", "The system is a closed loop…I get affected by the supply chain from the supply side where they provide me with the raw material and the packaging materials. At the same time, I impact the supply chain on the demand side"* and *"My start as a factory comes from the supply chain. I cannot operate without them, and my output ends at the supply chain also, because they will take the product from me (the factory)".*

Fourth, evidence will be shown from interviews eleven and twelve in Company-D, these evidences are as follows: *"Dual direction"* and *"If I can say both operations and supply chain, are impacting each other then it is, because it is more of a loop connected together and its success depends on the effective availability and collaboration of all supply chain member and the right utilisation of all resources within the supply chain through the production".* Fifth, interviews thirteen and fourteen in Company-E included the following evidence: *"the relation between the supply chain and the operations or the production are integrated", "All impact each other. If I could not make the raw material available at the right time, would not be able to put the production in practice" and "If I did not have a relationship with the suppliers and agreed with them to supply me the required materials with the agreed cost, time and amount. All this will impact the production".*

Finally, evidence will be shown from interviews fifteen and sixteen in Company-F as follows: *"you cannot match the supply according to the demand in the dairy sector. Usually in any sector, you check your demand plan, then check your supplies and operational capabilities and match between them accordingly to avoid excess capacities and stocks", "the parameters impacting the market start with the upper extreme supply of the raw milk prices and the market demand. Both control the whole business"* and *"the supply chain is the main controller of the process. Mainly starts from the production planning from the supply chain on different levels".*

4.4.3.6 SCOR Model

Dairy companies in Egypt do not adopt the SCOR model to measure their SCP and company operations. This is what the study relies on in measuring the effectiveness of SCP in Egyptian dairy companies and their relationship with the internal operations of these companies. Among the SCOR model attributes: Reliability, Responsiveness, Agility, Cost and Asset Management. This is what organisations should rely on in their SCP measurements.

The importance of the SCOR model in measuring the performance and effectiveness of SC systems emerged in the interview. Some results and evidence from interview eight about the effectiveness of applying SCOR model in Company-C are presented in this evidence: *"If you are speaking about something like the SCOR model…we have plenty of resources or capabilities…energy, time, material, and everything, and the sales' opportunities of course. We need KPIs to monitor and control all this and achieve the best benefit out of all these resources combined. These KPIs describe my current state and should direct me on how to improve my performance. When we apply a KPI we have two sides per each. First side is to monitor, and the second side is to improve".* The SC manager in interview sixteen of Company-F expressed his awareness of the SCOR model and applying part of it by mentioning the following: *"We follow part of the SCOR", "Not all of it to be honest. Some parts of the reliability and responsiveness are only activated but the rest are measured from a financial perspective"* and *"we need best practice. We should have at least one academic in the large producers to organise training programs to guide the suppliers towards creating the KPIs like at the SCOR where it really measures the performance starting from supplier of supplier until customer of customer. If you have a look on the SCOR you will note that the improvement does not come from one part in the middle. That is a required improvement".*

4.4.3.7 Research and Development

The interviews also covered the effectiveness of research and development in the operational performance in companies and the SCP. Some dairy producers' lack of research and development skills can lead to a decrease in the percentage of operational excellence in companies as well as a decrease in their SCP. The following will show evidence from interview five for Company-B: *"we in the production or the research and development- R&D. We need new materials; we send an order to the procurement department. Based on that, the procurement department starts to look for suppliers and send samples to the R&D to test it".* However, another exceptional case has a qualified R&D represented in the following evidence. Interview eight of Company-C indicated: *"They also work on adjusting the farms' supply curve which is inverted to match our demand curve. That is their R&D role, finding solutions to adjust their supply to match our demand curve. It is a separate department with a full team of workforce".* Also, interview ten of Company-D mentioned: *"We have the R&D department at Company-D with experienced production and quality engineers who are capable of improving this supplier* *and make him compete with the other monopolising suppliers...I have one of two options related to the supplier. Either to increase their number or to develop one of the existing suppliers".*

4.4.3.8 SAP System

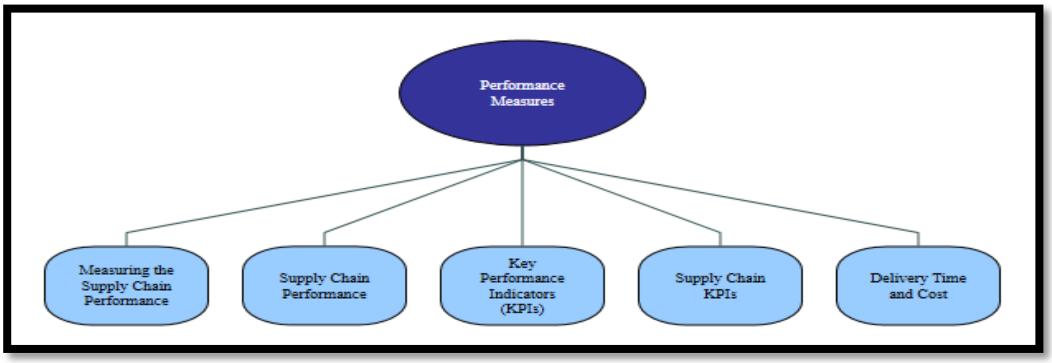
The relationship between the company's SC systems and its internal operations develops upon the adoption of the SAP system. This is what interview two of Company-A mentioned: *"We have the SAP system calculates all these things"*. Also, interview four of Company-B discussed the importance of implementing the SAP system to improve the relationship between SCs and the operations of dairy companies in Egypt. Evidence from this interview is mentioned as follows: *"The relationship between the operations and the supply chain became much better specially by applying the SAP system", "we have planners responsible for connecting between the procurement and the production through the SAP",* and *"The relationship totally changed since 2015 after using the SAP…Introducing the central supply chain concept for the whole group not only for the factory".* In addition, interviews seven and eight of Company-C provided the following evidence supporting the SAP utilisation as follows*: "SAP, and it is connected with Company-C's SAP and ERP as well. They take the order and transmit it to the warehouse, then they get the products, prepare it, sort it, make it ready for release"* and *"They have an automated system and use handhelds all connected with the SAP software".* Additionally, interview ten of Company-D mentioned: *"we implemented the SAP system".*

In brief, the SCOR model is not widely known by the dairy producers nor applied, the cleanliness measures are top priority, multiple suppliers, research and development and software like SAP is beneficial for integrating the SC members which will enhance the SC reliability, agility, and responsiveness.

4.4.4 Theme of Performance Measures

For defining operations and increasing the SCP in dairy companies, the performance measures that emerged from the data could be expressed into several codes, which are: Measuring the Supply Chain Performance, Supply Chain Performance, Key Performance Indicators (KPIs), Supply Chain KPIs and Delivery Time and Cost. These codes are illustrated in Figure 4.12, where the codes are presented for the performance measures theme.

Figure 4.12: Theme of Performance Measures



4.4.4.1 Measuring the Supply Chain Performance

Egyptian dairy companies rely on various tools to measure their SCP. Therefore, the interviews sought to understand an important question about the tools that are used in different companies to measure the SCP in different companies and the efficiency of each measurement in achieving the goals of the companies that relate to their plans for SCs and the extent of efficiency that it achieves for them. The study interviews targeted six Egyptian dairy companies, to research tools for measuring their SCP using different methods and tools, and to understand these tools in the way they work and the steps to implement correctly. This in turn helps the thesis to reach a conclusion about the efficiency of the various tools on the SCP in the Egyptian dairy producers.

Therefore, in this part, some guides will be presented about the equipment for measuring the performance of operations and SC in the Egyptian dairy producers. Some evidence from interview one for Company-A is: *"There is something called OEE-Overall Equipment Effectiveness: it's a key measure in the supply chain performance in terms of per line"*. Moreover, some evidence from interviews seven and eight for Company-C is: *"It's called the Distribution Plan (DRP). That's regarding the supply chain. Another part is the procurement".*

In addition to, one evidence from interview ten for Company-D as follows: *"By using the SAP".* Furthermore, some evidence from interviews fifteen, sixteen and seventeen for Company-F: *"Reliability, Responsiveness, Agility, Cost, Asset Management"*, *"We follow part of the SCOR"* and *"We have KPIs. I have created a report including the amount of supplies I am receiving from each supplier".*

Different performance measuring techniques were noted among the dairy producers. Some of them design their own following checkups. All of them rely on demand planning and The OEE to reflect their reliability and asset management in fulfilling their plans. SCOR appeared to be a goal for them to gather their scattered performance measuring techniques.

4.4.4.2 Supply Chain Performance

The SCP varies in Egyptian dairy companies, depending on the company's strategies, regulations, and the plans that it adopts in its SC systems. Therefore, the SCP in the companies cannot be compared separately in their components, but the SCP can be measured between the dairy companies, as global health organisations, have standards and measures for the efficiency and quality of companies. These measurements and standards are stable. Dairy producers must follow these different standards and SCP measures and product quality in order to conform their product to specifications and obtain accreditation certificates from international organisations.

The interviews addressed some questions about the SCP in these companies. Interview one shows evidence for Company-A, which is: *"It differs from one company to another, it is all internal measures. It measures part of the return on investment. So, asset utilisation is part of the supply chain KPIs. It reflects the status of supply and demand and the percent of production lines' utilisation based on its designed capacity. Also, we have the OEE"*. Interview four of Company-B also clarified some evidence, and this evidence are as follows: *"My role is to foresee the trends of supply and demand in the Egyptian market and adjust between them to fulfil the demand"* and *"I manage the milk supply planning for Company-B...I try to fulfil Company-B's supply chain needs based on Egyptian trends".*

Interview seven shows for Company-C, the following evidence: *"First thing we measure forecast accuracy. Secondly, we watch bias towards demand",* and *"We also watch the loading plan everyday between the factory and the DCs-Distribution Centres…to achieve 100% of the plan"*. Interviews eleven and twelve of Company-D also clarified some evidence as follows: *"in the critical times or high demand seasons we surly update those KPIs accordingly"* and *"Should check the overall supply chain performance and updates".* This indicates that they follow a make to stock (MTS)-Push strategy to fulfil a higher level of agility and responsiveness of performance according to SCOR. Sometimes they follow the make to order (MTO)-Pull strategy with foreign customers for exports like Company-E with processed cheese and white cheese. This achieves the agility, reliability, and asset management for SCOR.

Moreover, interviews nine, thirteen and fourteen for Company-E show evidence as follows: *"we have suppliers' assessment form…The procurement department cares about the specification and the delivery time. Not just the compatibility of the specifications. Based on the suppliers'* *assessment form, I might reach the result of dropping specific supplier", "We ensure that all our business partners share the same goal of enhancing the overall supply chain performance in terms of maintaining the market demand fulfilment with high quality products and keeping all the safety and security measures in consideration in the daily operations", "the production line should never stop. If it happens to stop, it means extra cost and loss for any reason, raw materials, malfunction, spare parts, labour, or timing...all this translated to loss"* and *"To get good quality raw materials available at the right time, partnership with trusted suppliers based on contracts"*. Interview sixteen of Company-F also clarified evidence as follows: *"in the SCOR where it really measures the performance starting from supplier of supplier until customer of customer".*

So, the push SC strategy with periodical demand forecasting checks to set the annual demand plan seems to best suit the dairy producers. That will increase their efficiency in lowering the SC cost. This plan is updated monthly and weekly if there is any sudden demand change. This achieves the balance between agility and efficiency in reducing cost.

4.4.4.3 Key Performance Indicators (KPIs)

Companies track KPIs and vary by the SC part. Either the supply side 'source' or the production side 'make', company size, and company goals. KPIs are defined as a group of indicators that measure the performance of employees, production steps and suppliers, and from which the performance and effectiveness of the companies are measured. Therefore, KPIs are different from one company to another, so different dairy producers can apply different KPIs from the other, due to the goals and strategies of different companies.

Therefore, in this part, some guides will be presented about the KPIs available and applied in the Egyptian dairy companies. Some evidence from interviews one, two and three for Company-A are: *"The KPIs have food safety incidents", "the food safety KPIs of the supply chain. The target is zero food safety incidents", "asset utilisation is part of the supply chain KPIs. It reflects the status of supply and demand and the percent of production lines' utilisation based on its designed capacity", "I think the responsiveness and the delivery decisions are related to the KPIs; you might think of Agility as a common attribute combining all of those", "Generally, plant KPIs usually generic around, OEE, overall equipment effectiveness, Conversion cost, Loss in process, First time release, Consumer complaints CPM, complain per million units produced, Production specifics, water, electricity and fuel, Service level agreement with internal stakeholders, shipping and delivery and Production plan compliance to sales requirements", "KPIs for the factory are conversion cost, cost per tons, OEE, Inventory is one of the KPIs", "We have a very primitive KPIs based on the supervisor assessment to the labour performance in terms of productivity, issues,* *following the instructions, following the daily check-ups, lack of concentration", "KPIs applicability is random"* and *"The KPIs for the production process should be based on the history of each equipment and each product to assure the change occurring".*

Interview four, five and six of Company-B also clarified some evidence, and this evidence is as follows: *"I have planning adherence KPIs. Out of stock percentage. Raw material or final product packaging material…Production achievements", "quality considered one of the KPIs",* and *"we have an annual plan…It starts with the marketing department, then the sales department to cover each area and supermarket".*

Evidence will be shown from interviews seven and eight in Company-C as follows: *"When the supplier provides me with the materials it is called service quality. For example, the customs clearance it is kind of a service", "report any NCR-None-Conformity Report if quality is out of specs from the supplier", "The quality, DPMU-the defect per million unit, it is one of the KPIs", "The CPMU-complaints per million units. We have a hotline for consumers to call and report any complaints related to any defect…Based on that, we measure the complaints percentage. Another KPI is the FTR-first time release…The higher the first time the better the process", "Those are the major quality KPIs; DPMU, CPMU, and FTR", "It reflects the efficiency with the quality, the availability…of a particular production line", "For the production KPIs, the plan attainment, which is the fulfilled percentage of sales plan" and "the performance, and the quality, it calculates the OEE KPI".*

Some evidence from interviews ten, eleven and twelve for Company-D as follows: *"we have many KPIs…one of them is the lead time if it is met as documented or not", "Cost, Number of suppliers, Material availability, Order fulfilment, Decision time between placing the milk sourcing until its delivery to the factory",* and *"the cost and the delivery time, number of suppliers, prices meeting our budget or not".* This is evident in the KPIs classification.

Interview nine, thirteen and fourteen shows for Company-E provided the following evidence: *"We have a set of KPIs for this laboratory", "We do have KPIs for the workers. Usually we do this assessment monthly, quarterly, and annually…There is a different form for each of the worker, the technician, the engineer, the shift supervisor, and the manager", "On-time delivery and have all the materials on the required time",* and *"the procurement KPIs are different than the quality, the production, or the final storage. It depends on the processes of each department".*

Interviews fifteen, sixteen and seventeen of Company-F also clarified some evidence as follows: *"two KPIs: cost and productivity…those are the core", "For the livestock sector, there is a large group of KPIs. First, the productivity includes 2 KPIs, the average production per cow, the total* *farm productivity per year, the income over feed cost which indicate the feeding cost and the return per cow compared to this cost",* and *"The order fulfilment cycle time and the order fulfilment on-time-on-full which is the case per rate and its time, its supplied amount and whether it is supplied at its designated time or not".*

KPIs are applied on the operational level of each phase along with the SC. The factory KPIs differ from the supplier's KPIs. It includes the parameters that assess the SCP periodically. That reflects the SC attributes in terms of reliability, responsiveness, agility, cost, and asset management.

4.4.4.4 Supply Chain KPIs

Unlike the last section which was handling what are the KPIs in general and if they are applied or not in the six companies. This section explains the SC KPIs specifically. To ensure the SCP, companies establish certain KPIs, by which companies ensure the effectiveness and efficient performance of their SCs. As it was explained previously, companies track different KPIs. This part examines several evidence that companies are applying different KPIs to ensure the SCP in the different dairy companies targeted in the thesis. First, the evidence in interview one for Company-A will be shown, and the evidence will be explained as follows: *"Under the food safety KPIs of the supply chain. The target is zero food safety incidents…In terms of safety, it is zero incidents and zero fatality, zero loss time engine. All those are safety and quality", "the KPIs are for the supply chain in general"* and *"asset utilisation is part of the supply chain KPIs".*

Second, the evidence in interviews four and five for Company-B will be shown as follows: *"monthly supply chain meeting with KPIs being reviewed by top management", "Every department has KPIs, and the supply chain has its own KPIs as well"* and *"It is a KPI related to the procurement specifically in the supply chain".* Third, the evidence in interviews seven and eight for Company-C will be shown, and the evidence will be explained as follows: *"Those are the supply chain KPIs which are related to the operations"* and *"We need KPIs to monitor and control all this and achieve the best benefit out of all these resources combined. These KPIs describe my current state and should direct me on how to improve my performance".*

Fourth, the evidence in interviews ten and twelve for Company-D will be shown as follows: *"all the KPIs we just discussed improve the overall supply chain performance"* and *"procurement KPIs".* Fifth, the evidence in interviews ten and twelve for Company-E will be shown as follows: *"The Egyptian national food safety (NFSA) approved…We audit those suppliers by ourselves not by a third-party company and ensure they are certified" and "I am determining a list of operational capabilities and supply chain KPIs. If both are fulfilled, you will enhance the overall* *supply chain performance".* Sixth, the evidence in interview seventeen for Company-F will be shown as follows: *"We have KPIs. I have created a report including the amount of supplies I am receiving from each supplier".*

4.4.4.5 Delivery Time and Cost

There are many Egyptian dairy companies that care a lot about the cost and delivery time, either for raw materials or the final products' delivery to the market and consumers. Especially in fresh dairy products with short shelf life like fresh milk products and yoghurt. Therefore, companies set some KPIs that relate to the cost and time of delivery of products and materials from suppliers to choose the best supplier to deal with, to reduce the cost. This provides more time for production to ensure quality and precedence in the market.

The interviews addressed some evidence that Egyptian dairy producers are setting some KPIs to ensure delivery time and cost commensurate with their goals. First, interview two for Company-A approved this by the production and R&D manager and this is evident as follows: *"the cost across the chain is a KPI"*. Secondly, interview five also agreed for Company-B, and the evidence as follows: *"the supply time duration, the price...pay on credit"*. Third, this is also explained in interview Seven in Company-C, and this is clear in the following evidence: *"Packaging, powder and spare parts for the machines. All these things need custom clearance. The faster it happens and spends less time in customs, the less it affects us. And it makes failure rates less".*

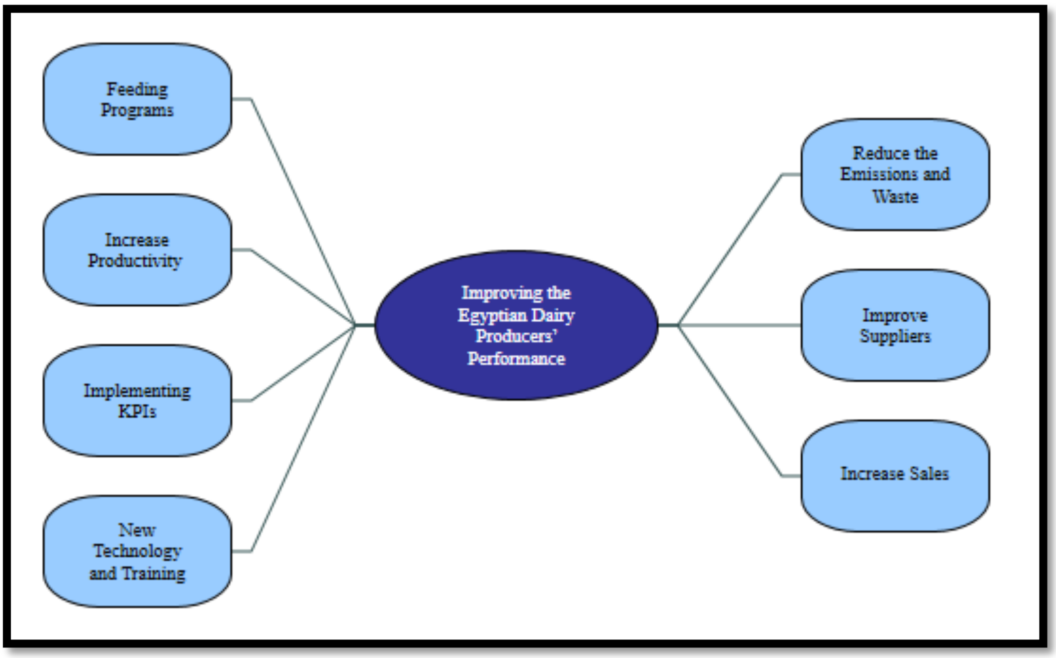
Fourth, this is also explained by interview eleven in Company-D in the following evidence: *"delivery time, the increasing number of suppliers, deficit in prices".* Finally, this is also explained by interview nine of Company-E with the evidence: *"we have suppliers' assessment form. We order specific raw materials with predetermined specifications at specific time. The procurement department cares about the specification and the delivery times. Not just the compatibility of the specifications",* and interview fifteen and sixteen in Company-F made this clear in the following evidence: *"the operations KPIs… fulfilling the factory's demand. The annual demand plan, the cost, and the amount you fulfil, how many times you reached stock out", "The case per rate is measured per supplier per orders delivered or the production adherence or plan adherence", "The imported items ETA (estimated time of arrival) with the shipping agencies and compare it with the actual delivery time and how to enhance it with the suppliers" and "we calculate the time and motion steady and compare it to the target time and seek improvements every now and then".*

Thus, SCP can be measured by specific KPIs on the operational level and the SC level. This will be reflected in the responsiveness and agility represented in the delivery time and the overall SC cost.

4.4.5 Theme of Improving the Egyptian Dairy Producers' Performance

For defining operations and increase the SCP in dairy companies, the improvement in the Egyptian dairy producers' performance that emerged from the data could be expressed into several codes, which are: Feeding Programs, Reduce the Emissions and Waste, Increase Productivity, Improve Suppliers, Implementing KPIs, Increase Sales and New Technology and Training. These codes are illustrated in Figure 4.13.

Figure 4.13: Theme of Improving the Egyptian Dairy Producers' Performance



4.4.5.1 Feeding Programs

The first goal of future plans to improve the quality of dairy companies in Egypt was to develop a consistent feeding system for the cows on farms to ensure the quality and the quantity of the raw milk produced. So, companies are interested in this to maintain and increase the production of the company's dairy products, whether from fresh pasteurised milk products with short shelf life or UHT milk with long shelf life. Where the interviews agreed that the quality of raw milk depends to a large extent on the health of the cows and the surrounding environment.

Here, evidence will be presented that adopting new systems for cows' feeding will help in developing their health and the SCP in dairy companies in the future. The following evidence is from interview one for Company-A: *"I will try to improve the supply chain practices, in terms of collection ways, and how to provide the farmers with feeding programs to enhance the milk production. It depends on the cows' herd and the feeding system".* Another evidence appeared in interview ten and eleven of Company-D: *"automated milking equipment, controlled feeding, and cooling system"* and "*provide their cows with the best feeding to increase their productivity of nutritious raw milk".* Also, Company-C in interview seven supported this by mentioning*: "check the cows' feeding, their medications and vitamins".* Figure 4.14 and Figure 4.15 Shows the automated milking area, the cooling system, and the feeding at Company-B for the Holstein cows' herd.

Figure 4.14: Company B Milking and Cooling System

Figure 4.15: Company B Feeding System

4.4.5.2 Reduce the Emissions and Waste

One of the companies' goals is to transform industries into green industries that care for the environment, in addition to reducing wastes which represent extra cost. These industries produce many environmentally friendly and healthy products. This is done by adopting green SC systems, which means developing SC plans, by which the harmful emissions from the company and the factory are reduced. Undoubtedly, the Egyptian dairy companies are very interested in reducing the level of emissions and laying down a lot of plans for reducing pollution and the waste specifically emitted from the production and their SCs.

In what follows, evidence from interviews on reducing emissions and waste will be presented as plans drawn up by dairy companies, and from which SC systems and performance in Egypt will be developed. This is evident in the interview two and three for Company-A, and this is reflected in the following evidence: *"Go lean…across the supply chain is to go lean. How to operate the production lines with the minimum crew, how to save the materials, loss in process, chemical usage, water, electricity…it's a continuous improvement. Of course, besides going green and the sustainability is part of it. How to improve my supply chain? Reduce the emissions"* and *"We work on minimising the waste"*. Also, Interview four of Company-B mentioned: *"Invest in the waste management"*. Interview ten of Company-D also agreed with the evidence: *"It is very* *important…to reduce the waste".* Supporting that, Interview thirteen of Company-C provided the following evidence: *"To reduce the waste and the defects of products".*

4.4.5.3 Increase Productivity

The goals of all companies are to set plans to increase production due to their goal of increasing their profitability. Companies set up different plans, but their goal is unified, which is to increase the productivity of companies. This is without a doubt the goal of the Egyptian dairy companies, which is to increase productivity, for example, increasing the number of suppliers, reducing the disputes that companies deal with, or following new production plans, or developing in the same factories and other various plans.

The following will discuss some of the evidence obtained from the interviews about the different plans that dairy companies are putting in place in Egypt, whose main goal is to increase the company's productivity. This is evident in Company-A through interview two as follows: *"As much as you can save money and increase productivity. It's a continuous improvement".* This is evident in Company-B through interview six and the evidence is as follows: *"We have built an extension to our factory at the same location to absorb more production lines and increase our production. In addition to introducing new products to the market"* (Figure 4.16).

Figure 4.16: Company B Factory Extension

It is evident in Company-C through interview seven and the evidence is as follows: *"We're currently applying methods for continuous improvement in manufacturing in Kaizen, Lean, and 6-Sigma"* and *"When we improve the production performance that allows us to get more output from the machines at the same time. Consequently, it allows us to perform maintenance at any time without pressure and without affecting efficiency as long as the machine is performing according to the plan and the designed efficiency".*

This is also evident in Company-F through interview eleven and the evidence is as follows: *"I need to increase the capacity to improve the performance of Company-F's factory. I need to increase the juice production capacity…install new equipment with larger capacity than the ones we have or replace the existing equipment", "we have future plans of development until 2027 and 2032 with detailed requirements for each year to fulfil its designed plan"* and *"I started the juice products from A to Z. New modifications in the milk products and the yoghurt. You will witness new yoghurt products in the market soon".*

4.4.5.4 Improve Suppliers

To ensure and develop the SCP in the dairy companies, the development of the suppliers with whom the company deals with must be ensured, for example by applying reward systems to ensure access to high quality raw materials at the lowest cost as soon as possible, or suppliers' awareness can be increased through some training courses. It will ensure the quality of transporting the raw milk and supplies to the factory, as well as the final products to the market.

Evidence from the interviews that were held with managers at six different dairy producers in Egypt will now be presented. This is clear from interview two in Company-A, and this evidence is as follows: *"The procurement is responsible for improving the quality of suppliers' selection. The quality is responsible for qualified suppliers regardless of what they provide".*

This is clear from interviews four, five and six in Company-B with the following evidence: *"Contracting with suppliers, tracking systems for the trucks connected with the market and the contracted suppliers, engaging key stakeholders, Growth in the animal welfare, invest in the waste management", "we hired supply chain director and warehousing manager…they studied the operational requirements and set a plan"* and *"Involve more technology in the supply chain to ensure on-time visibility with the supply chain members and have more control on managing our assets, our inventory and supplies' utilisation in each production line".*

This is clear from interviews ten and eleven evidence in Company-D as follows: *“We have our own MCC which is located in Damanhour”, “Build more MCCs”, “you build your MCC based on the place with the largest amount of milk, I do not have the freedom to choose it randomly”* and *“Increase our suppliers’ portfolio around the world with partnerships”.* This is also clear from interview thirteen in Company-E as follows: *“We aim to improve its supply chain and transform it to an integrated cold chain”* and *“Introducing new products with new packaging design, utilising tracking system for the sales, but we already implement tracking system within the supply chain to track any defect in the product from the raw materials to the final product materials”.* This is clear from interview fifteen in Company-F as follows: *“we need to improve the farming and the animals’ productivity on the agricultural level to reduce its cost and increase its productivity”.*

4.4.5.5 Implementing KPIs

There are some companies that do not adopt KPIs that relate to the SCP, and for this, these companies have their plans to implement KPIs to ensure that SCs are performing properly. One of the most important features of KPIs is to ensure that internal and external operations in companies operate according to the plans set to ensure their quality, efficiency, and future profitability.

Evidence from the interviews will be presented that indicates that the application of SC KPIs has a positive effect on the SCP. Therefore, Egyptian dairy companies depend on the application of KPIs in the future to develop the SCP. Evidence is represented in interview four for Company-B, and the evidence is as follows: *“Implementing KPIs. Building a system for that”.*

Evidence is represented in the interview eight for Company-C as follows: *“This goal is set for 4 to 5 years. We take this goal and subdivide our KPIs and look for areas of improvement to achieve this goal. This is our improvement strategy which we follow. We have a group of sub-KPIs”* and *“the same applies for productivity and so on. Each sub-KPIs should achieve certain values with historical data”.* More evidence is represented in interview fifteen and sixteen for Company-F as follows: *“we need to improve the supply chain KPIs in terms of operations specifically”* and *“We should have at least one academic in the large producers to organise training programs to guide the suppliers towards creating the KPIs like in the SCOR…If you have a look on the SCOR you will note that the improvement does not come from one part in the middle”.*

4.4.5.6 Increase Sales Increase Sales

Increasing sales in companies is one of the goals that companies care about. Increasing their sales stems from increasing their SCP. Egyptian dairy companies always set plans to develop the SCP, which in turn ensure an increase in the percentage of raw milk or materials used in manufacturing, as well as increase the quality of products, including increasing the productivity of companies with products of better quality and from them the company's sales increases.

Interview eight handled the plans of Company-C to increase its sales in the market, and this is evident in the following evidence: *"The business set a goal which is a big target. For example, to double the revenue, double the sales, increase the market share, or whatever. It is the overall business goals"*. While interview fourteen of Company-E discussed various plans to increase sales in the market, which are represented in the following evidence: *"We try to minimise the demand forecast error with the minimal deviation because it is the core. I have a specific number which I produce based on it. If this number changes, it will impact me positively and negatively. For example, my forecast indicates that I will produce 1000 units per month. Based on that, I ordered raw materials to cover the 1000 units per month, then he sold only 500 units. So, I will have 500 units available, or I will have raw materials to produce an extra 500 units which costs me; money, storage area, financial burden if I'm having a bank loan with interest rate, depreciation, and rent".*

4.4.5.7 New Technology and Training

The interviews paid great attention to developing new systems in production, using modern technology in manufacturing, and developing training courses for workers in dairy companies to increase the quality of products, reduce production costs, and follow the green and environmental systems of SC. The interviews also demonstrated the benefit of adopting new technology and its positive role on the SCP in the company's future. Moreover, adopting training courses for workers increases their awareness as well as for the correct implementation of environmental regulations.

Interview eight of Company-C dealt with a number of indications about the future plans of companies in adopting modern technology and training courses in order to increase the efficiency of SCs in companies, and these evidences are as follows: *"I will focus more on this area by using new technology, training, new resources to benchmark"* and *"investigating the causes of limited production line's efficiency, the root cause analysis, training the existing manpower for all the methods and techniques related to the continuous improvement; either lean or 6-Sigma. It is all part of their role"*. While interviews ten, eleven and twelve also agreed on that in

Company-D as follows: *"I am focusing on the lean management, and I wish to start applying it", "you do staff development programs and trainings"* and *"We introduce new products with better nutrition facts and enhance the marketing activities to increase the market share among the competitors".*

Moreover, interviews fifteen and sixteen agreed in Company-F and the evidence is as follows: *"Let's take the improvements we have for both…first, the agriculture, we have problem with the agricultural efficiency which led to increasing the costs of the agricultural processes"* and *"To have a training academy from the large companies…we need collaboration with suppliers and with customers".*

The key messages of the within-case analysis are: First, identifying the operational capabilities of each case. However, it differs from one company to another according to the existing number of production lines and the products produced. Second, risks appeared to be similar among the six cases, which represent the shortage of supplied materials and raw milk sources, the production risk in terms of breakdowns, cleanliness measures towards quality, and the increasing cost of raw materials. Third, performance measures differed from one case to another which will be summarized in the next section. Last, discussing how to overcome the risks and some potential performance improvement plans which ranged from increasing the productivity, improving suppliers in terms of cows' feeding, reducing the emissions and production waste.

4.5 Cross-Case Classification

This section provides a comparison among the six selected cases of Egyptian dairy producers. It provides a generic summary classification of the key characteristics and the differences between the selected Egyptian cases in this thesis in terms of the farms they deal with, whether owned or outsources, the number of plants, the number of production lines, the average number of suppliers, the plant location and size, and the milk products produced (Table 4.1). This guided the identification of the similarities and differences of the identified Operational Capabilities, CCPs and KPIs among the cases.

Figure 1.1 visualised the location of the selected cases to support the previous case classification provided in Table 4.1. The plants of Company-A, B, and F are located between both cities on Cairo-Alexandria Desert Road. Both Companies' C and E located their plants in the Industrial Zone in Cairo. Only Company-D's plant is in Alexandria. All plants being centralised in these locations near the highly populated cities with the most demand and labour force availability, in addition to its favourable weather and farming suitability is essential for the location selection decision. This is evident in interview three of Company-A with the evidence: *"Our factory is located in Nubaria where most of the farms are located"*. Also, the interviews four and six of Company-B provided the following evidence: *"The farm is in Nubaria on almost 3000 acres, it is located…nearer to Alexandria than Cairo."* And *"between Alexandria and Cairo. Both cities are known with the most percentage of local demand and their favourable weather for the cows' health and productivity of raw milk*". Figure 4.10 illustrated based on the personal observations held to Company-B's location prove that the factory is located within the Farm's boundaries and support better SCP. Interviews ten and twelve of Company-D also mentioned the following evidence: *"Factory is a 30.000sqm, located on the outskirts of Alexandria"* and *"This MCC usually located in a central place near the farm itself. So, they will make it easier for the farmer to take his cow there and avoid any manual milking"*.

The following subsections relates to three of the five major themes resembling the core constructs of a proposed operational and SCP best practice framework. Those are the operational capabilities, CCPs, and performance measures (KPIs). If dairy producers fulfil the elements of the three constructs, the remaining two themes will be achieved respectively. Those are: overcoming SC challenges and operational risks and improving the Egyptian dairy producer's performance, which remains out of the following cross-case classification. Because it highlights the commonalities of the core of the dairy producers' operations to create best practice framework's constructs.

4.5.1 Operational Capabilities

This section compares the concluded operational capabilities among the six cases by using the text search criteria function in NVivo12 to ease the search for the capabilities among the seventeen interviews and the two observations of each case. This function ensures the accuracy of word detection among the text to avoid missing any detail in the data sets and provide reliable cross-case comparison. Table 4.3 clarifies the similarities and differences between the operational capabilities across the six cases. The supporting quotes to these capabilities were discussed under Section 4.4.1.8. The six cases mostly share the same capabilities except that there is no evidence in the data that mentions the reliance on the tracking system in Company-A. This commonality explains and support the unified selection criteria of the research sample and qualifies the selected companies to adopt a best-practice framework.

Table 4.3: Operational Capabilities Cross-Case Comparison

Operational Capabilities	Case A	Case B	Case C	Case D	Case E	Case F
Production Line Efficiency/ Overall Equipment Effectiveness (OEE)	x	x	x	x	x	x
Production Line Flexibility	x	x	x	x	x	x
Storage Capacity	x	x	x	x	x	x
Operating Capacity System	x	x	x	x	x	x
Tracking System		x	x	x	x	x
Packaging	x	x	x	x	x	x
Labor Competency	x	x	x	x	x	x
Lead Time	x	x	x	x	x	x

Note: x indicates the existence of Operational Capability in each case.

4.5.2 Critical Control Points

Following the same approach applied to conduct cross-comparison for the operational capabilities, the following table clarifies the similarities and differences between the CCPs across the six cases. The supporting quotes to these CCPs in each case were discussed under Section 4.4.1.7. Aforementioned, CCPs differ according to the product being produced. This thesis and this section in particular focuses on the milk products' CCPs. They differed from one company to another. Either grouped or separated or having different naming for it. For example, the microbiological tests include the bacterial total count. Therefore, Table 4.4 list the most identified CCPs among the six cases as mentioned in the interviews for research integrity. For instance, Company-F does not have UHT temperature because they only produce pasteurised milk with its different assortment of flavours and fats level.

Table 4.4: CCPs Cross-Case Comparison

CCPs	Case A	Case B	Case C	Case D	Case E	Case F
UHT Temperature	x	x	x	x	x	
Bacterial Total Count	x	x	x	x	x	x
Antibiotic Residues	x	x	x			x
UHT Filter	x	x	x	x	x	
UHT Time	x	x	x	x	x	
Pasteurization Temperature	x	x	x	x	x	x
Packaging Tests	x	x	x	x	x	x
Hydrogen Peroxide Concentration	x	x			x	
Holding Time	x	x	x	x	x	x
Microbiological Tests	x	x	x	x	x	x
Chemical Tests	x	x	x		x	x

Note: x indicates the existence of the CCPs in each case.

4.5.3 Key Performance Indicators

This section compares the available KPIs in the six dairy producers. Some producers have primitive KPIs' as mentioned by one of the interviewees and others follow a more structured procedure to monitor their performance and seek improvements. Some evidence supporting the KPIs of each case can be found in Section 4.4.4.4. Then will be followed by Table 4.5 to classify the similarities and the differences between the KPIs applied in the six cases. Generally, performance measures centred around responsiveness, delivery decision and agility. Then, the SC KPIs are then divided to plant KPIs, and some participants named it asset utilisation and divided it into, the production lines' capacity and utilisation. In both cases they represent the 'make' side of the SC. Then, the livestock KPIs representing the 'source' side of the SC. Firstly, according to the recorded data in the interviews held, the plant KPIs include sixteen indicators that differ from one company to another. Some KPIs are divided into sub-measures. Cost is assessed based on the conversion cost and the materials' prices. Time is measured based on the decision time and the lead time, and suppliers are assessed based on the supply time duration and the price of supplies.

Secondly, although the livestock KPIs are performed by those companies who own their farm(s), other companies also mentioned some of the KPIs held by their collaborating farms. This is noted in the classification mentioned in (Table 4.1 and 4.5).

Table 4.5: KPIs Cross-Case Comparison

KPIs	Case A	Case B	Case C	Case D	Case E	Case F
Plant KPIs 'Make'						
Overall Equipment Effectiveness (OEE)	x		x	x	x	x
Loss in Process	x	x	x	x	x	x
Complaints Per Million Unit (CPMU)	x		x			
Production Utilities	x		x	x	x	
Plan Adherence or Order Fulfillment	x	x	x	x	x	x
Stakeholders' Service Level Agreement	x			x	x	x
Inventory (Out of Stock Percentage)	x	x	x	x	x	x
Labor Productivity	x			x	x	x
Quality	x	x	x	x	x	x
Defect Per Million Unit (DPMU)	x		x		x	x
First Time Release (FTR)	x	x	x	x	x	x
Safety	x	x	x	x	x	x
Cost	x	x	x	x	x	x
Time	x	x	x	x	x	x
Number of Suppliers	x	x		x	x	x
Livestock KPIs 'Source'						
Average Production per Cow	x	x	x	x	x	x
Annual Farm Productivity		x	x			x
Income Over Feeding Cost		x	x		x	x

Note: X indicates the existence of the KPI in each case.

4.6 Likert Scale Analysis

The 5-point Likert scale was used as a continuation step to the seventeen exploratory semi-structured interviews as an ending question. The SCP attributes were ranked; (1) indicate the very low performance and (5) indicate the very high performance.

The Likert scale analysis section is divided into two major parts. First, the averaging analysis to evaluate the performance of each company according to the SCOR attributes and the overall average of each SCOR attribute in accordance with the selected six companies. Second, counting the respondents' frequency of each performance scale whether it is very high, high, neutral, low, or very low and creating a percentage of it.

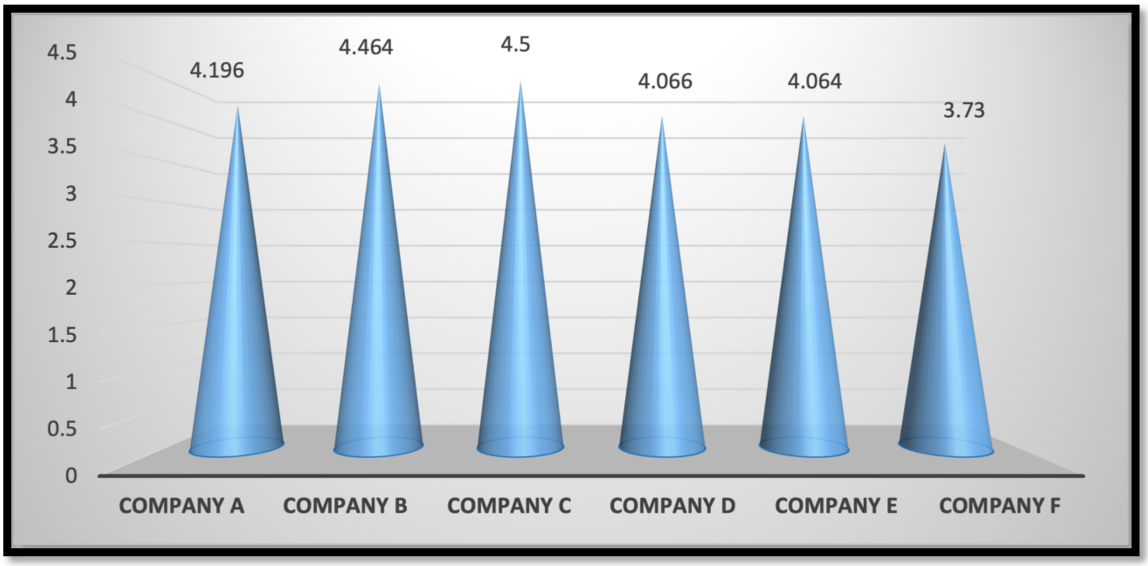
4.6.1 SCOR Attributes Averaging

This part is divided into two subheadings. The first subheading presents each company's performance average separately and assesses each SCOR attribute within each company. The second subheading presents the overall SCOR attributes compiled from the six companies. The detailed calculations for the Likert analysis will be found in Appendix Nine.

a. Companies' Performance

Company-B and Company-C achieved very high performance and the remaining four companies achieved high performance and still looking for areas of performance improvement. That is explained in detail with the qualitative within-case analysis. Company-B recorded an average equal 4.464 and Company-C 4.5. Contrarily, Company-A achieved a high-performance score with an average equal 4.196, Company-D with an average 4.066, Company-E with 4.064, and Company-F comes with the least average equals to 3.73 but remains within the high-performance range referring to Table 3.11. The following bar chart represent visually the averaging representation per each company. The following charts were created by using Microsoft Excel.

Figure 4.17: Total Performance Average per Company



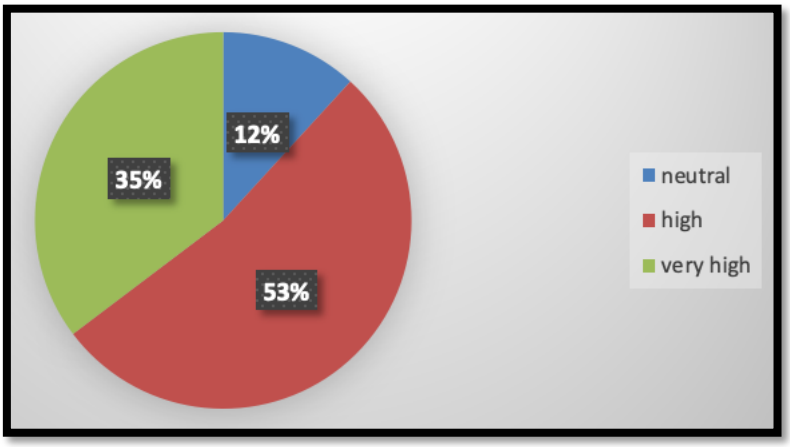
b. SCOR Attributes

This section presents the overall averaging of each attribute of the SCOR model according to the participants' recorded assessment compiled from the six companies to their own performance. This is calculated by aggregating the average of each attribute from the six companies and dividing the total over six. Accordingly, Agility recorded the highest score compared to the other four attributes among the six companies with average equals to 4.49. Then, followed by Reliability with average 4.22, responsiveness with 4.02, Cost with 4.05 and Asset Management with 3.96. This means all the SCOR attributes are relatable to the Egyptian dairy producers selected with high performance for Cost and Asset Management and very high performance for Reliability, Responsiveness and Agility.[1]

4.6.2 SCOR Attributes Frequency

Regarding Reliability, it could be observed that the number of the respondents with "high" with percentage of 52.9% is higher than the respondents with "very high" with percentage of 35.3% then finally, the number of the respondents with "neutral" with percentage of 11.8%. Figure 4.18 clarifies the percentages in a pie chart design.

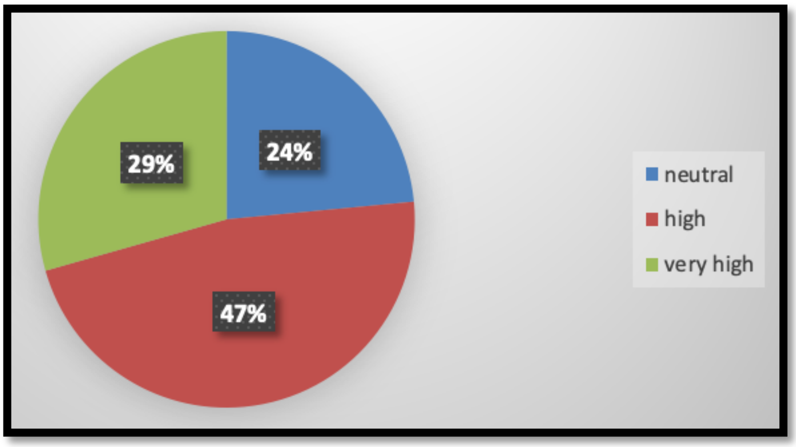
Figure 4.18: Top Management Perception for Reliability



Responsiveness could be observed from Figure 4.19 that the number of the respondents with "high" with percentage of 47.1% is higher than the respondents with "very high" with percentage of 29.4% then finally, the number of the respondents with "neutral" with percentage of 23.5%.

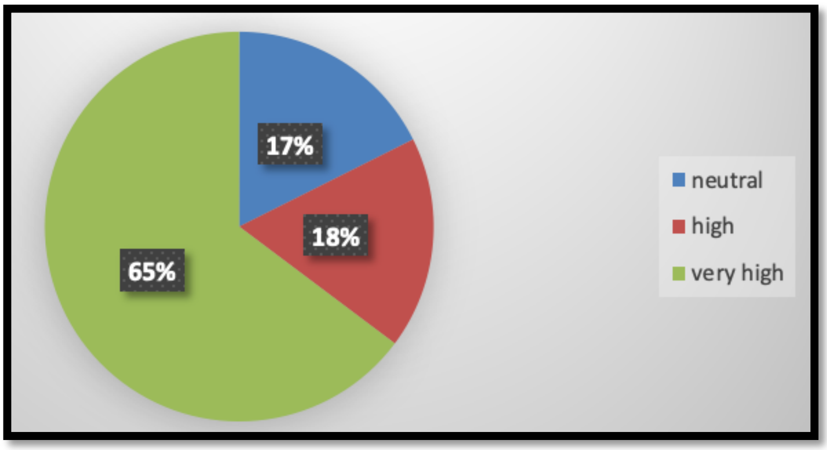
RL=5+4.33+4+4+4+4=25.33/6=4.22
RS=4.66+4.66+3.5+3+4+4.33=24.15/6=4.02
AG=4+5+5+5+4.33+3.66=26.99/6=4.49
CO=3.66+4+5+4+4.33+3.33=24.32/6=4.05
AM=3.66+4.33+4.5+4.33+3.66+3.33=23.81/6=3.96[1]

Figure 4.19: Top Management Perception for Responsiveness



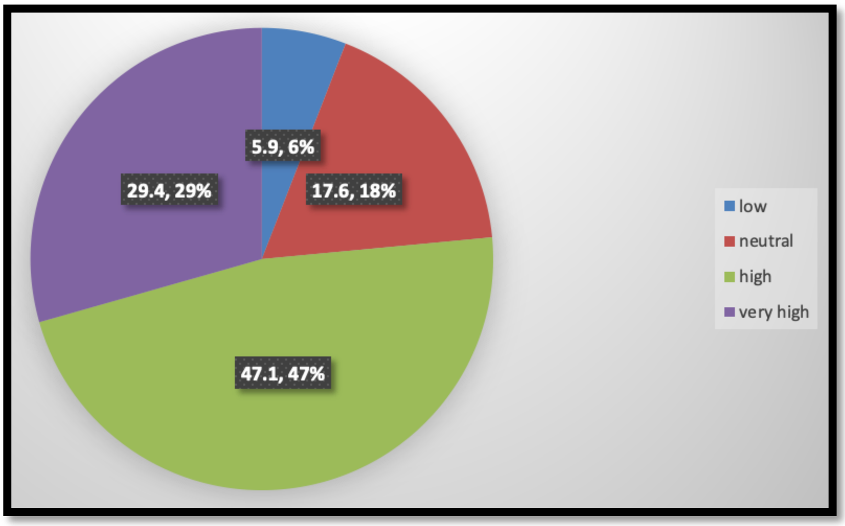
Agility could be observed that the number of the respondents with very “high” with percentage of 64.7% is higher than the respondents with “high” and “neutral” with percentage of 17.6% (Figure 4.20).

Figure 4.20: Top Management Perception for Agility



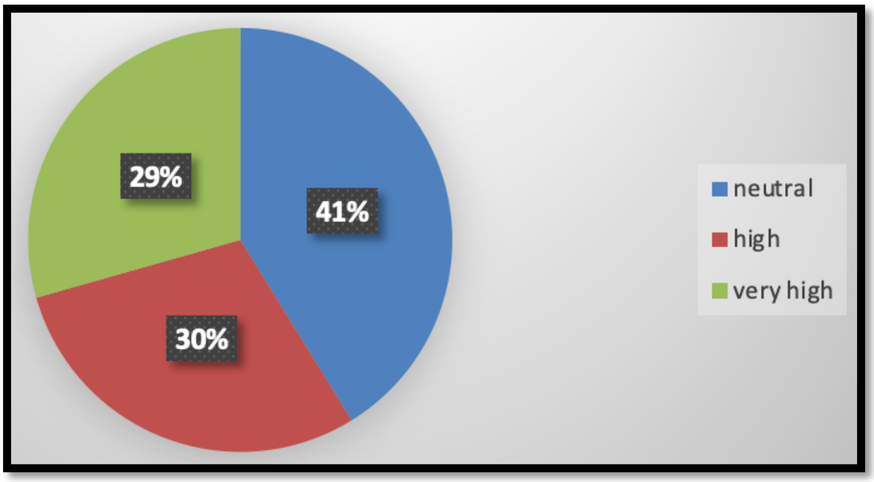
Cost could be observed that the number of the respondents with “high” with percentage of 47.1% is higher than the respondents with “very high” percentage of 29.4% and the number of the respondents with “neutral” percentage of 17.6%. Then finally, the number of the respondents with “low” percentage of 5.9% (Figure 4.21).

Figure 4.21: Top Management Perception for Cost



Asset Management could observe that the number of the respondents with "very high" and "high" with percentage of 29.4% higher than the respondents with "neutral" with percentage of 41.2% (Figure 4.22).

Figure 4.22: Top Management Perception for Asset Management



The Likert scale analysis shows that the six companies perceive their SCP as high to very high. That supports the commonality of the selected sample of companies. But the respondents' detailed answers recorded contradictions of their perceived high performance. It spotted several areas that lack improvement.

4.7 Summary

This chapter provides an in-depth analysis of the seventeen interviews and the two observations that have been undertaken for implicating of SCOR model on the selected six large Egyptian dairy producers. Several topics were predominant from the responses collected from the interviews. Five major themes were identified. First, the theme "**operational capabilities and critical control points**" was the first theme addressed in the interviews in some Egyptian dairy companies, based on the interviews' questions. It included codes related to; 1) The number of production lines, as well as its products and quality requirements, as well as the number of suppliers and materials. 2) Classifications of production lines have an impact on their performance as a single production line can enter the production of several different products and not just one product. 3) Production lines in dairy companies are one of the most important elements of the operational capabilities. That is to optimise their cost and asset utilisation in the most reliable way. 4) The most important goal of dairy companies is to produce safe dairy products, the main goal of which is to ensure quality, ensure the level of safety, and eliminate bacteria that can spoil dairy products. 5) Measures and certificates of quality and safety security. The interviews handled the use of different quality and safety measurements and certifications for the different dairy companies targeted in the thesis. 6) Defining the CCPs used to measure the quality of the final product's safety. 7) The multiple kinds of CCPs in the Egyptian dairy companies. 8) Depending on the number of production lines, their classification, as well as their distribution to the company's different products.

Second, the theme "**Risks affect operations and supply chain performance**" was the second theme that was addressed in the interviews. The codes discussed in this theme is 1) Source of raw materials. Dairy companies rely on different sources to obtain raw milk and materials, and there are two sources to obtain raw milk, either from the company's farm or from powdered milk suppliers, MCCs and external farms. 2) Operational risk. Companies face many risks, and the most critical risk is the operational risk in the company. As, it reflects in shortage of products' offerings to the market and waste of raw milk supply before getting into the factory for processing. 3) Raw materials risk. Another risk facing dairy companies in Egypt is raw materials, as these materials, such as packaging materials, may not meet the specifications and lead to spoilage of dairy products. 4) Cleaning and breakdown risk. Hygiene risk is one of the vital risks that affect dairy producers negatively. There are a large number of organisations that monitor the hygiene of dairy products. 5) Production risks facing companies for various reasons, including suppliers, breakdowns, and other reasons. 6) Energy and energy instability have a great impact on the raw materials as well as the final products. The temperature difference leads to a shortage of raw milk, especially in the summer. 7) The performance of the machines can cause danger to the dairy companies because with the passage of time the machines need periodic maintenance to ensure their quality and performance because due to the performance of the machines can affect the quality of the dairy products produced from them. 8) Risks of malfunction such as malfunction that occur to the internal machinery in the factory, resulting in a waste of production time and an increase in cost. 9) High prices for raw materials used in production and the variation in the prices of the supplied materials, which may ultimately lead to losses in the companies' balance sheets.

Third, the theme “**Overcoming Supply Chain Challenges and Operational Risks**” discussed the following codes: 1) Number of Suppliers the companies deal with. There are companies that deal with a small number of suppliers, so they do not use SC systems that are identical to other companies that deal with a large number of suppliers. 2) SC challenges and operational risks; it is SC risks. 3) Shortage of raw materials reflects the imbalance with the suppliers, and it is a reason that might reduce dealing with suppliers. 4) Cleanliness Measures Toward Quality. Hygiene standards towards quality are different standards set by the company to reach the required quality according to the plans and regulations used by companies according to health and nutrition institutions. 5) SCs are one of the most important factors affecting companies’ plans. Demand plans are employed, and from which the company reaches equilibrium states to balance between the ‘source’ and the ‘make’ of the dairy SCs. 6) The SCOR model is a model developed to assess the relationship between the company's operations and SCs and their potentials of improving and optimising their performance. 7) The continuous development of companies requires continuous research and development. 8) The SAP system is a system that is adopted in some dairy companies to ensure the visibility in their SCs.

Fourth, “**performance measures**” discussed: 1) Measuring the SCP illustrates the use of various tools to measure the performance of the companies' SCs. 2) SCP. The interviews also revealed that the SCP in the Egyptian dairy companies differs according to the different measuring tools. 3) The companies' priorities differed in setting their key performance indicators (KPIs), some of which depend on production, some that depend on the company's operations, and some of which are concerned with the employees of the company. 4) SC KPIs which ensures the SCP that are concerned with the quality of raw materials, transportation methods, etc. 5) Delivery Time and Cost. There are also key performance indicators (KPIs) that are set for suppliers to ensure delivery times at the times that companies want and achieve their goals.

Finally, the theme “**Improving the Egyptian dairy producers’ performance**” discussed: 1) Feeding Programs to adopt healthy feeding programs for cows on farms to ensure the quality of raw milk and to develop SC systems. 2) Developing SC systems is to reduce waste and harmful emissions and to transform the industry into a green industry. 3) Developing SC systems to increase the productivity of companies, including increasing the profitability of companies. 4) Improving Suppliers and increase their awareness to ensure better SCP. 5) Implementing KPIs to ensure product quality and SCP. 6) Increasing the company's sales and increase the products in the market, and this stems from increasing the SCP. 7) New Technology and Training to develop modern technology and trainings for workers to adopt modern systems for SCs.

Last, Table 4.6 provides summary of the key findings from the interviews and the observations to be validated in the following chapter by FGs consisting of different stakeholders in the SC to compose the best practice framework’s constructs. This process will strengthen the validation process of the results from different perspectives in the SC.

Table 4.6: Phase One Findings-Best Practice framework Elements

Operational Capabilities	Critical Control Points (CCPs)	Plant KPIs 'Make'
Production Line Efficiency/ Overall Equipment Effectiveness (OEE)	UHT Temperature	Overall Equipment Effectiveness (OEE)
Production Line Flexibility	Bacterial Total Count	Loss in Process
Storage Capacity	Antibiotic Residues	First Time Release (FTR)
Operating Capacity System	UHT Filter	Complaints Per Million Unit (CPMU)
Tracking System	UHT Time	Production Utilities
Packaging	Pasteurization Temperature	Plan Adherence or Order Fulfilment
Labour Competency	Packaging Tests	Stakeholders' Service Level Agreement
Lead Time	Hydrogen Peroxide Concentration	Inventory (Out of Stock Percentage)
	Holding Time	Labour Productivity
	Microbiological Tests	Quality
	Chemical Tests	Defect Per Million Unit (DPMU)
		Safety
		Cost
		Time
		Number of Suppliers
		Livestock KPIs 'Source'
		Average Production per Cow
		Annual Farm Productivity
		Income Over Feeding Cost

Chapter 5 Phase Two-Explanatory Focus Groups Analysis and Results

5.1 Introduction

This chapter covers the process and the results of the second empirical phase of this thesis. Its main purpose is to support and validate the results of the first exploratory phase. The FGs will validate the elements and sub-elements of the proposed conceptual framework created from literature and investigate the relationship between them to confirm the theoretical data saturation. Two FGs are conducted. They are composed of diversified participants from the Egyptian dairy SC, including managers from the dairy companies, suppliers, ministries, and governmental authorities. Accordingly, a detailed best practice framework validated by different SC practitioners will be proposed to be applied to the Egyptian dairy producers who have similar operational capabilities and challenges. The best practice includes a set of performance indicators (KPIs) to assess their operational and SCP.

This chapter follows the same qualitative data analysis steps followed in phase one. It starts with; the process of conducting the FGs and their findings, the overall findings of the FGs held to reach data saturation, reviewing some pieces of evidence used during the FGs to support answering the five RQs, and a summary of the whole chapter.

5.2 Focus Group Process

This section reviews the FG arrangement process. It is divided into two subsections. First, it addresses the data reduction process and presentation of the data. Second, it discusses the key findings of each FG held and contrasting between them.

Table 4.6 summarised the proposed framework's constructs with their sub-elements in simplified terms to be understandable to the practitioners. These were stemmed from the extracted themes from the interviews. This table includes the key three themes representing the operational capabilities including the CCPs and the SC and operational performance measures (KPIs). The KPIs are classified into the production level at the plant 'make' and the supply level which covers the livestock 'source'. The remaining two themes were covered by open-ended questions during the FG (Appendix Five). This table was shared with the participants in the FG meeting to summarise and discuss any missed elements related to the research scope.

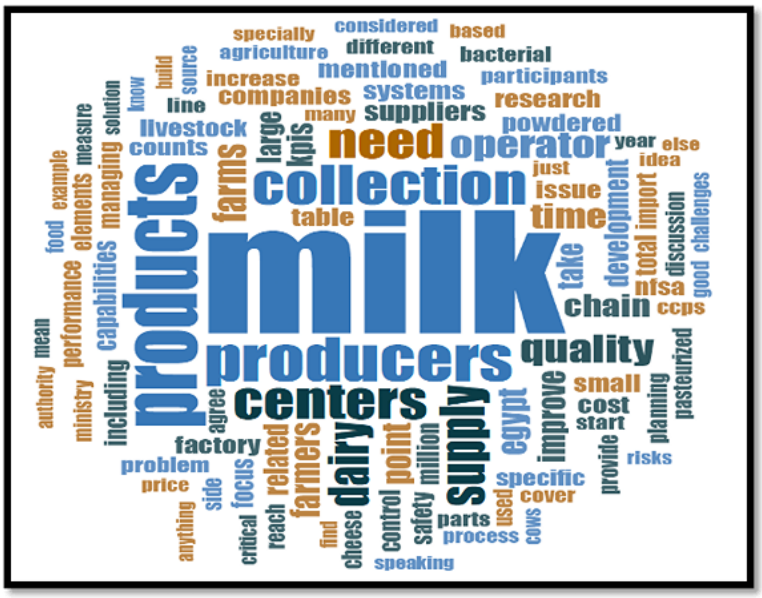
5.2.1 Focus Group Data Reduction and Display

The researcher transcribed each FG into a Microsoft Word document and combined it with the researcher's notes. This transcription was supported with photos shared by one of the participants during the first FG on Zoom meeting and some follow-up notes sent by the participants after the FG. A sample transcription can be seen in Appendix Eight.

This phase followed the same process of analysis of the interviews in the first phase. The two full transcriptions of the FG were logged in NVivo12 for analysis, to create a word cloud, also visual illustrations, and finally to tabulate the data analysis and findings. It allowed the researcher to reduce the data according to the RQs into key themes and categories.

First, the researcher reviewed the full transcriptions thoroughly, with the Zoom recording to look for new themes and note the participants' reactions towards the given answers. Then, a word cloud was created by counting the top 100 stemmed words in the FG transcription with a length of 4 letters at least. This to validate the findings of the first phase and ensure that there are no emerging themes appearing to support the theoretical saturation by validating the research constructs (Figure 5.1).

Figure 5.1: Focus Group (FG1&FG2) Word Cloud



Appendix Ten clarifies the details of some of the word counts including the weighted percentage of each word and the similar words used to resemble the stemmed words appearing in the word cloud to help the researcher validate the appearing four themes from the data inductively. The dominant four key themes are risks, critical control points (CCPs), operational capabilities, and key performance indicators (KPIs). Those themes with the sub-themes resemble the elements and the sub-elements of the validated framework. It shows the most frequent words in both FGs to validate the themes of phase-one and look for new ones. It confirmed the themes emerged from the transcripts and allowed the researcher to go through the transcriptions again and the Zoom recordings to reflect on the emerging themes according to the word count frequency. The participants did not focus on the risks in the FGs. They referred to risks as issues in their answers and provided supporting images presented during the FG like Figure 5.5. It recorded a very minimal percent compared to the other themes, because they commonly agreed on them and they acted accordingly. This leaves the best-practice performance framework to be composed of operational capabilities, CCPs, and KPIs. Those will be supported by performance improvement plans and solutions to overcome the SC risks and challenges. Also, few participants mentioned risks and KPIs related to the products' delivery. The researcher excluded delivery as a theme because it sits out of this thesis' scope.

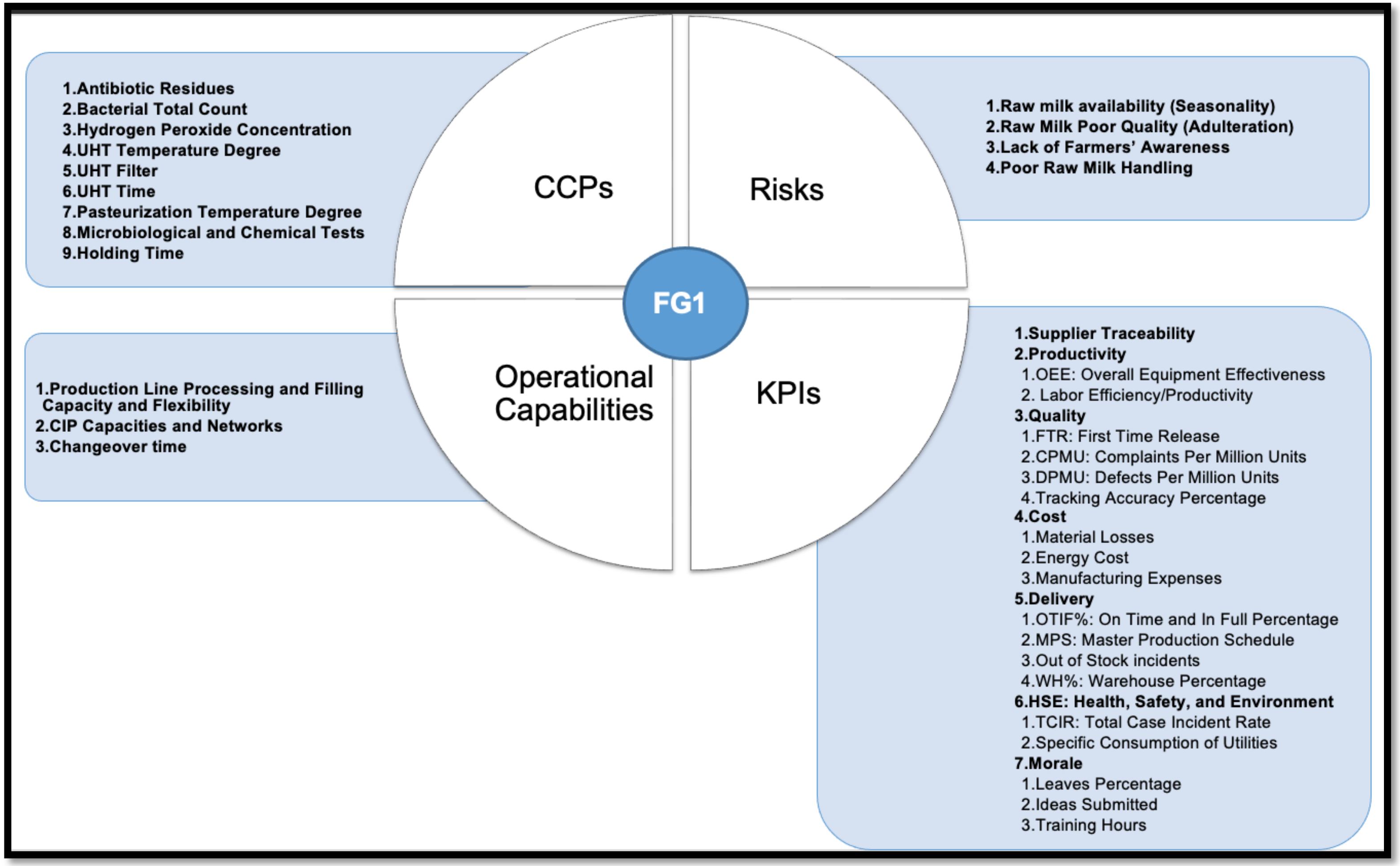
5.2.2 Focus Group Findings

This section covers the findings of each FG to answer the RQs and validate the research findings. The following subsections, including FG1 and FG2, were created to clarify the key constructs that emerged and validated by the participants in each FG. The key themes appearing in the FGs transcriptions were driven by the most frequent word count after going through the FGs transcriptions and notes multiple times and noting the participants' reactions to each other's replies to the questions, including their approval or disapproval to the elements proposed. This helped in fine tuning the themes extracted from the first phase. Then, followed by a section compiling both FGs findings to present a validated framework with detailed elements and sub-elements.

5.2.2.1 Focus Group One Findings (FG1)

After previewing a summary PowerPoint presentation (Appendix Eleven) and Table 4.6 to the participant, which includes the five themes extracted from phase one findings for validation, the researcher asked the following question: “Does this table clearly identify the elements related to the operations and the supply chain management performance dimensions?”. Figure 5.2 compiles all the key sub-elements related to the proposed framework’s constructs, representing the key findings of the first focus group (FG1) to answer this question. Those sub-elements are the outcome of the FG1 transcription, and the supporting notes sent by the participants. The researcher noted the participants’ focus and agreement on some elements rather than the others during the discussion. They confined the risks to the raw milk issues and confirmed the operational capabilities. Also, their reactions and impressions were significant to the classification of some KPIs and the naming of some CCPs. Accordingly, the researcher used different queries on NVivo software to extract the key findings of the FG transcriptions. Besides the mapping function to link the FGs findings to cover the key themes of phase one and answer the RQs. That includes text search, word count, and stemmed word count to emphasize the criticality of the emerging framework's elements for dairy producers’ performance and reach a more precise naming for those elements.

Figure 5.2: FG1 Findings-Source: Author



First, risks represent the first construct found in FG1. Four risks were detected: raw milk availability (seasonality), raw milk poor quality (adulteration), lack of farmers' awareness, and poor raw milk handling. Participant 1 from the National Food Safety Authority (NFSA) highlighted the four mentioned risks in his explanation of the current dairy sector situation and provided the following evidence: *"the problem in the supply", "When there is shortage in raw milk, they use powdered milk", "Nobody is helping and assisting those random farmers who own over 5 million cows around Egypt and produces 90% of milk production." and "took samples of the milking equipment after cleaning and found the bacterial count 300.000 before the milking process. So, first of all, the cleaning is a total mess"*. This was supported by Participant 3, the food safety manager from Company-D and Participant 4 quality assurance head from Company-B, they mentioned respectively: *"over 90% of the raw milk production is from the small farmers, not the large farms and it is directed to the production of cheeses such as mozzarella, roomy, all this considered waste for the milk and it is not controlled" and "we have many problems with them in their quality and the food safety specifically".* Accordingly, the participants confirmed the risks identified from the literature and the first phase, including the interviews and observations.

The following three figures are prepared and shared by Participant 1 during FG1 Zoom meeting. The figures are prepared in Arabic, however, the researcher added English translation to the figures to maintain the credibility of the data presented. These figures are based on actual inspection of raw milk sources in Egypt, including some real photos for MCCs sites. Figure 5.3 illustrates the total bacterial counts before and after milking at each stage. It recorded a dramatic increase in the bacterial counts from less than 10.000 to exceed 3.000.000 by using primitive milking equipment, that reduces the quality of raw milk drastically. Figure 5.4 provides further detailed explanation for the contamination progression using manual milking technique to cause the bacterial counts to reach 56.000.000, which in turn causes milk adulteration. Moreover, Figure 5.5 shows the primitive filtration technique using an unhygienic piece of cloth. In addition, the MCC worker washes the cloth on the floor which increases the bacterial and chloroform counts in the raw milk. All this explains the current risks available in the dairy SCs in Egypt. Also, it highlights the bacterial counts in milk at each stage in the SC where there should be strict KPIs and CCPs applied to obtain high-quality raw milk which in turn ensure the production of safe and secure dairy products.

Figure 5.3: Milk Contamination Sources with Bacterial Count at The Farm Before Delivery with Milking Equipment Limited Possession-Source: NFSA Head, translated by Author

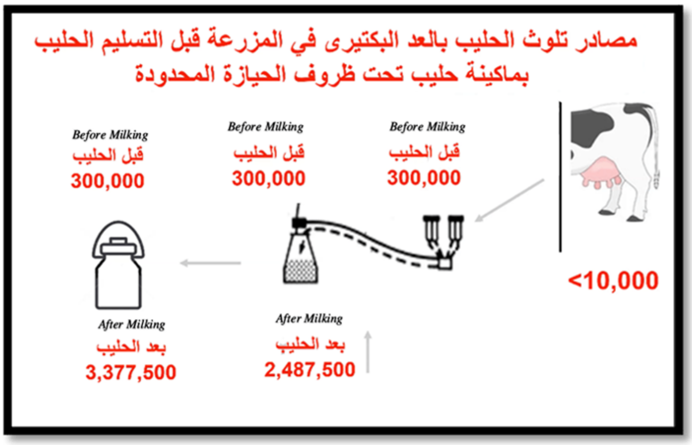


Figure 5.4: Milk Contamination Sources with Bacterial Count at The Farm Before Delivery with Manual Milking-Source: NFSA Head, translated by Author

Figure 5.5: Milk Receival at Collection Centres-Source: NFSA Head, translated by Author

Then, moving to the second construct, the CCPs recorded from FG1 are eight: Antibiotic Residues, Bacterial Total Count, Hydrogen Peroxide Concentration, UHT Temperature Degree, UHT Filter, UHT Time, Pasteurisation Temperature Degree, Microbiological and Chemical Tests, and Holding Time. Participants of FG1 approved the CCPs listed in the proposed table, evidencing that by Participant 1 and 5 respectively: *"All other elements I agree upon and there are authorities inspect that"* and *"CCPs & Livestock KPIs are fine with me".* But Participant 4 disagreed with some elements listed, claiming that they are indicators for the CCP not the CCP itself. The following evidence supports his claim: *"we use them to measure the CCP. Bacterial Total Count, Antibiotic residues, Packaging tests, microbiological tests, and chemical tests. For example, the packaging test is not a CCP. The CCP is the package sealing itself which we audit. Another example, the UHT temperature leads to sterilisation, so I'm monitoring the temperature by measuring it. That's why measuring the temperature is not a CCP, but the temperature degree itself is the CCP. The same goes for the tests. This is my own point of view".* Also, Participant 3 merged the 'UHT time' with 'holding time' and mentioned the following evidence: *"The holding time agrees…you are working ultra-heat treatment on over 130 degrees for 6 seconds; this is the holding time of the product inside the equipment".* Regardless of the few divergent points of view of both participants, they explained and discussed the elements correlated to the CCP itself, which does not sit far from the listed CCP element. The recorded slight differences in the participants' points of view in representing the applied CCPs appears to be in the naming only, but not the CCP itself.

Third, there have been differences among the participants on the operational capabilities. Participants 3 and 5, both are managers from Company-D and C. They approved the operational capabilities, listed in Table 4.6 but expressed their preference in merging them to the operational KPIs, as they are interrelated. Participant 3 expressed his confusion between both by mentioning: "*they are related… operations are positively correlated to the supply chain, so of course anything in the supply chain will benefit the factory if I have 10 suppliers instead of only 2 that would make a difference*". Also, Participant 5 mentioned: *"Operational Capabilities/Plant KPIs should merge"*. On the other side, the remaining participants approved the three listed operational capabilities as they are. Those operational capabilities are production line processing and filling capacity and flexibility, CIP capacities and networks, and change over time. Participant 4 evidenced that in the following evidence: "*Such capabilities include cooling system, CIP system to ensure the hygiene of the equipment, training for the workers".*

Fourth, the finalised KPIs concluded from FG1 are Supplier Traceability, Productivity, Quality, Cost, Delivery, HSE: Health, Safety, and Environment, and Morale. This list is stemmed from detailed feedback sent by Participant 5, who is the research and development manager at Company-C, one of the large dairy producers. He prepared Table 5.1 and sent it to the researcher shortly after the FG1 meeting. It includes the operational capabilities and the plant KPIs merged to form the following metric. This metric reflects how Company-C assesses their performance. It includes all aspects related to operations and supply of safe and secure dairy products from their perspective. HSE includes TCIR: Total Case Incident Rate, and Specific Consumption of Utilities. Quality includes FTR: First Time Release, CPMU: Complaints Per Million Units, DPMU: Defects Per Million Units, and Tracking Accuracy Percentage. Productivity includes OEE: Overall Equipment Effectiveness and Labour Efficiency/Productivity. Delivery includes OTIF%: On Time and In Full Percentage, MPS: Master Production Schedule, Out of Stock incidents and WH%: Warehouse Percentage. The remaining KPIs explain themselves.

The following metric covers the detailed KPIs related to the dairy operations and SC. It is proposed by Company-C, the dominating company in the Egyptian dairy sector, and approved by another top five dairy producers. The head of the NFSA, the governmental authorities, and other suppliers also approved the related KPIs to their specialisation. All these factors validate the importance of the proposed KPIs in this metric to form part of the best practice framework. Accordingly, this was the most comprehensive and detailed KPIs proposed by the participants who accepted the proposed list in Table 4.6.

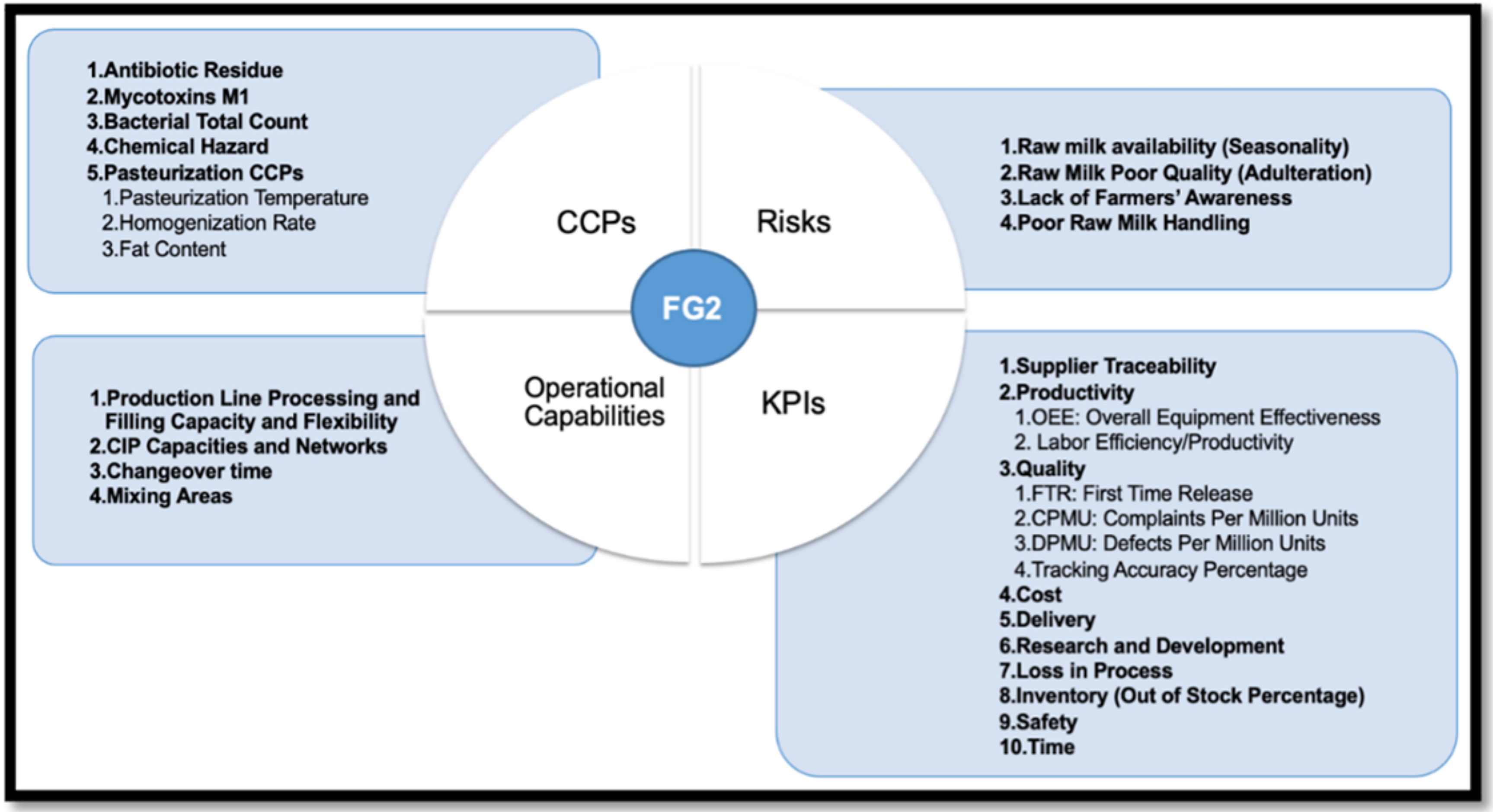
Table 5.1: Operational and Supply Chain KPIs identified in FG1

HSE	Quality	Productivity	Cost	Delivery	Morale
TCIR	FTR%	OEE %	Material Losses	OTIF%	Leaves %
No. of Incidents	CPMU	Labor Productivity	Energy Cost	MPS Adherence	Ideas Submitted
Specific Consumption of Utilities	DPMU		Manufacturing Expenses	Out of Stock incidents	Training Hours
	Tracking Accuracy%			WH Capacity%	

5.2.2.2 Focus Group Two Findings (FG2)

Figure 5.6 clarifies the key findings of the second focus group (FG2) held to confirm the findings of FG1 and the first exploratory phase (semi-structured interviews and observations). The following discussion follows the same process of FG1.

Figure 5.6: FG2 Findings-Source: Author



In general, FG2 supported and reported a high level of similarity with the findings of FG1 with few elements added to some constructs. The participants agreed on the same risks mentioned in Phase One. For example, Participant 8 represents one of the suppliers in the Egyptian dairy SC, evident by mentioning: *"The risks in the dairy chain represented especially in the seasonality in the raw milk supply"*. Operational capabilities are also the same from FG1, but with one more capability recorded, which is the mixing areas. Participant 7 from TetraPak, the UHT milk package supplier, classified the operational capabilities according to the milk products portfolio produced, either UHT milk or pasteurised milk, and this is evident by*: "If the plant produces both, then we need to have mixing areas, and the classification of the production lines should match the processing capacity and the filling capacity. At the same time, we should design the plant according to the filling line portfolio to match each capacity and achieve the flexibility and the changeover time".* And: *"the CIP capacities and the CIP networks, because we need to wash different items at the same time varying between processing and filling. Therefore, the CIP should be clearly indicated under the operational capabilities because it could resemble a 'showstopper' at sometimes".*

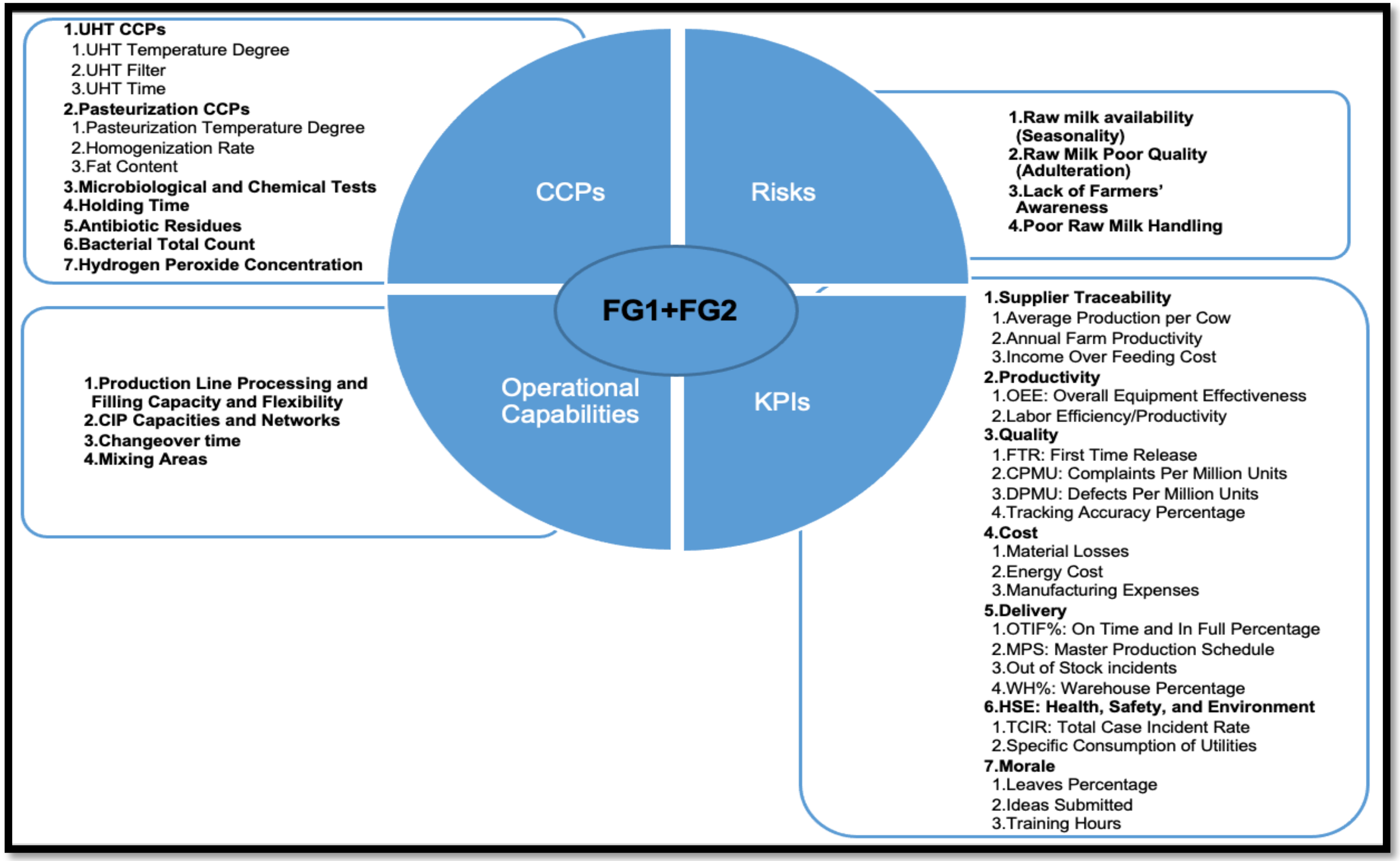
Moving to the CCPs, it differed from FG1 according to the participants' specialisation. They added two CCPs, Mycotoxins M1, Chemical Hazard, and classified the Pasteurisation CCPs in detail into, pasteurisation temperature, homogenization rate, and fat content. Participant 10 had a claim represented in the following evidence: *"The more the number of the CCPs, the less control we have and the more issues.".* Therefore, we note that the number of CCPs recorded in FG2 are less than FG1 and more specific. He also mentioned: *"the chemical hazard, and the antibiotic residues are considered CCPs."* and *"I cannot classify the UHT filter as CCP".* At the same time, Participant 7, packaging supplier, got into the details of the pasteurisation CCPs by providing the following evidence: *"The pasteurisation temperature, the homogenization rate in the pasteurisation equipment, the fat content, if I have standardisation unit to produce consistent milk portfolio…Those are the CCPs related to the pasteurisation".* Also, Participant 9, from the ministry of agriculture, discussed the CCPs on a farm level and he linked it with the risks by mentioning the following*: "The first risk at the small and medium farms is the antibiotic residue. Why? That's due to the lack of awareness about the withdrawal time of antibiotics from the livestock's body. Second, the feeding, which might contain natural toxins which are the mycotoxins M1. For us, those are critical control points. Third, the cold chain value starts from the milking process until the raw milk reaches the factory or the milk collection centre. This cold chain is considered also a critical control point. The total bacterial count increases with the increasing time until the raw milk reaches its destination and that leads to refusing the raw milk.*

Then, one of the most critical issues is the milk adulteration en-route, in addition to the antibiotic residues and the mycotoxins". Although Participant 9 discussed the CCPs from the suppliers' perspective which resides in the 'source' side of the scope of this thesis, it cannot be added to the list of CCPs applied within the production process at the 'make' side of the SC in the proposed framework. Nevertheless, it still gives insight to the current situation in the Egyptian dairy SCs.

Last, the ten KPIs recorded in FG2 are a mix of the KPIs proposed in Table 5.1 representing the interviews' findings and FG2. Nevertheless, no new KPIs emerged in FG2 discussion. Those are Supplier Traceability, Productivity, Quality, Cost, Delivery, Research and Development, Loss in Process, Inventory (Out of Stock Percentage), Safety, and Time. Regarding FG2 meeting discussion, the KPIs were discussed by two participants from the supply side, not from the governmental authorities. That is due to their involvement with the dairy producers and interaction with the production processes. Participant 7 provided the following evidence: "*Regarding the KPIs related to the production, I can tell that this table covers all the key elements to enhance the performance".* Also, Participant 8, powdered milk supplier, provided the following evidence covering multiple KPIs: "*we can improve our capabilities to produce powdered milk beside our improvements to the milk collection centres improvements and the hereditary development, that will increase our cow's productivity and reduce our imports of powdered milk and consequently reduce our cost of production*".

The researcher prepared a comprehensive compiled Figure 5.7 to display the concluded findings of FG1 and FG2 in detail. This will be discussed in the following section to fulfil the theoretical saturation of the data presented in this thesis.

Figure 5.7: FG1 & FG2 Compiled Findings (The Best Practice Framework)-Source: Author



5.3 Focus Group Overall Results for Data Saturation (Best Practice Development)

This section reviews the findings of the second phase to assess the data saturation of the thesis findings. It means there are no new constructs appearing by conducting further FGs. In general, participants of the second phase (FG1 and FG2) showed support of the findings from the first phase (Table 4.6), which provided a detailed classification of some elements to formulate the best practice framework. Nevertheless, some participants focused on the supply side rather than the manufacturing side. Additionally, two participants suggested the inclusion of the distribution side to the proposed framework. Accordingly, the researcher recorded all points of views in the following sections but kept the best practice framework coherent and matching the scope of the thesis. Participant 5 expressed his willingness to include KPIs related to the 'deliver' side of the SC by mentioning: *"we have not spoken at all about the part after production until it reaches the consumer. Is it at your research scope? I cannot note any KPI for this part except traceability"* and Participant 7 supported this by providing the following evidence: *"for the traceability, as you mentioned in the KPIs and the number of suppliers. There should be a registered list of all suppliers and full traceability of the 'in and out'. I mean even the final product should have traceability".* This expands out of the scope for this thesis but still some KPIs, such as traceability extends along in the SC including 'source', 'make', and 'deliver'.

The diversification between knowledgeable participants from various disciplines in the dairy field represents a different point of view for each RQ, and reviews whether they are with or against each element listed in the findings of phase one. This supports the heterogeneity of the data and the generalizability of the thesis findings. Regardless of the small sample size, it allows covering any missed topics related to the thesis scope.

According to the data collected and analysed in the second phase of this thesis, no new themes or constructs emerged compared to the first phase during the FGs. The difference appeared in the naming of some elements only, with a clearer classification of the constructs and their supporting sub-elements. Subsequently, Figure 5.7 compiled the main four constructs and the sub-elements explored and validated along this thesis. It is noted the similarity of the elements mentioned in FG1 and FG2. The naming and the classification are the only differences. No substantial additions have been discussed in FG2. Most importantly, the following figure introduces detailed operational and SC KPIs within a performance assessment framework to guide the dairy producers to measure their performance.

The following table summarises the concluded number of elements per each of the four constructs; risks, CCPs, operational capabilities and KPIs, including both data collection phases of this thesis, to reflect how the researcher reached the data saturation. This clarifies the validation of the framework's elements and sub-elements.

Table 5.2: Constructs and Elements Emerging from FG1 and FG2

Constructs	Number of Elements per Construct			
	Phase 1: Interviews & Observations	Phase 2: Focus Groups		
	17 **Interviews & 2 Observations**	**FG1**	**FG2**	**FG1+FG2**
Risks	8	4	4	8
CCPs	11	9	5	14
Operational Capabilities	8	3	4	7
KPIs	18	7	10	17

5.3.1 Risks

The researcher explored risks in the Egyptian dairy sector by different participants in the FGs, to cover the scope of the dairy SC. Those risks are mainly centred on the milk supplies, in terms of availability and quality with the other elements associated with it, the poor handling techniques, and the lack of awareness of the raw milk suppliers or farmers. It affects the 'make' of the SC represented in the operations and in-return the provision of safe and secure dairy products. This validates the findings of phase one with a greater emphasis on the quality and hygiene of raw milk.

5.3.2 Critical Control Points

Based on the FGs held, the researcher found the most accurate presentation of the CCPs differs from one product to another. Therefore, based on the thesis sample including the milk products. As shown in Figure 5.7, the CCPs should be classified based on the product being produced, either UHT milk or Pasteurised milk, and the remaining CCPs are unified to all kinds of milk produced but with different parameters. For example, Participant 4 of Company-B provided the following evidence describing how they apply the CCPs*: "the five highlighted elements are not CCPs, but we use them to measure the CCP. Bacterial Total Count, Antibiotic residues, Packaging tests, microbiological tests, and chemical tests"* And *"the packaging test is not a CCP. The CCP is the package sealing itself which we audit. Another example, the UHT temperature leads to sterilisation, so I'm monitoring the temperature by measuring it. That's why measuring the temperature is not a CCP, but the temperature degree itself is the CCP. The same goes for the* *tests.".* Participant 3 provided the following evidence to clarify the interrelation between the CCPs and the operational capabilities: *"in my opinion, the UHT filter is not CCP"* and *"It can be classified as OPRP. We have CCPs and OPRP. Both are measured on the production line. If the CCP is rejected this product will not get out of the factory or reach the market. The OPRP you can note it during your operation but proceed with the production.".* The CCPs were validated in both FGs to confirm the explored CCPs from the interviews and observations. However, the CCPs got a much more precise classification in accordance with the production of milk products.

5.3.3 Operational Capabilities

Some participants merged their answers related to the CCPs with the operational capabilities, and other participants merged the KPIs with the operational capabilities. This assures the interrelation between the framework's constructs. Evidently, Participant 3 suggested removing the packaging as an operational capability and supported his point of view with the following evidence: *"If I got another paper than TetraPak, I'm not talking about the capabilities anymore rather than the integrity in our production. All the large dairy producers use the same packaging materials using TetraPak from Saudi Arabia or Nigeria".* At the same time, he mentioned: *"The labour competency is an operational capability for sure", "The efficiency means, I'm calculating how many packs produced in specific time with which quality",* and *"I believe the lead time is dragged under the OEE".* He added the following quote which supports that the integration between the company's stakeholders enhances the operational capabilities*: "I can add something related to the owner or the stakeholders. This is an operational capability. In our case, our company belongs to Mansour Group. The large producers in Egypt are JUHAYNA, LAMAR-Talaat Mostafa, Beyti-ALMarai, LABANITA-Mansour, LACTEL-Halawa, all these owners reflect in strong operational capabilities to expand their production lines and shift to fully automated production lines, train their labours and else".* Last, Participant 5 confirmed the mentioned operational capabilities, however, he suggested combining them with the operational and SC KPIs as indicated in Table 5.1. Thus, the validated operational capabilities are the production line capacity and flexibility for changeover and the time related to it, the CIP capacities and networks, and the mixing areas.

5.3.4 Key Performance Indicators

The final proposed KPIs included in Figure 5.7 represent metrics of performance measures assessing the operational and SCP. The KPIs proposed by the participants match the scope of research to cover the 'source' and 'make' of the dairy chains to ensure the production of safe and secure dairy products. This is the outcome of diversified data collected from key experts in the entitled companies, major suppliers controlling the dairy industry, and governmental authorities monitoring food safety. Therefore, the KPIs are divided into 'source KPIs' and 'make KPIs'.

The 'source' KPIs represented in the suppliers' traceability, which assess the supplier's performance. Three sub-elements are measuring the supplier's performance. Evidencing that, Participant 1 mentioned: *"the supplier with the raw materials and the traceability. Those are the three things we need to talk about if you want. All other elements I agree upon and there are authorities that inspect that"* and Participant 3 also provided the following evidence supporting the importance of suppliers' traceability*: "the number of suppliers is definitely a KPI for the factory".*

Then, the 'make' KPIs are productivity, quality, cost, delivery, health, safety, and environment (HSE), and morale. Each KPI is measured by several sub-elements. First, Participant 3 explained the productivity by providing the following evidence: *"The CPMU is definitely a KPI"* and *"OEE we measure it based on the full production line with its labour and the factory manager. For example, this line produces 5 tons per hour, you produced 4 tons and 200, why? Your target which is the OEE should be 4 tons and 800…including the labour, the equipment and everything related to the factory"* and *"Time, again time is related to the OEE".* Second, quality KPI as a detrimental indicator for the dairy products' safety and security is measured in the quality of production line performance quality and the final product quality. Participant 4 explained this KPI by providing the following evidence: *"Under the Plant KPIs, Loss in Process and Defect Per million Units are both dragged under the production waste. Part of this waste happens in the processing and calculated per litre and the other happens in the packaging which is calculated by the package"* and *"The CPMU is a KPI…All those are indicators which we can measure to assess whether our operations are good or bad."* and *"the safety of the products can be measured by the DPMU and the CPMU. So, it is measured several times".* Then, measuring the production process goodness once started by the first-time release and tracking the accuracy percentage. Followed by cost, when it comes to operations, it is measured based on the materials losses or wastes, the energy cost, and the manufacturing expenses. After that, the delivery, where the plant assesses their percentage of commitment to delivering the products on the specified time planned for it, and its availability in the warehouses. Furthermore, the health, safety, and environment reflect the rate of incidents occurring at the plant and the utility consumption. Last, the labour morale is also measured in terms of their leave percentages, the development training hours accomplished, and their collaboration with the company by introducing new ideas.

All this is supported by evidence provided by the participants confirming the KPIs listed. For example, Participant 5 evident this as follows: *"everything is covered based on your scope",* Participant 7: "*I agree that the KPIs enhancement starts from the supply side",* and Participant 10: "*I was just confirming that you covered all these issues".* This validates the findings of phase one with better classification and adding the morale KPIs to measure the employees' performance and Health, Safety, and Environment elements. Those distinctive KPIs are specially customised on the dairy sector operational and SCP. Besides, the suppliers' traceability covers the supplier's performance to assess and overcome the risks related to the raw milk shortage.

The next section will discuss and illustrate how these findings are helping in answering the RQs.

5.4 Using Focus Groups to Answer the Research Questions

This section is divided into five sub-headings, each subheading dedicated to reviewing the answers from both FGs related to each of the five RQs. The results are illustrated with mind maps to summarise the key elements and sub-elements to consolidate the best practice framework. This acts as a preparatory step for the following discussion chapter to show the progression of the supporting evidence from the FGs to the best practice development throughout the empirical work held during this research. The following mind maps are created by using NVivo12 software.

5.4.1 RQ1: What are the key operational capabilities, including the Critical Control Points (CCPs), in large-size Egyptian dairy producers?

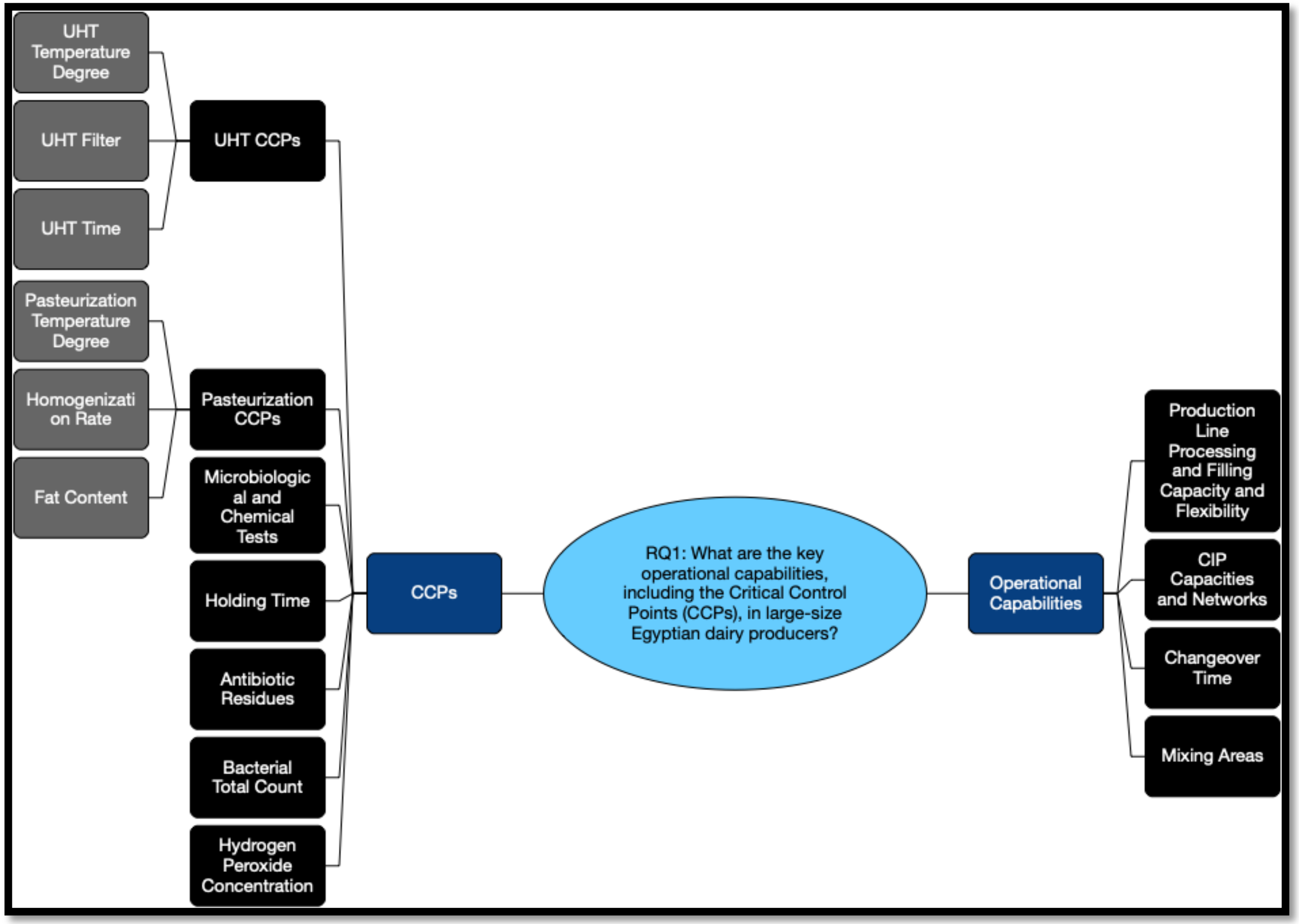
Figure 5.8 summarises all mentioned elements related to the operational capabilities and the CCPs gathered from FG1 and FG2. The researcher has asked the FGs' participants the following question related to Table 4.6, which included the extracted operational capabilities and the CCPs from Phase One, to ensure that the participants of the first phase have covered all elements. "**Given your experience, what elements does this table lack?"**. Some comments are followed to reinforce the data saturation.

Participant 1: *"All other elements I agree upon and there are authorities inspect that"*

Participant 8: *"for the critical control points, I find it covering the chemical tests and the microbiological tests"*

Participant 4 mentioned: *"self-sufficiency. Our farm used to fulfil 70% of our needs. We have our own milking parlours, we used to cover the remaining 30% from large farms in Egypt and I audit them myself".* It links the self-sufficiency of raw milk from the supply side of the dairy chain to their operational capabilities and how they ensure the safety of their products by auditing the other raw milk sources themselves to maintain the quality of the products.

Figure 5.8: RQ1 Overall Results Mind Map-Source: Author

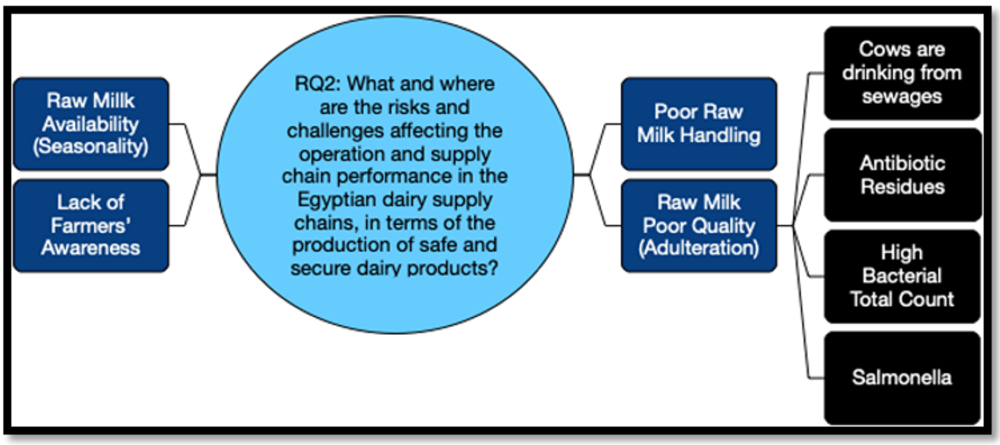


The following section reviews the summary of the FGs' findings related to RQ2.

5.4.2 RQ2: What and where are the risks and challenges affecting the operation and supply chain performance in the Egyptian dairy supply chains, in terms of the production of safe and secure dairy products?

The participants of both FGs felt open to sharing all the risks they are facing either the managers from the dairy companies or governmental authorities keen to enhance the Egyptian dairy sector production. The FGs' findings related to risks are focused substantially on the 'source' side of the SC. The participants discussed the risks related to the raw milk supply, which represent a critical issue to produce safe and secure milk products. Such risks are related to the lack of availability and its low quality. Figure 5.9 summarises the key findings of FG1 and FG2 to answer RQ2. This can be classified into risks related to the company itself including seasonality and the lack of farmers' awareness, this can be controlled by proper demand planning and training and awareness to the farmers and employees. Then, challenges related to the industry include the raw milk's poor quality and poor handling. That requires collaboration from other stakeholders like the government and suppliers to provide the support needed in terms of the hygienic tools for milk handling and suggestion to develop the farms and MCCs to increase and preserve the raw milk quality.

Figure 5.9: RQ2 Overall results Mind Map-Source: Author



Some of the quotes mentioned by the participants will be discussed to reflect how the participants are aware of the risks in the Egyptian dairy sector and they are keen on finding solutions to overcome such risks to enhance the dairy producers' performance. For example, Participant 1, the NFSA head, detected the risks from *"supplier zero"* who is an individual farmer who owns a limited number of cows or even one cow only and does not have milking tools nor the basic hygiene practices handling the raw milk. Based on that, he suggested a tracking system and awareness programs optimise their performance.

Participant 1: *"The whole issue is in the livestock area", "in the year 2010 we tried to convince the EU to import powdered milk from the countries they determine for us and we will produce the dairy products and export it back to them, but the EU refused. They said you do not have cattle hygiene.", "link the traceability with the supplier and the milk specifications…a system for the farmers who own less than 6 cows? Can they compete by any means and be included in the circle? The answer is yes", "nobody is helping and assisting those random farmers who own over 5 million cows around Egypt and produce 90% of milk production", "took samples of the milking equipment after cleaning and found the bacterial count 300.000 before the milking process. So, first of all, the cleaning is a total mess",* and *"very reputable companies which we inspect and if they are performing well, we add them to the whitelist, and all goes well. The problem resides in the milk they use. When there is a shortage of raw milk, they use powdered milk"*

Participant 4 from Company-B supported Participant 1 from FG1 on the poor quality of most of the raw milk supplies in Egypt. He provided the following evidence: *"the problem resides when we do supplier audits to many farms in Egypt to get raw milk from them and we reject them."*

Participant 7 from the packaging supplier in FG2 focused in detail on the poor quality of the majority of the raw milk supply in Egypt, which does not qualify it to get into the production of milk products. He mentioned: *"The milk collection centres are not Grade A raw milk; they provide Grade B and C raw milk. Grade B and C cannot be used directly in producing premium milk products…The collection centres collect from anybody who owns one or two cows without focusing on the quality. I can tell there are extensive efforts provided to enhance the quality of the milk collection centres, but their milk does not match the quality of Grade A raw milk which is used in the production of the UHT long shelf life."*

Participant 8 from the powder milk supplier in FG2 supported Participant 1 and 4 by mentioning the following quotes related to the raw milk supplies, lack of availability, and poor quality: *"The problem resides mainly in the availability of the raw milk. 80% of the loose milk is still not under control. Approximately 25% of the loose milk is only utilised", and "bad handling and the lack of awareness which leads to wasting 70% of the raw fresh milk in the market."*

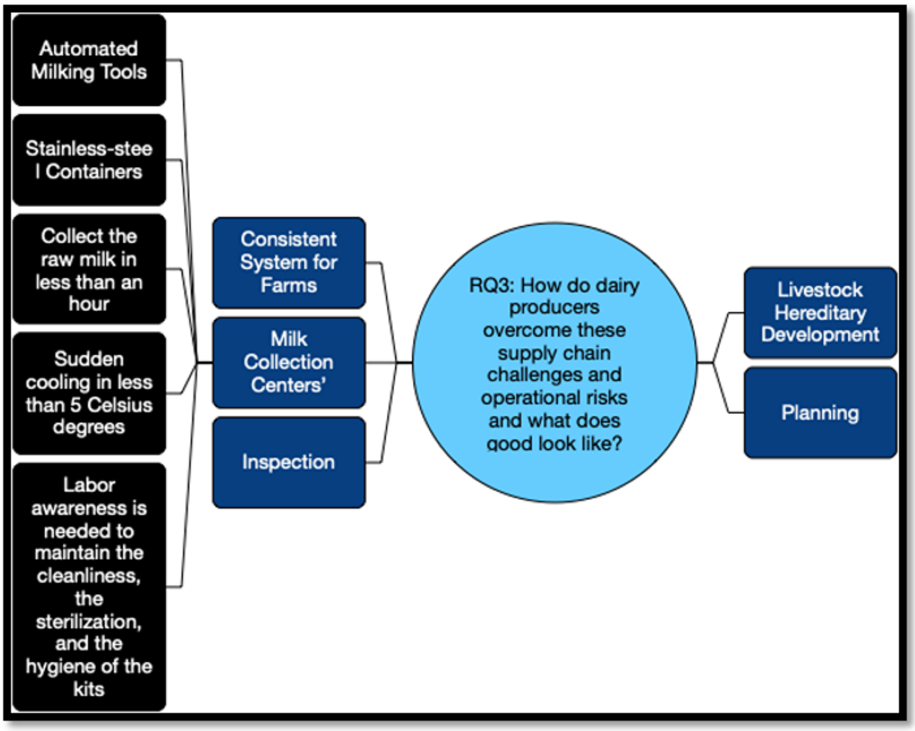
Participant 10 from the ministry of trade in FG2 also supported the other participants and he added that Egypt imports powdered milk due to all these risks related to the local raw milk supply state. He mentioned: *"We all know that most of the issues are related to the raw milk* *supply. The raw milk supply in Egypt is not in its perfect state.", "90% of the raw milk productivity in Egypt is based on the individual milking of small farmers in upper Egypt and still lacks intensive veterinary efforts", "The small farmers control the majority of the raw milk supply. They need support because they own the majority of the livestock in Egypt. However, we have a very limited number of large farms that own the specialised dairy herd of livestock. And the milk collection centres require intensive efforts for development", "Egypt has a deficit in the raw milk trade balance and its dairy products with 336 million USD",* and *"we have a 2% increase in the raw milk supply productivity in Egypt and our imports of powdered milk are also increasing with 10%. So, the gap is increasing between our local raw milk supply and what we are forced to import to fulfil our demand for dairy products"*

The following section includes a summary of the answers stated in the FGs related to answering RQ3.

5.4.3 RQ3: How do dairy producers overcome these supply chain challenges and operational risks and what does good look like?

Based on FG1 and FG2, when the researcher asked the participants RQ3 as it is, they provided the following answers. Participants from the ministry of agriculture and the national authority for food safety provided drastic solutions to overcome the previously mentioned risks related to the low quality and quantity of the raw milk supply in Egypt. This represents an inevitable solution to the development of the dairy sector in Egypt. Also, participants from the dairy producers suggested solutions related to the planning and inspection of their suppliers periodically. Figure 5.10 summarises the proposed solutions to overcome the existing risks in the Egyptian dairy SCs.

Figure 5.10: RQ3 Overall results Mind Map-Source: Author



Participant 1 from FG1 mentioned: *"they take very high-quality milk...or they use powdered milk."*, *"We need to utilise the 5 million cows with higher productivity. That is the challenge."*, and *"if I reduced the bacterial total count by applying the cleanliness measures and we sell the milk with better total count, the farmer will sell the raw milk at a higher price."*

Participant 4 from one of the large dairy producers in Egypt suggested*: "we are currently building a new milking parlour to triple the amount of milking supply on a personal level to suit our quality. That's why I agree that we, as dairy companies, do not focus on the small farmers."*

Participant 5 representing Company-C gave another example from FG1 representing a large dairy producer. He mentioned: *"enlarge my collection centre to include the capabilities to supply good quality milk. Such capabilities include a cooling system, a CIP system to ensure the hygiene of the equipment, training for the workers at the MCC or the farmers themselves."*

Participant 10 from FG2 supported the reliance on the imported powder milk as a safe alternative for supply to fulfil the dairy producers' production plan: *"The situation altered after COVID19. Many large dairy producers preferred to have local suppliers. Most of the dairy producers rely on imported powdered milk, and they face a shortage of powdered milk supply."*

Regardless of the risks, Participant 9 supported the other participants by providing the following evidence: *"These are the problems we are facing, and I agree with my colleague in terms of the collaborative planning between the producer and the supplier to sustain the supply process based on a trusted relationship between both of them".*

Participant 7 also supported this with the following evidence: *"to match the supplier capacity with the plant capacity and avoid the delay in raw milk receival. And the more important point is the planning",* and *"Our hope to increase the efficiency of the small and medium farms. It is unlike the large farms where we deal with only one source, but with the milk collection centre, I deal with around 50 or 30 sources. So, I need to increase the efficiency of those collectors to enhance their raw milk quality to what reaches the quality of raw milk coming from large farms...We will provide them with the tools and equipment to test the adulteration, the antibiotic residues, mycotoxins, or pesticides"*

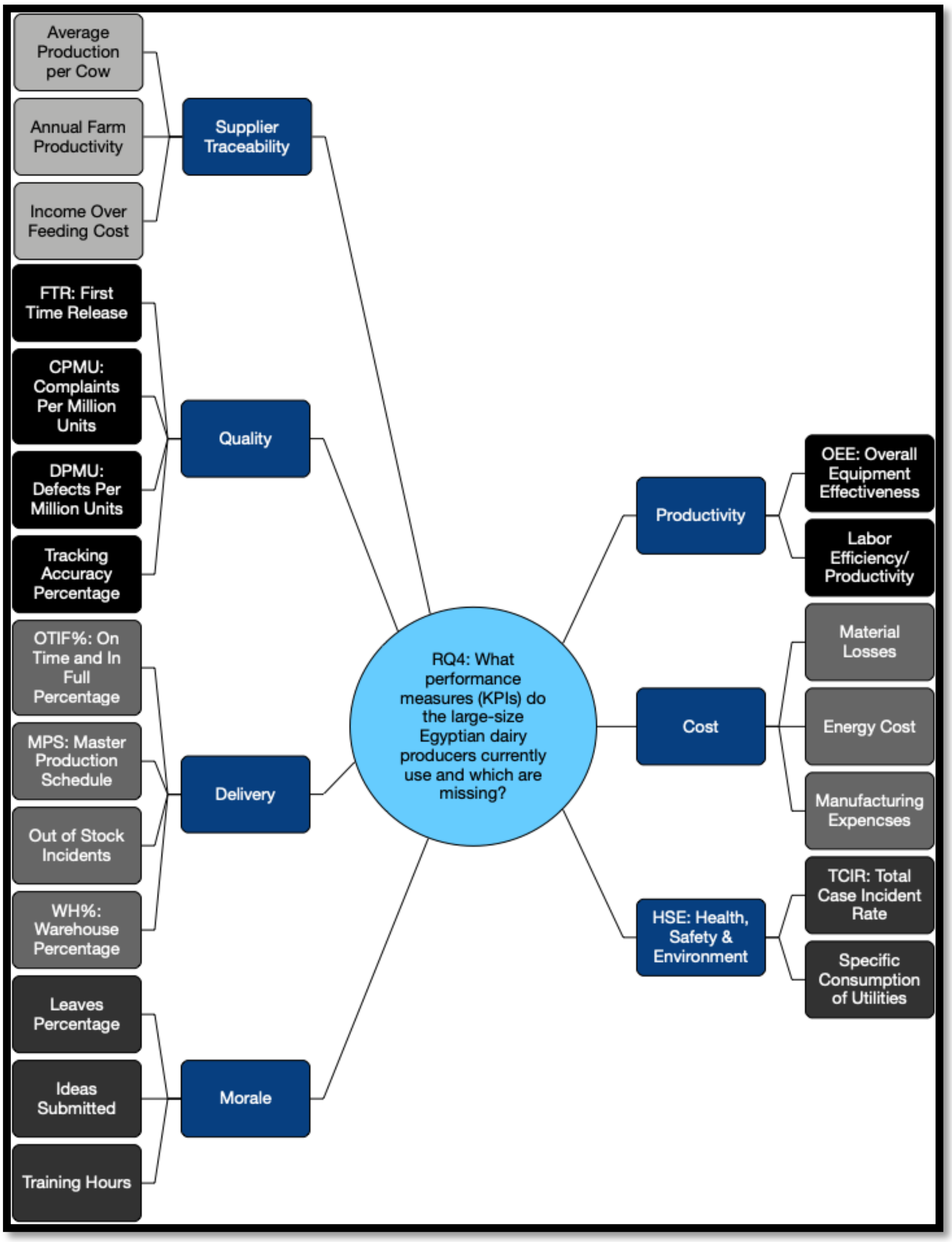
The following represents the core of this thesis by listing the proposed KPIs within the validated best practice framework, which serves to answer RQ4.

5.4.4 RQ4: What performance measures (KPIs) do the large-size Egyptian dairy producers currently use and which are missing?

The participants from the FGs helped in reshaping clear KPIs metrics covering the scope of 'source' and 'make' of the SC. FG1 was more detailed about the KPIs on both sides the 'source' and 'make' and FG2 confirmed this. The following sample of evidence from the participants supports this. This reflects that the researcher has reached data saturation in proposing a best practice list of KPIs that enable the dairy producers to assess, measure, and enhance the operational and SCP in terms of the sufficient amount of dairy products' production.

The following mind map illustrates a metric of the KPIs concluded from the participants in FG1 and FG2. Additionally, Participant 7 mentioned the following quote explaining the importance of traceability along the SC, including the downstream side, and tracking the final milk product even though, the downstream side 'deliver' sits out of the scope of this thesis, but he felt enthusiastic to share further details: *"for the traceability, as you mentioned in the KPIs and the number of suppliers. There should be a registered list of all suppliers and full traceability of the 'in and out'"* and *"the final product now has a magnet part attached to the new packaging to enable its traceability even with a mobile device...the suppliers should have their traceability of the sources of raw materials".* Figure 5.11 shows a compiled and refined list of KPIs from the top large dairy producers in Egypt, which is validated by the FGs to compile a guide to be followed by the peer producers. That will enable the Egyptian dairy sector to fulfil larger share of demand from local Egyptian dairy producers.

Figure 5.11: RQ4 Overall results Mind Map-Source: Author



The last section discusses the answers related to RQ5. When the researcher asked the participants: "**How do dairy producers overcome these supply chain challenges and operational risks and what does good look like in terms of reliability, responsiveness, agility, cost, and asset management?**" and "**What is the direct impact of applying these performance measurements (KPIs) on the dairy producers?**".

5.4.5 RQ5: How to improve the Egyptian dairy producers' performance against risks and challenges using the SCOR model's SC attributes?

Figure 5.12 illustrates the findings related to improving the dairy producers' performance and exploring the SCOR model applicability. The figure is then followed by a discussion of the participants' answers classified according to the SCOR model attributes. Those answers guide fellow practitioners towards future improvement regarding the SCOR model attributes' applicability. The attributes are reliability, responsiveness, agility, cost, and asset management.

Figure 5.12: RQ5 Overall results Mind Map-Source: Author

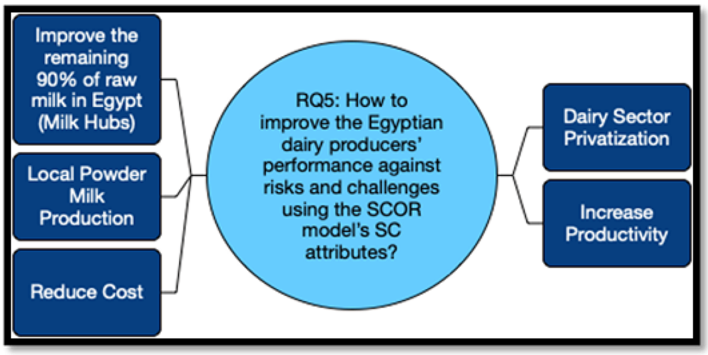
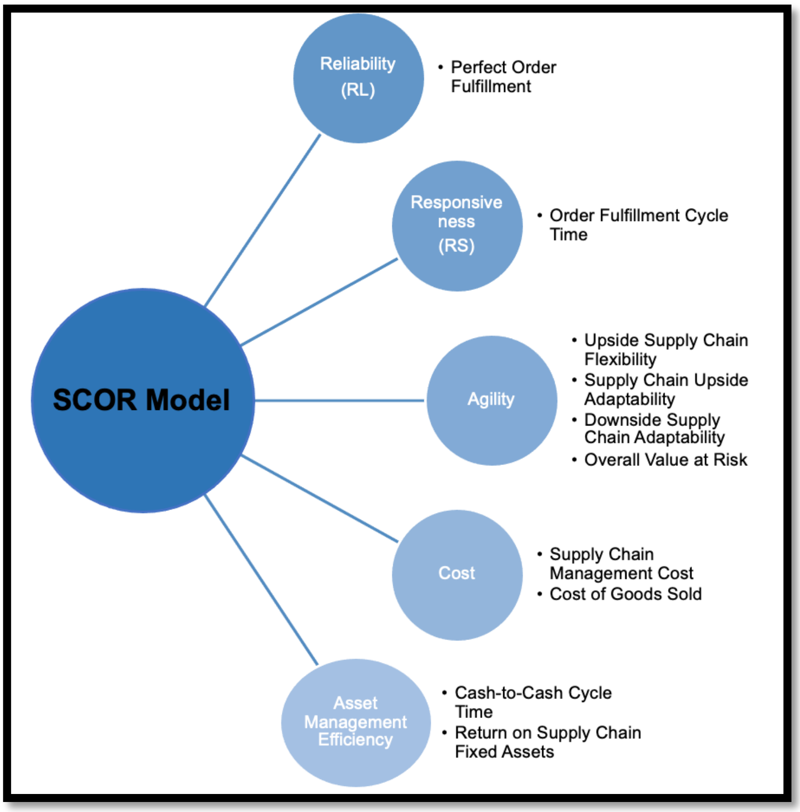


Figure 5.13 acts as an illustration of the SCOR model attributes, to guide the discussion of the following paragraphs and contrast the FGs' findings to the SCOR model's applicability in the Egyptian dairy sector. Each section will cover the participants' contribution to improving the dairy producers' performance according to each of the following attributes.

Figure 5.13: SCOR Model 'Make' Metric- Source: (APICS, 2018)



Although the sample of the thesis all belongs to the private sector. Participants from FG1 stressed on the idea that privatisation of the dairy sector's producers is the key solution to develop the supply side of the dairy chain 'source' besides enhancing their own operational capabilities 'make'. Focusing on the development of both sides of the chain will enhance the dairy sector in Egypt. Supporting this, Participant 1 mentioned: *"We need someone from the private sector to build this idea"*. Also, the milk hub solution proposed by NFSA participants helps in achieving the SCOR attributes to enhance the overall SCP in terms of reliability, responsiveness, agility, and cost. Other than that, asset management would be considered only in case the farm, or the milk collection centre is owned by the dairy producer.

5.4.5.1 Reliability

Some participants discussed the order fulfilment from different angles. For example, Participant 1 from FG1 evident the need to further develop the capabilities of the large dairy producers to fulfil diversified product portfolios in sufficient amounts to fulfil the demand. He mentioned: *"There is a very limited amount of production of pasteurised milk in Egypt. The majority of milk production is sterilised TetraPak milk"*. Also, Participant 6 and 9 from FG2 highlighted the initiative the ministries are taking to support the dairy sector: *"ministerial decree number 94 was issued in the year 2020 to organise the milk collection centres", "Development plan at the ministry of agriculture to include the milk collection centres to the whitelist and to obtain the HACCP certificate",* and *"we developed the milk collection centres and the small farmers and we have a system to distribute the automatic milking parlours on the small farmers and improve the livestock herds and intensified the veterinary care by The General Organization for Veterinary Services and all its branches...we already started the improvement system*".

This also reflects the asset management attribute, as it reflects managing their assets in terms of their livestock and the collection centres.

5.4.5.2 Responsiveness

Participant 1 mentioned a detailed explanation about developing the idea of a milk hub by providing the following evidence: *"vets are the first service to be provided…There should be a refrigerator at the hub to contain all the needed vaccines and assign someone...He will vaccinate the cows based on their date of birth. Also, we will have a unit for the cattle...We made the ton of cattle feeding equals 2400 EGP...So, we reduced the cattle feeding price for them...This takes us to the last unit of genetic improvement and the traceability and the tracking of the records to trace the origin of the raw milk coming from which farm."* and *"If I am a large dairy producer and kept this hub idea in my mind to build it, assign an expert for it and audit it myself, it can be easily done. As I can build my own farm, my own collection centre, so I'm capable of creating a hub. I'll provide the farmer with these services, and he will provide me with more quantities of raw milk".* In addition, Participant 3, 4, and 5 supported the hub idea by mentioning: "*large dairy producers should collaborate to implement this idea and look for the long run rather than the short run."* and *"We are working towards this goal in integration with hub idea proposed by Participant 1, that will improve the performance for sure"* and *"I find the hub idea brilliant".*

However, Participant 4 opposed at some point to mention: "*I'm speaking from a producer's perspective; I do not get milk from collection centres from the beginning of establishing the company. We do not accept raw milk from collection centres. We rely only on our own farm's productivity. This option is not valid for everyone. We have enough investment, but it is not an option for other producers".*

5.4.5.3 Agility

Some participants provided some evidence related to agility, although they did not mention it explicitly. Some evidence were provided as follows, Participant 1: *"supplier zero should be registered at the national food safety authority to enable us to have full traceability from the farm until the products",* Participant 8*: "We should have a farm and a consistent system for the milk receival, otherwise we will need accompanying dairy products production to the UHT milk, like yoghurt and cheese",* and Participant 6*: "We carefully counted the milk collection centres in Egypt during 2020 and the livestock. That enabled us to have an electronic database that resembles a map for the livestock in Egypt and pointing the location of each city" and "826 milk collection centres centered around 14 cities only of all Egypt's cities".*

5.4.5.4 Cost

The discussion between the participants during FG1 and FG2 linked many of their insights regarding the performance with managing cost. Some participants suggested recommendations to reduce cost and enhance the productivity of the suppliers and the dairy producers. The following quotes address areas of managing the costs in the SC and proposing cost optimisation solutions. Participant 3 mentioned: *"small farmers need assistance to improve their milking quality and consequently benefit the dairy producers. This parameter will improve the operations and reduce the cost.",* and "*The raw milk takes the major percentage of the variable cost*.", Participant 1 also provided the following evidence concerning the raw milk supplier: *"increase the cow's productivity and reduce the cost of production"* and Participant 9 mentioned: *"The raw milk pricing should be reconsidered to match the final product's price".* Also, he linked the impact of enhancing the asset management on the cost by providing the following evidence: *"The HACCP certified milk collection centres who have traceability to their sources, can sell their raw milk with higher prices and be compared to the large farms' prices".*

5.4.5.5 Asset Management

The last attribute in the SCOR model is asset management. It is concerned with managing all resources in the dairy SC. Supporting this, Participant 1 from FG1 suggested governmental guidance towards increasing all kinds of support: *"financial push comes from the central bank of Egypt, and he approves that. So, on a personal level I support anyone willing to adopt the hub idea for implementation"* He added the following evidence to reflect the benefit of establishing the hub idea by linking between agility and asset management: *"the hub creator will take advantage to belong to the whitelist, assist him in the exports and give him other privileges".*

Participant 6 from FG2 also mentioned the government increasing interest in development*: "we noted the guidance of the political leaders towards designing and manufacturing equipment and tools to increase the milk collection centres efficiency. It is 100% national manufacturing by military production with higher productivity and less price", "the bank of agriculture agreed to extend the loan term up to 8 years. Also, there is a ministerial decree to assign a managerial coordinator to improve the milk collection centres",* and *"the ministry of agriculture adopted the hereditary development program".* He added: *"The first phase planned to improve 205 milk collection centres….and importing specific livestock herd specialised in the milk productivity with over 6 to 7 times more than the normal range of our local productivity."* And *"The General Organization for Veterinary Services intense its veterinary services to ensure they are free of any diseases and maintain a good feeding, care, milking processes, and the improper and unhygienic raw milk handling equipment from the milking places to the collection places to ensure the availability of top-quality raw milk for production and exports. The ministry of agriculture is establishing 10 new collection centres in different places centred around the small farmers where there is lack of collection centres availability."* and *"We are going to have locally produced powdered milk very soon".* That supports the power of the large dairy producers to collaborate with the government to enhance their sources of raw milk by supporting the small farmers who possess most of the raw milk supply in Egypt compared to the large farms. This reflects on the long term in reducing the overall SC cost, agility, and reliability in fulfiling the orders. The following section includes a summary of the chapter including the key sections covered.

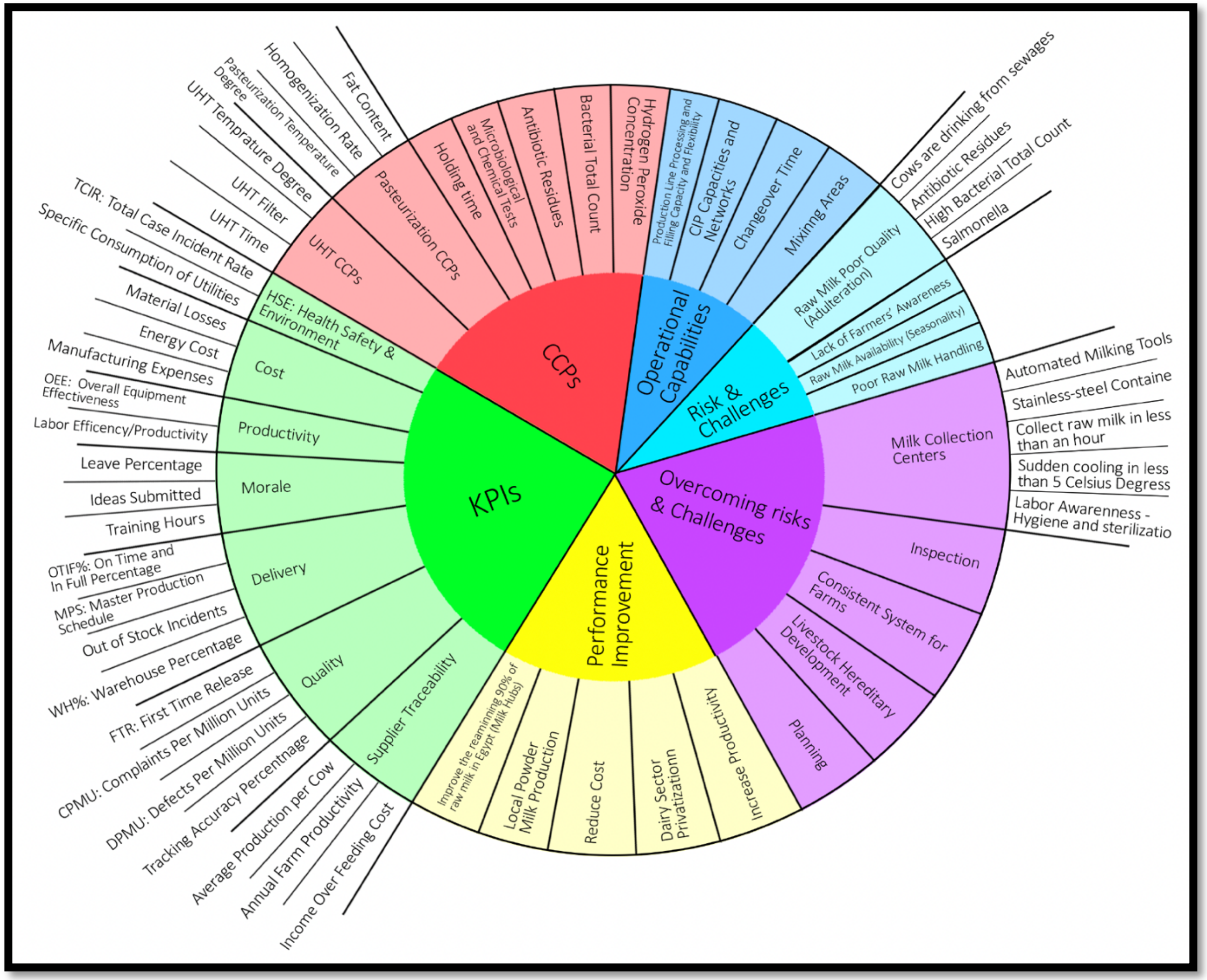
5.5 Summary

To summarise, going back and forth with the data and comparing the findings of FG1 to FG2 assured the data saturation, which adds to the research validity. This section will act as a prologue to the next chapter to ease contrasting the findings with previous studies.

The results of this phase covered the five themes but were centred on four key themes representing the framework's constructs with twenty-two sub-elements concluded from both FGs. First, risks remain existing and threaten the progress of the Egyptian dairy industry and recorded four sub-elements. Second, the participants had some disagreements on the seven generic CCPs related to the production of pasteurised milk and UHT milk in terms of their naming. However, their explanation reflected the same checkpoints held to the product within the processing phase. Plus, they all approved that CCPs differ according to the product being produced. Third, the operational capabilities mentioned in both FGs ranged between three to four. The researcher found it more accurate to keep them classified into four capabilities to reflect more accuracy to the operations. Last, the FGs helped to categorise a metric of indicators to assess the operational and SCP. The FGs refined seven generic KPIs related to the 'source' and 'make' of the SC. Each indicator includes sub-elements to ease the measurement of performance.

Then, the researcher examined the data saturation by contrasting the results of the FGs to the first phase in terms of the proposed best practice framework. This was done by supporting each construct by several pieces of evidence showing its progression and development through the data sets. The last section represents the essence of this thesis' findings towards answering the RQs. It ensured that all RQs are met with answers supported by enough supporting evidence to maintain the research validity and reliability. Figure 5.14 compiles the overall results including the main constructs and their sub-elements. The findings represented in this figure will be discussed and contrasted to the literature in the following chapter.

Figure 5.14: Overall Results Including the Main Constructs and Their Sub-elements



Chapter 6 Discussion of Findings

6.1 Introduction

This chapter emphasises the key findings of all empirical work held. It included interviews composed of open-ended questions and Likert scale and observations. Then, FGs in Phase Two to validate the framework's constructs compared to what is found in previous literature. This highlights the key contribution of this thesis. This examines the relationship between the empirical part of this thesis and the theories; RBV, network and institutional. It explores the operational capabilities, including the CCPs, the risks affecting the dairy sector, and proposing KPIs, within a best practice performance framework for the Egyptian dairy producers.

The inductive approach of the data analysis, in both phases, validated the research findings towards theory by generating in-depth data about the dairy producers' operational and SCP. This is rarely covered in previous literature in the agricultural sector and the dairy specifically.

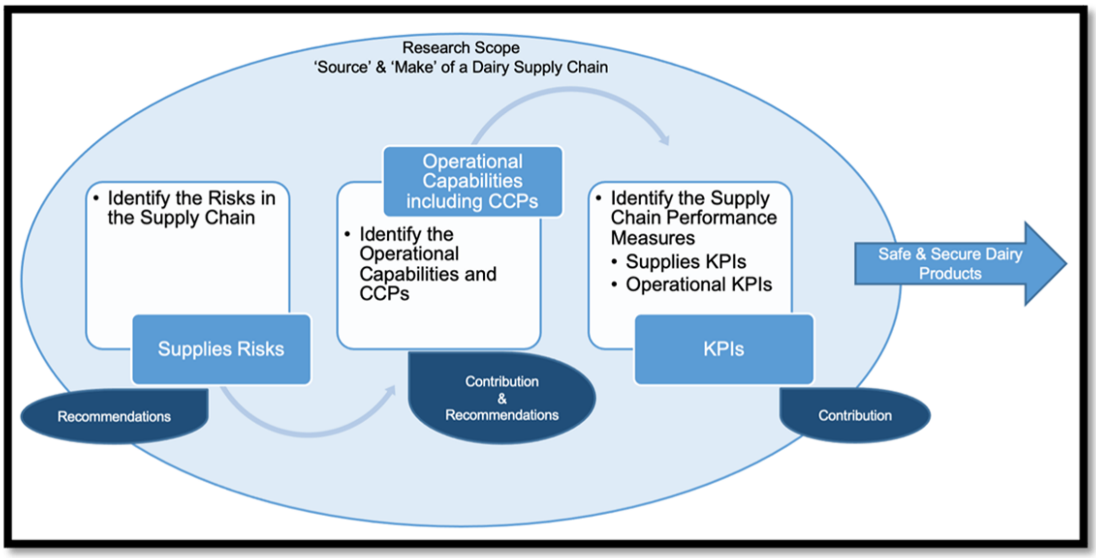
The findings of the empirical findings obtained in this thesis are the sum of the collaboration of six large dairy producers, governmental authorities, and suppliers. Therefore, the findings of this thesis are represented in four major constructs composing a best practice framework including operational capabilities, CCPs, KPIs, and risks. These four constructs contribute to the emerging five themes from phase one by identifying the best practice framework's elements to overcome the risks and challenges and improve the dairy producers' SCP. It will act as a guide for the remaining Egyptian dairy producers of medium and small-size producers to assess and enhance their capabilities and performance.

This chapter will start with discussing the empirical findings to answer each of the five RQs. Then, followed by explaining the proposed KPI metrics. Last, providing a summary of the chapter.

6.2 Empirical Findings in Relation to RQs

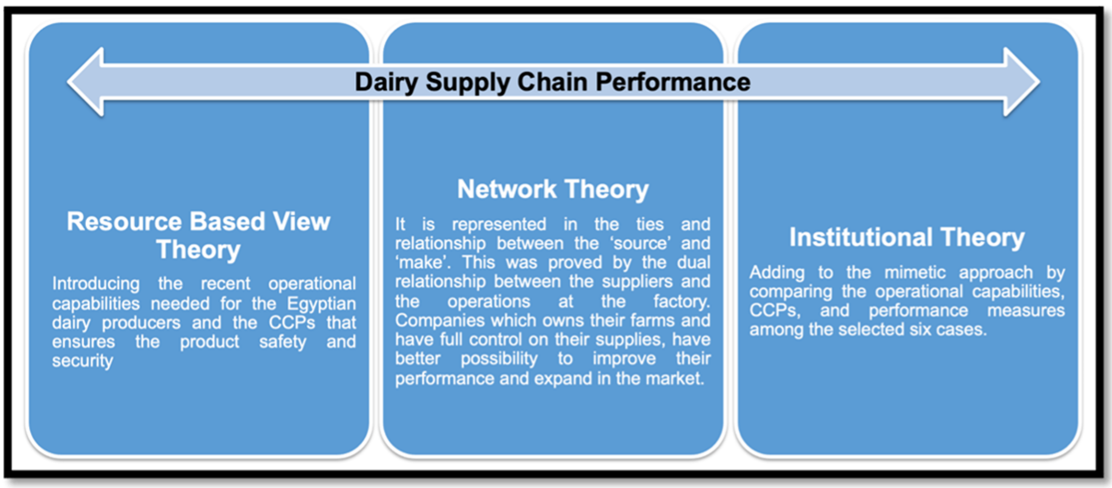
This thesis identified four constructs and forty-six elements in total from the FGs, including the risks, CCPs, operational capabilities, in which seventeen elements represent the KPIs to resemble a best-practice guide to be followed by other dairy producers in Egypt to enhance their SCP (Table 5.2). That resembles the core contribution of this thesis. Eighteen KPIs were identified in phase one and then validated and restructured into seventeen KPIs in phase two by different key members in the dairy SC. This gave a broad perspective on validating the findings of the first phase in case the researcher missed highlighting any area related to the topic. The process toward reaching the findings of this thesis can be summarised in visual illustration (Figure 6.1) to resemble the linkage between the constructs which were explored and validated. It starts with identifying the risks affecting the dairy SCs. It resides mainly in the supply side of the SC, or the 'source' according to the SCOR model. This thesis will provide recommendations in the next chapter to overcome such risks. Then, identifying the operational capabilities and the CCPs which resemble the 'make' side of the SCOR model and covering its attributes' applicability by the selected cases. This part will add to the contribution and the recommendations of this thesis. Last, identifying KPIs metrics to guide the Egyptian dairy producers to assess and measure their performance of safe and secure products. This also will add to the contribution of this thesis and to the literature.

Figure 6.1: The Process Toward Contribution and Recommendations-Source: Author



In general, the empirical phases of this thesis matched the constructs identified based on the existing literature and extended them to add to the three theories: the RBV theory, the network theory, and the institutional theory. Figure 6.2 summarises the key contributions towards the relevant theories. Identifying the operational capabilities including the CCPs from the selected dairy producers will extend the applicability of the RBV theory in assessing the management of all resources in the SC which will impact their performance. Employees' development and training about the food safety standards and the detailed CCPs for milk production to achieve the required quality within the best practice framework. According to (Shaw et al., 2020: Yu et al., 2018: Yang and Konrad, 2011: Kraaijenbrink et al., 2010: Theriou et al., 2009) this adds to the sustainable SCP and fulfils better market demand. Both RBV and network theories work on a relational base (Kauppi and Hannibal, 2017: Theriou et al., 2009). It investigates the risks and challenges in the wider SC. That was proven in the interviews where the participants explained the relation between the suppliers and the factory and how they are both interrelated to maintain the operational and SCP. For example, the milk purchasing manager of Company-D mentioned: "*If I can say both operations and supply chain, are impacting each other then it is, because it is more of a loop connected together and its success depends on the effective availability and collaboration of all supply chain member and the right utilisation of all resources within the supply chain through the production*". Further details under Section 4.4.3.5 Supply Chain and Operations. Last, the institutional theory is basically about comparing different companies' existing capabilities, CCPs, and KPIs by following the mimetic approach to introduce a best practice (Kauppi and Hannibal, 2017: Ketchen and Hult, 2006: DiMaggio and Powell, 1983). Thus, the dairy producers can adhere to the detailed proposed CCPs to assess their operations and SC KPIs from the early stages in the chain. Measuring the CCPs will ease assessing the KPI and managing the overall SC accordingly. This can be achieved by providing the farmers and the labour with the suitable tools and training needed to control the process against the risks from the beginning. That is achieved by conducting the cross-case and within-case analysis by looking for a pattern among the six dairy producers who participated in this thesis. The six cases are of the top producers contributing to the Egyptian dairy market. This qualified them to collect eligible data for a best practice framework.

Figure 6.2: Contribution Towards Existing Theory



The following table highlight some of the existing data found in the literature and what is explored from the empirical work to contrast between the existing data and the explored data from both phases which is discussed in detail right after the table. The findings of the second phase (FG1&FG2) did not record new significant themes compared to the first phase (interviews and observations) but concentrated on the development of sub-themes related to the supply side and enhancing the raw milk quality and quantity instead of relying on the imported powdered milk by establishing a milk hub and local powdered milk factory. This initiative was suggested by NFSA, the governmental authority, to be adopted by a company from the private sector that has enough capital to fund the applicability of this initiative. That ensures a sustainable flow of raw milk (Rousing et al., 2020), which in turn will increase the production of dairy products to the local and global markets. The findings of the second phase confirmed the findings of the first phase and introduced better classification and assurance of the themes and sub-themes. In addition, it added further confirmability of the findings of phase one by introducing solutions and recommendations to enhance the dairy sector's performance. Also, it introduced a more compressive list of what should be done, in terms of the operational capabilities they should have, the CCPs, and the measures needed to monitor and improve their operational performance of producing safe and secure dairy products.

Table 6.1: Summary of Elements Identified

Constructs	Literature	Findings
Operational Capabilities	**Coltman and Devinney (2013)** 1. Active customer engagement (AE) 2. Cross-functional coordination (CF) 3. Creative solutions (CS) 4. Operations improvement (OI) 5. IT infrastructure (IT) 6. professional delivery (PD)	**Phase1:** 1.Production Line Efficiency/Overall Equipment Effectiveness (OEE) 2.Production Line Flexibility 3.Storage Capacity 4.Operating Capacity System 5.Tracking System 6.Packaging 7.Labor Competency 8.Lead Time **Phase 2:** 1.Production Line Processing and Filling Capacity and Flexibility 2.CIP Capacities and Networks 3.Changeover time 4.Mixing Areas
CCPs	**El-Gendy et al. (2010)** 1.location of the plant 2.plant design 3.absence of air filtration	**Phase 1:** 1.UHT Temperature 2.Bacterial Total Count 3.Antibiotic Residues

	4.absence of resistant glass windows 5.machinery layout 6.keeping records 7.absence of protective maintenance of equipment 8.controlling the cooling system 9.water analysis **Ammar (2017)** 1.the reception 2.the heat treatment 3.cooking 4.packing and storage	4.UHT Filter 5.UHT Time 6.Pasteurisation Temperature 7.Packaging Tests 8.Hydrogen Peroxide Concentration 9.Holding Time 10.Microbiological Tests 11.Chemical Tests **Phase 2:** 1.UHT CCPs • UHT Temperature Degree • UHT Filter • UHT Time 2.Pasteurisation CCPs • Pasteurisation Temperature Degree • Homogenization Rate • Fat Content 3.Microbiological and Chemical Tests 4.Holding Time 5.Antibiotic Residues 6.Bacterial Total Count 7.Hydrogen Peroxide Concentration
Risks & Challenges	**Njage, Opiyo et al. (2017)** • Manual operations by personnel increase the risks of contamination • the risk of raw materials • the risk of the final product and the extent of safety contribution and the packaging concept • extent of intervention steps • the degree of production process changes • the rate of product/ process design changes **El Nakib (2015)** • raw milk quality and delivery to plants • hazard risks • variation of consumer taste • difficulty in delivering the raw milk to the factory • variation in the quality and taste of consumer • hazards risk represented in accidents or electricity shut down. **Chen et al. (2013)** **Operations risks:** • deviations from producing the specified quality and quantity at the specified time • disruption risks caused by major disasters such as flood, earthquake, or economic crisis **Bandaly (2012)** **External risks**: • IT systems failure	**Phase 1:** 1.Source of Raw Materials 2.Operational Risk 3.Raw Materials Risk 4.Cleaning and Breakdown Risk 5.Production Risk 6.Energy Risk 7.Machines Performance Risk 8.Malfunction Risk 9.Prices Risk **Phase 2:** 1.Raw milk availability (Seasonality) 2.Raw Milk Poor Quality (Adulteration) 3.Lack of Farmers' Awareness 4.Poor Raw Milk Handling

<table>
<tr>
<td></td>
<td>• supplier failure
• natural disasters and accidents (e.g., fire or theft)
Internal risks:
• machine breakdowns
• import or export restrictions
• transportation failure
• increasing customs duty
• fluctuation in customers’ demand
• technological change
Production risks:
• employees’ risk (injuries, stress and drugs issues, and bullying)
• property risk (lack or inappropriate maintenance, accidents such as fire and storms)
• environmental risk (pollution and leakage of materials)
• criminal risk (theft and fraud)</td>
<td></td>
</tr>
<tr>
<td>SC KPIs</td>
<td>APICS (2018)
<table>
<tr><th>Attribute</th><th>SCOR 11.0 Metric</th></tr>
<tr><td>Reliability</td><td>RL 1.1 Perfect order fulfillment</td></tr>
<tr><td>Responsiveness</td><td>RS 1.1 Order fulfillment cycle time</td></tr>
<tr><td rowspan="4">Agility</td><td>AG 1.1 Upside supply chain flexibility</td></tr>
<tr><td>AG 1.2 Supply chain upside adaptability</td></tr>
<tr><td>AG 1.3 Downside supply chain adaptability</td></tr>
<tr><td>AG 1.4 Overall value at risk</td></tr>
<tr><td>Cost</td><td>CO 1.1 Total cost to serve</td></tr>
<tr><td rowspan="2">Asset management efficiency</td><td>AM 1.1 Cash-to-cash cycle time</td></tr>
<tr><td>AM 1.2 Return on supply chain fixed assets</td></tr>
</table>
(Moazzam et al., 2018)
Reliability (RL)
RL1.1 Perfect order fulfilment
RL2.1 Percent orders delivered in full
RL2.2 Delivery performance to customer commit date
RL2.4 Perfect Condition
Responsiveness (RS)
RS1.1 Order fulfilment cycle time
RS2.1 Source cycle time
RS2.2 Make cycle time
RS2.3 Delivery cycle time
Agility (AG)
AG1.1 Upside SC flexibility
AG1.3 Overall value at risk (VAR)
Cost (CO)
CO1.1 SC management cost
CO1.2 Cost of goods sold
Asset Management (AM)
AM1.2 Return on SC fixed assets
AM1.3 Return on working capital</td>
<td rowspan="2">Phase 1&2:
1. Supplier Traceability
• Average Production per Cow
• Annual Farm Productivity
• Income Over Feeding Cost
2. Productivity
• OEE: Overall Equipment Effectiveness
• Labor Efficiency/Productivity
3. Quality
• FTR: First Time Release
• CPMU: Complaints Per Million Units
• DPMU: Defects Per Million Units
• Tracking Accuracy Percentage
4. Cost
• Material Losses
• Energy Cost
• Manufacturing Expenses
5. Delivery
• OTIF%: On Time and In Full Percentage
• MPS: Master Production Schedule
• Out of Stock incidents
• WH%: Warehouse Percentage
6. HSE: Health, Safety, and Environment</td>
</tr>
<tr>
<td>Product safety and quality KPIs</td>
<td>(Mbaga et al., 2011)
1. Quality certification
2. Quality Control Specialists
3. Worker’s training and knowledge
4. Workers’ health, safety, and welfare
5.Environmental management Practices
6. SC partners’ safety and quality requirements</td>
</tr>
</table>

Operations KPIs	**(Mishra & Shekhar, 2016)** 1. Quality 2. Customer satisfaction score 3. Speed 4. Dependability of percentage of delivered orders 5. Flexibility 6. Cost 7. Process knowledge improvement	• TCIR: Total Case Incident Rate • Specific Consumption of Utilities 7. **Morale** • Leaves Percentage • Ideas Submitted • Training Hours

Firstly, this thesis extends the applicability of the *RBV theory* by identifying the operational capabilities and the CCPs needed to ensure the production of safe and secure milk products. Both were not sufficiently identified in previous literature. The operational capabilities were briefly discussed by Coltman and Devinney (2013). Then, evolved to dynamic capabilities by Yiu, et al. (2020). It means integrating the internal and external resources and skills to match the dynamic market changes towards achieving a competitive advantage. The exploration of the needed operational capabilities to maintain safe and secure dairy production was held by interviewing the top large dairy producers in Egypt. The detailed list of capabilities from Phase One included a mix of resources, skills, and competencies in utilising these resources represented in the equipment utilisation. Phase Two validated this list to focus on the resources and their utilisation specifically.

Eight operational capabilities were identified among the six cases participating in Phase One of this thesis. Those were more detailed and classified on the 'make' level compared to what is included in previous literature to focus on the equipment effectiveness, capacities, leading time, and tracking systems. Other stakeholders during the FGs limited the operational capabilities to four only, to focus on the operability of the processing lines. Those stakeholders are suppliers and governmental authorities, besides the managers from the six cases. The proposed list includes four capabilities: the production line capacity and flexibility, CIP capacities and networks, change-over time, and mixing areas. The six dairy producers share similar capabilities because they are large dairy producers serving the same segment of consumers and controlling the pareto of the Egyptian market. Those capabilities enabled them to produce safe and secure dairy products and perform on a satisfactory level. Nevertheless, they were not sufficient to fulfil the local demand. Consequently, this proposed list of unified operational capabilities including the CCPs will guide those producers besides the medium and small dairy producers to join the competition, optimise their capacities according to the demand and fulfil a larger share of local demand for dairy products.

Then, many contradictions were recorded in determining the CCPs from one research to another and from one practitioner to another. Those are mostly different from what is mentioned in the literature. But it is agreed that they are the checkpoints during the processing to ensure the product's safety while proceeding to the next step of production as part of their GMP under the operational capability (Abd El-Razik et al., 2016). Ammar (2017) was more accurate than El-Gendy et al. (2010) in specifying and listing the relevant CCPs to dairy production. Both empirical phases of this thesis identified new seven CCPs for dairy production, where the UHT milk CCPs and the Pasteurisation milk CCPs are subclassified to three checkpoints each, according to the product specifications.

Five CCPs of them are mutual among all producers. But their target values differ according to the product intended to be produced. Other CCPs differ from one product to another. As this thesis's scope includes milk products, there are three CCPs for the UHT milk including the UHT temperature degree, UHT filter, and UHT time. Besides, three CCPs for the pasteurised milk include the pasteurisation temperature degree, homogenization rate, and fat content. Such classification for the operational capabilities and the CCPs clarifies the auditing process for the dairy producers to monitor their production process.

Secondly, the Network theory was reflected in the applicability of the stakeholder's analysis to investigate the ties among the SC members. That was held by inviting different stakeholders in the dairy SC to validate the findings of Phase One. This reflected in managing the risks and challenges existing in the SC which appeared specifically in the 'source' and 'make'. The suppliers, governmental authorities, and producers identified four key risks and challenges affecting the SCP. Those are raw milk availability and quality, lack of farmers' awareness, and poor handling. Many risks were identified in previous literature. The literature classified risks into internal (operational risks) and external (supply risks) (Bandaly, 2012: Chen et al., 2013: El Nakib, 2015: Njage et al., 2017). Controlling and mitigating those risks can be held by focusing on the strong ties between the suppliers and the governmental authorities, which reflect the stakeholders with high power and interest influencing the dairy producer's performance. The cases with higher SCP were vertically integrated by owning their farms. That was a key in keeping the identified risks to a minimal level.

Last, the applicability of the mimetic approach under the *institutional theory* appears in this thesis in iterating the exploration of performance measures (KPIs) among the six selected cases to compile a best practice SCP framework for other dairy producers in Egypt. That was achieved by contrasting the already existing KPIs in the investigated cases compared to the SCOR model. It was found that the Egyptian dairy producers do not follow the SCOR model due to their lack of awareness about it. However, it is crucial to structure their KPIs according to it and ensure the coverage of the five 'make' performance attributes, including reliability, responsiveness, agility, cost, and asset management (APICS, 2018: Moazzam et al., 2018). This thesis proposes a detailed list of classified KPIs extracted from the top Egyptian dairy producers to enable any dairy producer in Egypt, including SME to assess their performance. That resembles the core of a best practice performance framework. New KPIs were added to what is mentioned in the literature with a detailed practical classification. The list of KPIs covers the 'source' including three elements to assess the supplier traceability KPI to add to the agility attribute. Those are newly introduced elements to SCOR metric 11.0. Besides introducing six KPIs, including their sub-elements to assess the 'make' in a dairy producer. Those are: productivity and quality add to the reliability attribute, the cost is classified with detailed three sub-elements, delivery adds to the responsiveness, and last, HSE and employee's morale are new attributes that extend beyond the asset management to provide a detailed reflection of performance which is specially customized to assess the development of safe and secure dairy products.

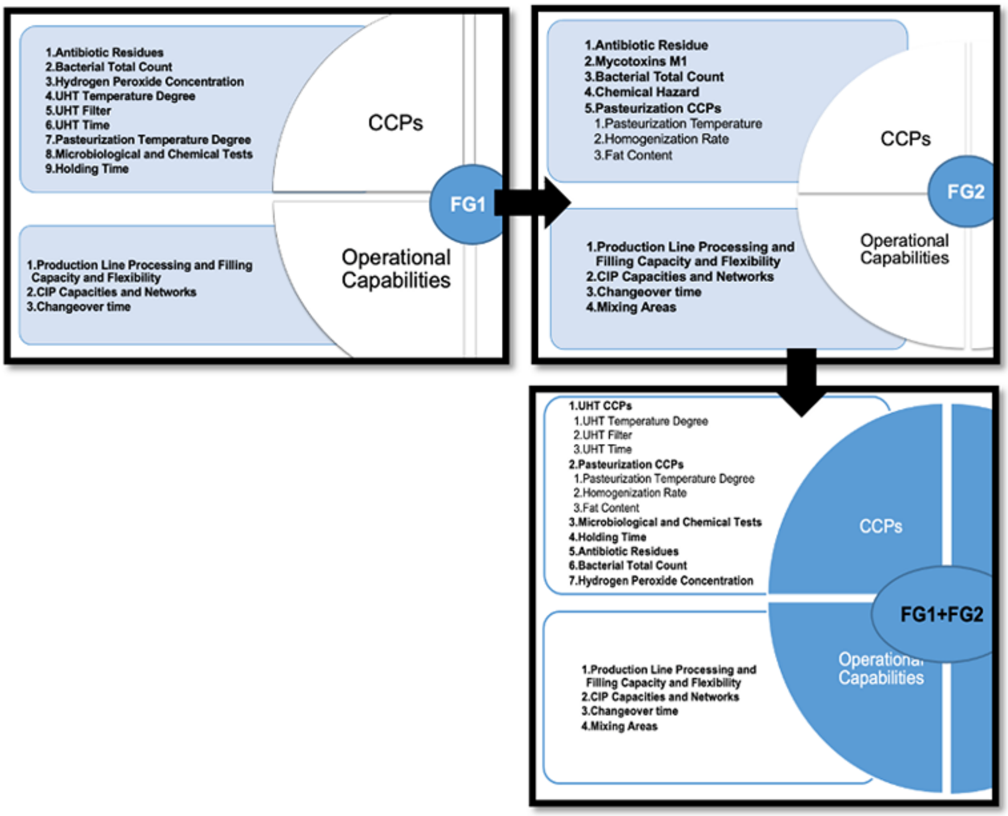
To summarise the findings according to the institutional theory, 1) vertically integrated SC represented in managing their capital and functioning in a group provides better transparency and enables them to be more efficient. 2) there is a different number of CCPs according to the product type and different interpretations for it, 3) investments in production line technology and traceability are essential to increasing capacity and agility while not affecting quality, only the large dairy producers can afford this. 4) Working on a demand-driven SC is beneficial based on the updated customer demand, 5) Line flexibility, agility, speed, and capacity of production are key, and it appears that many of these players do changeovers frequently with lots of products. That reflects its efficiency. Some companies have better production schedules than others according to their demand plan accuracy. 6) The large dairy producers adopt the ISO standards on different disciplines like food quality and the environment. Applying these standards is obligatory by the government and NFSA to qualify them for exports.

The following sub-headings will discuss the key findings of each RQ. In addition to the contribution to knowledge by introducing a best practice framework including a list of KPIs for the Egyptian dairy producers. The difference between the following discussion and the FGs' contributions towards each RQ in Section 5.4. It shows the progression of the findings along the empirical work journey by going through the two phases and contrasting them to the existing literature and theory in detailed discussion.

6.2.1 RQ1: What are the key operational capabilities, including the Critical Control Points (CCPs), in large-size Egyptian dairy producers?

This question is divided into two major parts, both are covering the 'make' of the SC. It ensures the production of safe and secure dairy products. Those are the operational capabilities and the CCPs. Figure 6.3 clarifies the progression process of introducing them within the best practice framework. That is the outcome of the validated results from both phases.

Figure 6.3: The Evolution of The Concluded CCPs and Operational Capabilities for The Egyptian Dairy Producers



Firstly, the operational capabilities are considered an essential construct to assess and enhance the dairy producers' performance (RBV theory). Hirunyawipadaa and Xiong (2018), Shaw et al. (2020), Kraaijenbrink et al. (2010), and Coltman and Devinney (2013) identified some generic operational capabilities which enable the producers to manage their resources in a way to add value to their processes and enhance the SCP. That included customer engagement, IT infrastructure, cross-functional coordination, professional deliveries, and operations improvement. Accordingly, the proposed operational capabilities are exclusively identified for the Egyptian dairy producers to match the existing risks and potential performance improvement. The key operational capabilities concluded from the empirical part of this thesis are production line processing and filling capacity and flexibility, CIP capacities and networks, changeover time, and mixing areas.

Secondly, there has been a lack of identification of the operational capabilities and CCPs for the dairy sector in literature to answer this RQ. The literature specified some generic CCPs like reception, heat treatment, cooking, and packing and storage (Ammar, 2017). Also, through the investigation of the HACCP in small cheese production plants in Egypt, El-Gendy et al. (2010) listed some CCPs like the location of the plant, its' design, absence of air filtration, absence of resistant glass windows, machinery layout, keeping records, absence of protective maintenance of equipment, controlling the cooling system, and water analysis. Most of them are not considered as CCPs, except controlling the cooling system and the water analysis. The CCPs are those inevitable checkpoints where the product is checked for safety approval or rejection to proceed with the processing and reach the final product state. Thus, a key finding noted among the producers is the different interpretations of the term CCP. Moreover, its applicability and existence differed among the producers on both levels, the 'source' or 'make'. However, the CCPs applicability is critical to ensure the safety of dairy products, and it is preferable to be applied on the 'source' level to ease its fulfilment during production (Rousing et al., 2020). This thesis reached detailed classified CCPs to be monitored in the production process. As it differs according to the product being produced. This thesis handled the CCPs in producing milk products specifically.

The CCPs are as follows; UHT CCPs include UHT temperature degree, UHT Filter, and UHT Time. The Pasteurisation CCPs include Pasteurisation Temperature Degree, Homogenization Rate, and Fat Content. Also, there are some generic CCPs applied to all processes. Those are the microbiological and chemical tests, holding time, antibiotic residues, bacterial total count, and hydrogen peroxide concentration. These milk CCPs are the first introduced to the literature in this research area covering the scope of the Egyptian dairy sector. That extends to the application of the RBV theory with a clear identification of CCPs to the Egyptian dairy producers' capabilities to enhance milk production, which contributes to enhancing their SCP. That is by ensuring the availability of sufficient amounts of milk products to fulfil the local and global market demand.

6.2.2 RQ2: What and where are the risks and challenges affecting the operation and supply chain performance in the Egyptian dairy supply chains, in terms of the production of safe and secure dairy products?

Figure 6.4: The Evolution of The Concluded Risks in The Egyptian Dairy Sector

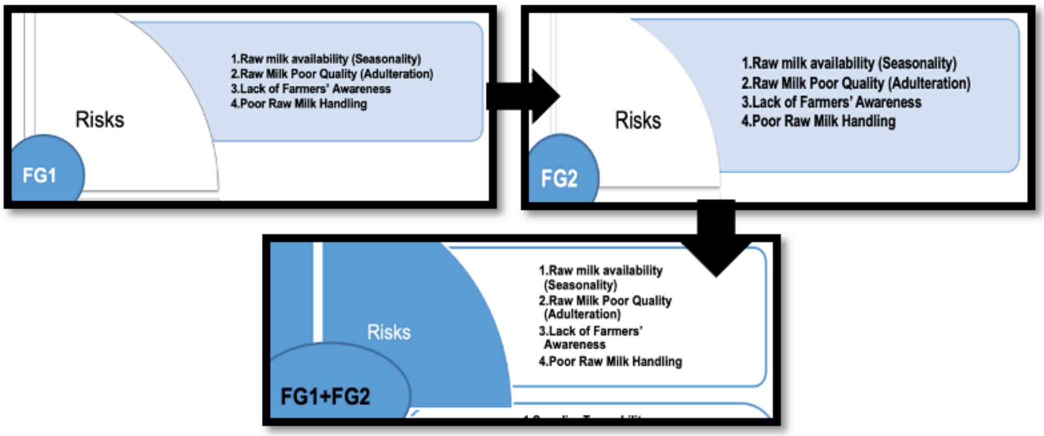


Figure 6.4 clarifies the risk classification from the FGs held which validate the first phase of interviews and observations. There are different classifications for risks in the SC literature as shown in (Table 6.1). Generally, it is classified into internal and external risks (Mohamed, 2015: Bandaly, 2012: Schaper et al., 2010). Although the dairy producers are expanding and increasing their capacities to absorb the increasing demand (Euromonitor, 2020), the International Labour Organization (2020) assured that Egyptian dairy producers rely intensively on the imported milk powders to fulfil this percentage. El-Gendy et al. (2010) and El-Hofi (2010) both investigated the HACCP application to overcome any internal risks related to the processing of safe and secure dairy products. That is confirmed with the selected large dairy producers who are all certified by HACCP. Bandaly (2012) mentioned some external risks including supplier failure (network theory), which was intensively emerging from both phases of empirical work of this thesis. Thus, this thesis extends to network theory by investigating the ties between the supplier and the producers and managing the SC risks. The vertically integrated dairy SC appears to be the best applicability of strong ties of the network theory in the Egyptian dairy sector. That is by having the dairy producers have their own farms to ensure a sustainable flow of good quality raw milk supply. That appears in the shortage of raw milk local supplies, which leads to filling only 72% of the local demand. The findings of this thesis approve this as a major risk affecting the dairy producers, in addition to providing detailed risks that reside in the supply side of the dairy chain, and at the same time, it is external to the dairy producer's factory. Also, Mishra and Shekhar (2016) and Tate (2017) highlighted that the low production per cow resembles a source of risk

for the dairy producers. This is also residing in the supply side of the dairy chain and appeared in the first empirical phase. It is covered later in the KPIs introduced to assess the performance of the suppliers to enhance the overall SCP. The concluded risks restrict the Egyptian dairy producers to fully utilising their capabilities to fulfil an extra share of the local milk products' demand.

Evidently, Participant 4 supported this by mentioning: "*Company-B get use of the separation of raw milk which might represent a challenge for some companies but not for Company B. As the company produces its own milk and dairy products but sells its cream for other dairy producers. By doing this, Company B got benefit from this challenge to achieve indirect profit*".

6.2.3 RQ3: How do dairy producers overcome these supply chain challenges and operational risks and what does good look like?

The empirical part of this thesis has explored ways to overcome the SC challenges and risks in both phases. The researcher ended the interview in phase one by asking the participants: "***What are your future plans for improving your SC performance***?", and again in the second phase, the researcher asked them: "***How to improve the large dairy producers' performance against risks****?*". This was to validate the exploratory findings and ensure the coverage of all possible solutions from different perspectives in the SC. A major theme with eight subthemes was identified in the first phase included, overcoming the potential identified risks impacting the Egyptian dairy producers and solutions to overcome it (Section 4.4.3).

This thesis introduces solutions to improve the operations in the Egyptian dairy SCs to overcome the existing risks. This acknowledges the participants' acceptance of the SCOR model and its contribution to reshaping the KPIs. That has been assessed by using the Likert scale provided to the participants at the end of the interviews in phase one. Curkovic et al. (2013), Septiani et al. (2016), and Bian et al. (2016) used the Likert scale to assess the FMEA, the risk SC model, but they did not include the SCOR model as a more comprehensive model.

The five points Likert scale included their self-perceived assessment regarding the five key attributes of the SCOR. The descriptive analysis of the Likert scale has revealed some gaps. First, the dairy producers' lack of applicability and knowledge of the SCOR model as a reference to assess their performance and their familiarity with each attribute of the SCOR as separate concepts. Regardless, most of the practitioners' ignorance about the SCOR model, it has appeared from their answers that they look for lean strategic tools to enhance their SCP while creating their own performance assessment criteria. Second, the secondary data provided by

Euromonitor (2018) revealed that the top dairy producers participating in this thesis are achieving good performance according to international standards. Nevertheless, when they were asked to assess their own performance, they revealed some deficiencies regarding the quality of raw milk supplied, managing their capacities according to the demand and balancing the cost accordingly and spotted the light on ways of improvements for them. That includes both the processing itself at the factory level ‘make’, or the supply side of the dairy SC, which indicates the milk source ‘source’. That means that the main issue resides in managing the mismatched gap between the farms’ supply to fully utilise the production capacity and fulfil the market demand. That appears in the summer season where the cows’ productivity of raw milk decreases due to the hot weather, and it does not fulfil the production lines’ capacities. Thus, they need to enhance their ‘source’ by relying on diversified sources of raw milk and increase their farm's productivity, in parallel to monitoring their production of products by fully utilising their operational capabilities and following the food safety standards (CCPs).

All the six cases participating in this thesis assessed their performance regarding the SCOR attributes between high performance and very high performance. This supports their rank as the top six dairy producers in the Egyptian market and supports the selection criteria and the conducted stakeholder analysis. However, by getting into the details of assessing each performance attribute among them we find that the frequency of agility responses recorded very high performance. That is justifiable. Because the six cases have their own contracted farms or suppliers and control most of their SC members by functioning within a group. This achieves high agility in adapting to the changes in the market demand. Then, reliability, responsiveness, and cost recorded high performance. Nevertheless, the cost attribute recorded one response with low performance and three responses with neutral. This means that cost as an attribute needs further improvement. Last, asset management recorded neutral performance. This appeared in the operational capabilities which need further utilisation to fulfil better demand.

The inconsistency between the Likert scale findings and the data provided in the literature and the data presented by Euromonitor (2018) prove that the dairy sector in Egypt is witnessing controversy in data presentation between what is published and the risks they face. The Likert scale findings reflect the participants’ subjective perception, which is not statistically significant, but it gives a glimpse of their self-assessment which resembles the gap between where their performance actually stands and where they should be. This hinders them from enhancing their performance. Therefore, introducing the KPIs according to the SCOR attributes’ guidance should direct the Egyptian dairy producers to enhance their performance.

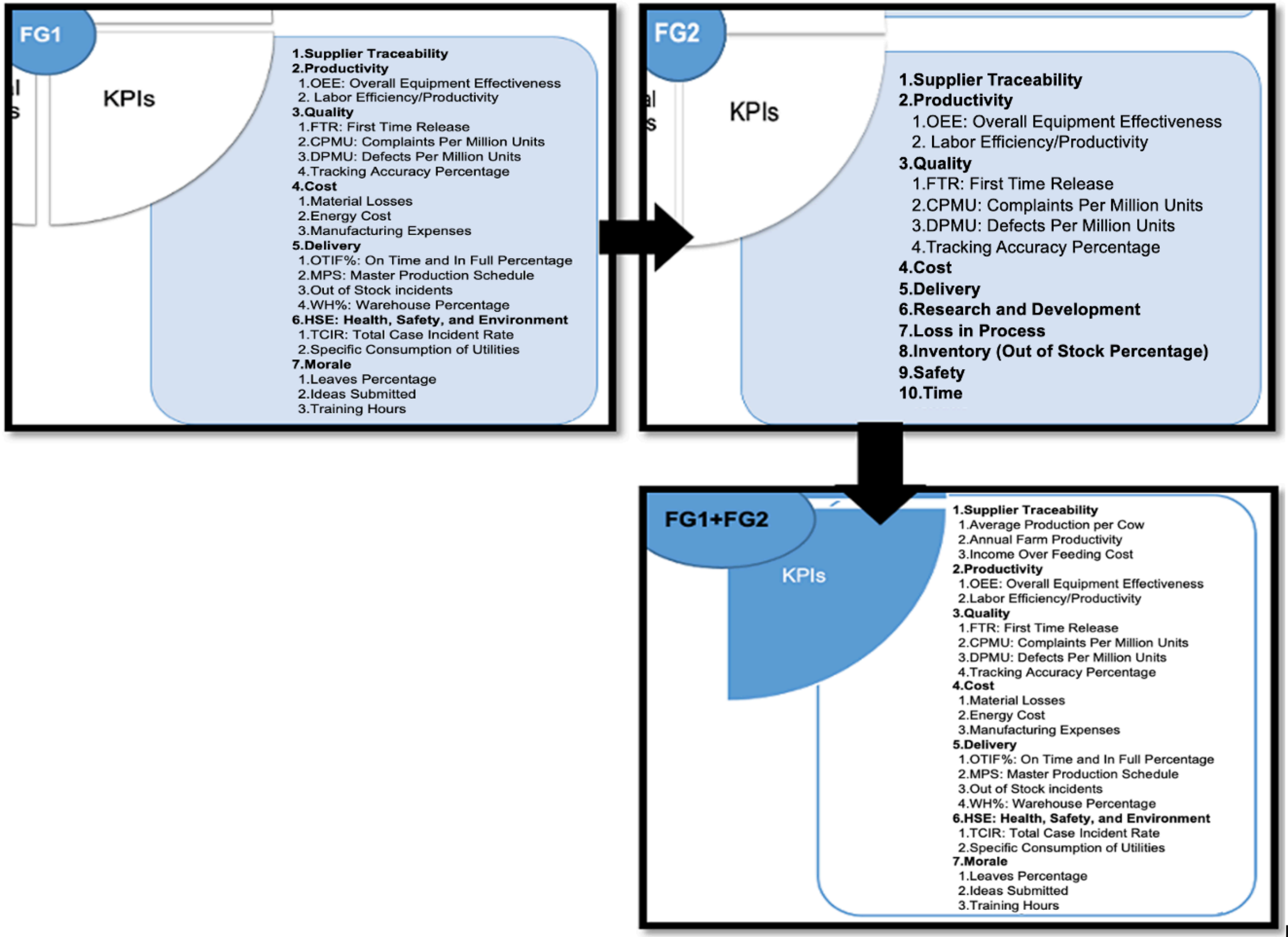
6.2.4 RQ4: What performance measures (KPIs) do the large-size Egyptian dairy producers currently use and which are missing?

It was challenging to answer this question, especially in the first phase of the empirical part of this thesis. Participants were reluctant to reveal such information, and they were confused to classify their own measures. Nevertheless, two managers from different companies created their own list of performance measures either for the factory 'make' side of the SC, or the procurement manager created a list of measures to assess their suppliers periodically, the 'source' side of the SC. Then, two other managers from other companies followed some quality standards like the lean strategy and the six sigma to guide their proposed KPIs. This led to introducing the proposed list of KPIs (Table 6.1) which made it easier for the participants in the FGs in the second phase, to share more data or confirm the list. Also, three participants in FG1 suggested their own amendments to the list to reflect what is already applied in the companies, which they are representing. Thereafter, the researcher finetuned all these data and notes to fine-tune the proposed KPIs to resemble a detailed performance assessment to guide the Egyptian dairy producers. Thus, KPIs standardisation among the Egyptian dairy producers is key to benchmark their performance by ensuring sustainable production of high-quality safe and secure dairy products.

The literature was limited in this area. Nevertheless, Moazzam, et al. (2018) modified and tested the KPIs proposed by APICS (2015). It included a mix of SCOR metrics to assess the dairy producers' performance in New Zealand. Also, Mbaga et al. (2011) introduced KPIs for the product safety and quality, and operations. Haddad (2016) noted the gap in the literature to introduce an operational benchmark performance framework including KPIs.

This thesis provided detailed applicable KPIs representing the key KPIs of the best practice framework that enable the Egyptian dairy producers to assess their operational and SCP (Figure 6.5). It follows a different classification than the five major SCOR attributes, but it covers them all and extends to add a detailed classification for supplier traceability, HSE, and morale. That is the core contribution of this thesis, being part of the best-practice framework along with the identified operational capabilities and CCPs. It was explored from the interviews and validated by the FGs. Additionally, the participants added the morale KPI to reflect the contribution of the personnel to enhancing the operational performance. This can be measured by the new ideas they introduce to the company, and it reflects the outcome of their experience besides the training provided to them and keeping in consideration their leaves which indicates their performance level. The reliability attribute appears to reflect the productivity and quality KPIs with the sub-elements measuring them. Then, responsiveness is reflected in the delivery KPI. Afterward, Agility can measure with supplier traceability. Followed by cost and measured with three sub-elements including the material losses, energy, and manufacturing expenses. Last, asset management is reflected in the delivery and Health, Safety, and Environment KPIs. These new practical KPI metrics provide better understandable classification to professionals in the Egyptian dairy sector rather than the generic SCOR metric 11.0 (APICS, 2018). It extended the range of KPIs to include the employees' morale along with the health, safety and environment and the supplier traceability to fit the safe dairy products production. This is explained furtherly in Section 6.3.

Figure 6.5: The Evolution of The Concluded KPIs for The Egyptian Dairy Producers



6.2.5 RQ5: How to improve the Egyptian dairy producers' performance against risks and challenges using the SCOR model's SC attributes?

The SCOR was used as a reference to introduce a list of measurable KPIs for application. Regardless of the disagreements among the participants in the first phase of data collection, the participants of the second phase, agreed on a determined two classified KPIs' sections for the 'source' and the 'make'. It represents comprehensive KPIs metrics covering the performance dimensions that match the year 2021. It is collected from different perspectives including governmental authorities, producers, and suppliers. One participant stressed that 'quality' cannot be classified as a separate KPI. But it is reflected in some sub-elements measuring the production performance quality like CPMU and DPMU.

Relying on multiple sources of data from different stakeholders covers all possible recommendations to enhance the operational and SCP. This appeared in developing the supply side of the dairy chain by improving the performance of the small farmers and the milk collectors within a monitored system either to function within a cluster or by creating a milk hub. Participant 6 in FG2 introduced the idea of establishing a 'powdered milk factory' as a drastic solution to support the Egyptian dairy sector and ensure a sustainable supply of alternative sources of milk rather than fresh raw milk or the imported powdered milk. He expressed that the Egyptian government is currently working on this project and will be launched soon, evidencing that: "*we are currently preparing to establish a powdered milk production factory*". This will save time and cost and sustain a steady rate of supplies to enhance the production of dairy products. Also, Participant 1 from NFSA in FG1 expressed his frustration regarding that every company build its own farm or milk collection centre instead of the whole large dairy producers collaborate to build a milk hub to serve the whole Egyptian dairy sector, including LEs and SMEs. That will ensure the sustainable supply of high-quality raw milk and eliminate large share of risks. He mentioned: "*We need to find a solution to improve this sector and improve the remaining 90% of raw milk in Egypt…'milk hub'. It means a milk collection centre plus services...It's not just about collecting the raw milk from the farmers for whatever fee and regardless all the problems in the milk...We have 3 goals; increasing the cow's productivity, increase the quality of the raw milk, reduce the cost*"**.** Therefore, collaboration is key to achieve a sustainable business model. Besides, controlling the supplier selection is the essential decision in controlling the SCM sustainability and quality. It reflects the agility and responsiveness of the SCOR attributes.

Participant 6 in FG2 explained the efforts of enhancing the asset management and reliability according to the SCOR attributes by focusing on importing specialized herds for the large farms and crossbreeding them to have an 'Egyptianized herd'. That is considered an investment in their assets to reduce the cost in the long run, which will limit importing this specialised herd in the future. Also, he explained their efforts in improving the quality of milk products by reducing the bacterial count in the supplied raw milk. That can be done by improving the awareness of small farmers and providing them with the needed tools to maintain the raw milk quality and keep the bacterial count to the minimum (Tomaševi and Dekic, 2017).

There are opportunities opposing the challenges in the sector. This appeared in the risks of shortage and delay in the imported supplies. Therefore, it is recommended to collaborate internationally and benefit from others' expertise, resources, and capabilities. Seek further value chain applicability and best practice concept. This will reflect in resources optimisation, reduction of costs, faster delivery to access the global market. The proposed KPIs can be used to assess the operations and SCP and seek such opportunities. Section 6.3 summarises the proposed KPIs metrics within a best practice framework applied to the Egyptian dairy producers.

6.3 The Proposed KPIs Metric

The Egyptian dairy producers rely on their own measures rather than SCOR 11.0 level 1. Nevertheless, SCOR should be applied to restructure their performance assessment measures to optimise their performance. The literature clearly indicated how useful SCOR is to practise in the developed countries. Nevertheless, this is not the case to the Egyptian dairy producers yet. That was due to their lack of awareness of such useful tool. The empirical phases of this thesis compiled the best performance measures applied by the large Egyptian dairy producers to create a metric to guide the assessment and measurement of the dairy producers' performance (Figure 5.14). Additionally, it resembles the development of a refined list of KPIs to guide the Egyptian dairy producers. That is the outcome of the conducted interviews and FGs.

Some challenges faced by the researcher in the data collection regarding the KPI's. Some participants abstained from mentioning their exact performance measures and most of them mentioned the KPI without providing details on how they measure it and what is the acceptable range to consider their performance good. They considered such data confidential, and other companies did not have a clear systematic list of measures to follow. Such ambiguity regarding a clear list of guiding KPIs for dairy producers in the literature and for professionals in the dairy sector restrains their potential for improvements. Therefore, introducing these detailed KPIs will guide them to monitor, assess, and detect their weaknesses and opportunities to enhance their performance. Some participants expressed their urgency in needing such data. Nevertheless, this thesis lacks quantification for each KPI. That could be covered in future research.

This thesis adds to (Liu et al., 2019: Bier, 2020) by specifying clear explanations of the proposed performance measures (KPIs) to eliminate any source of confusion or lack of clarity for both academics and practitioners. Having such a metric is beneficial for sustainable performance and overcoming any sudden risks.

The following section summarises the chapter and links to the last chapter, conclusions, limitations, and recommendations.

6.4 Summary

To conclude, this chapter summarised the research findings in comparison to what is found in the literature and what was still missing, and its contribution towards existing theory. Also, it comprehensively answered each of the five RQs supported with evidence collected throughout the research process. Although the exploratory research is not generalizable, it was conducted to answer the RQs and collect any missing data in this researched area. The exploratory nature of this thesis emphasises the importance of this thesis by identifying the main constructs of an operational and SCP framework. This acts as a base to discuss opportunities for future research and the limitations of this thesis in the next chapter. Last, this chapter discussed the findings to highlight the theoretical and practical contributions and future recommendation in the following chapter.

Chapter 7 Conclusions and Recommendations

7.1 Thesis Summary

The purpose of this thesis was to introduce a best practice framework, including operational and supply chain KPIs metrics to guide the Egyptian dairy producers toward sustainable production of safe and secure dairy products. This is the first practical framework to be introduced to guide the dairy industry in Egypt, as one of the developing countries. This guides their processing of safe and secure packaged milk products. This framework is created based on the SCOR 'make' attributes, which are not yet familiarised by the Egyptian dairy producers. The researcher modified SCOR metric 11.0 with new sub-elements to fit its practical implementation in the Egyptian dairy sector to improve its SCP to represent a key contribution of this thesis (as shown in Figure 7.1). Those new sub-elements are the employee's morale, the health and safety environment, besides including the supplier traceability. Thus, this thesis explored the operational capabilities including the CCPs, and the risks affecting the Egyptian dairy producers' operational and SCP to introduce KPIs to optimise their performance.

Despite the wide coverage for the area of risk management and SCP in the literature, this thesis reviewed approximately seventy peer-reviewed articles between 2000 and 2021. Those articles were considered from the top five contributing journals in the area of uncertainty in operational SC planning. Also, the researcher supported this search process by using other databases, including Google Scholar to ensure the coverage of the research topic from different perspectives and different markets.

This thesis builds on (Munir et al. 2016: Tate, 2017: Liu, et al., 2019: Bier et al., 2020) to address the gaps identified in the literature in the past twenty years by adopting the qualitative approach for investigating the operational capabilities, CCPs, performance measures, and the risks affecting them in the Egyptian dairy sector. This is the first in-depth qualitative cross-case study that investigates the operations of the dairy producer's sector. This study, for the first time, provides multiple views from an in-depth perspective which provides a high level of internal validity and understanding from industry experts, of Egyptian dairy producers' operations. This provides an 'industry first' holistic view of the Egyptian dairy sector by using a qualitative methodology (interviews and observations) from grassroots to operations management in these critical companies.

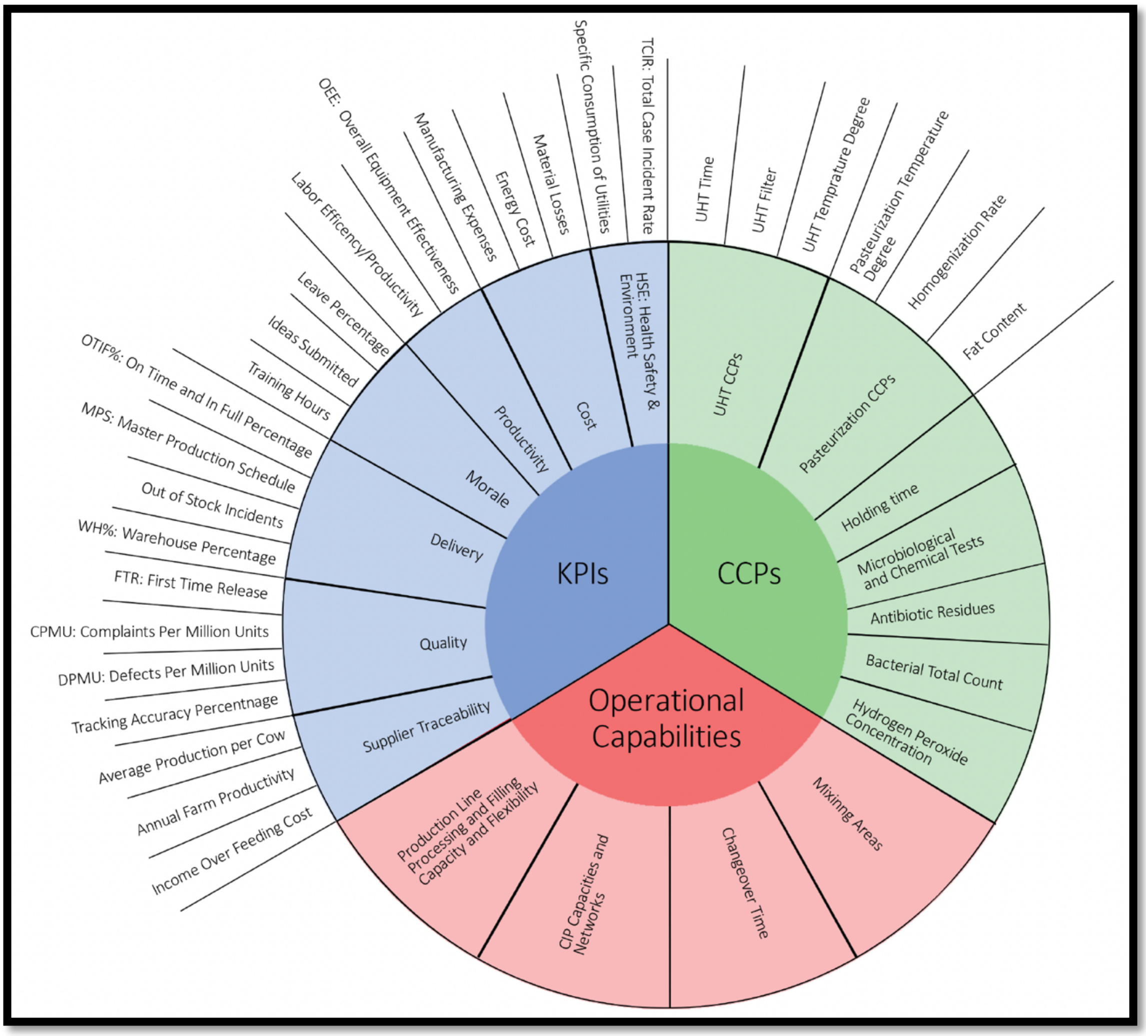
Further gaps addressed are the mismatch between supply and demand in the Egyptian market and the absence of using a model like SCOR or other performance measurement frameworks in the Egyptian dairy sector. Thus, a comparative case-study including six large Egyptian dairy producers was used as a methodology to explore the best set of operational capabilities including the CCPs and their current SCP measures to introduce a best practice performance framework for the first time to guide the dairy producers of all sizes in Egypt towards optimising their SCP and fulfil the unfulfilled demand.

In Phase One seventeen exploratory semi-structured interviews with key informants from the dairy companies and two observations were conducted to identify the emerging themes related to the research phenomenon from six of the top large Egyptian dairy producers. Those themes are: **Operational Capabilities and Critical Control Points, Risks Affect Operation and Supply Chain Performance, Overcoming Supply Chain Challenges and Operational Risks, Performance Measures, and Egyptian Dairy Producers' Performance Improvement**. They represent the most widely discussed themes in relation to the interview questions asked which are linked back to the RQs. Discussing these themes with in-depth investigation with the industry experts helps to cover the scope of enhancing the Egyptian dairy producers' performance in terms of producing safe and secure dairy products. Then, followed by a second phase including two FGs. Those included different stakeholders including governmental authorities, ministries, suppliers, and practitioners from the dairy companies. FGs were used to validate the elements and sub-elements to approve the findings of the first phase and cover any missing data to compile the best practice framework. Both phases were analysed using NVivo12 software to conduct thematic analysis and visualise the data into maps and figures.

The researcher conducted stakeholder analysis to support the sample selection of key informants to ensure their relevance to the research topic and achieve better coverage to the data related to this thesis. It supported the exploration of the network theory covering the scope of the dairy sector in Egypt, as one of the developing countries, by exploring the strong ties between the suppliers and governmental authorities with the dairy producers and their role in improving their SCP against the existing risks and challenges. That appeared in companies belonging to the private sector that are vertically integrated and function within a group. This played a major role in securing their SCs and maintaining their supply of resources and products. Moreover, the exploration of the existing operational capabilities and the newly classified milk CCPs from the RBV theory's lens. Also, it is recommended to create a milk hub, which is an advanced concept of MCC with supporting services to the small farmers and individual milk collectors. Such initiative needs action from the government to authorise the milk hub as a qualified supplier and facilitate unified training opportunities among the dairy sector's practitioners.

Accordingly, the view of the RBV theory helps dairy producers to better understand and develop their current capabilities and practices. A lack of CCPs classification, KPIs identification, awareness about the SCOR model as a performance assessment tool was noted in the empirical investigation of this research compared to the developed countries. Thus, this thesis supports the theory and extends the knowledge in the context of the dairy sector in Egypt by the following guiding list of indicators for dairy producers (Figure 7.1) which is part of the best practice framework and extracted from the overall results in Figure 5.14. Such narrowing down emphasises the key addition to practitioners out of the overall research findings. These three key elements will guide them to optimise their performance.

Figure 7.1: Validated Operational Capabilities, CCPs, and KPIs for The Egyptian Dairy Sector



Lastly, institutional theory is important to understand what is going on in terms of existing issues and risks and provide answers to overcome them in the future by collaborating with the government legislation. It supported the creation of the best practice framework by using the mimetic approach. This was represented in the comparative case-studies held to compare the six cases' KPIs to propose a holistic practical guide of KPIs, operational capabilities, and CCPs for the dairy producers in the developing countries for the first time introduced to the literature (Figure 7.1). The comparative study concluded that there is a lack of support from the government, a lack of funds, and a fragile base of digital communication infrastructure and energy stability on a regional level. That led the large dairy producers, who belong to the private sector, to improve their capabilities and practices on an individual basis. Each producer started to improvise according to their available funds and their power and interest in controlling the larger share of the local dairy market. That enables them to vertically integrate by owning other SC members like the farms, MCCs, or even distribution companies with trucks supported by tracking devices and networks. That extends the applicability of the stakeholder analysis and the network theory in the practical context. All this increased the competition among the top market players, which left the remaining producers out of competition due to a lack of capabilities and awareness about how to improve their production of safe and secure products. The researcher suggests the governmental authorities, including NFSA and the ministry of agriculture specifically, to provide the producers who are willing to join the competition, with the awareness to adopt the proposed best practice framework to benchmark their performance of producing safe and secure products qualified for the local and international food safety standards like ISO, OHSAS, and FSMS. Nevertheless, the government approves this proposed framework, but they are calling the private sector to adopt this initiative and spread awareness among the other dairy producers.

The participants of the FGs approved the constructs that emerged from the first phase and added new sub-elements to the two themes: **Overcoming Supply Chain Challenges and Operational Risks, Performance Measures** by including the suppliers' traceability and focusing on the employees and the health and safety of products and the production environment. Moreover, they suggested the inclusion of the 'deliver' part of SCOR to the 'make' metric 11.0 by covering the distribution side of the SC to add to the thesis findings. But it is not included in the scope of this thesis because few risks affect the distribution of packaged milk products compared to raw milk. Also, FGs added to the depth of each theme by proposing a further detailed classification of the KPIs and the CCPs specifically to improve the dairy producers' performance in terms of improving the supply side and better utilisation of the existing operational capabilities. This adds to what is published in previous literature by identifying clear seven CCPs for milk production. That is a new level of detailed classification that was not recorded in previous literature for the scope of processing milk products in developing countries. These CCPs differ according to the milk product being produced, whether it is UHT or Pasteurised. The UHT milk CCPs include temperature, filter, and time. The Pasteurised milk CCPs are temperature, homogenization rate, and fat content. Those are part of four core operational capabilities, which are production line processing and filling capacity and flexibility, CIP capacities and networks, change over time, and mixing areas. The operational capabilities and CCPs are key factors affecting the dairy producers' performance in terms of the production of sufficient amounts of safe and secure dairy products to fulfil the market demand. That can be monitored by the detailed performance measures metric (KPIs) designed to extend the SCOR five attributes to include supplier traceability, productivity, quality, cost, delivery, health, safety, and environment, and morale. These comprehensive KPIs cover the 'source' and 'make' sides of the SC to ensure the provision of safe and secure dairy products (Figure 7.1). That provided better credibility to the research findings and achieved the research aim by providing detailed answers to each RQ (Chapter Six).

This section summarised the ongoing process of conducting this thesis and highlighted the key contributions to the existing theories and to practitioners in the dairy sector. Then, highlighting the research limitations and recommendations for future research.

7.2 Research Contributions

This section summarises the key contributions from this thesis. It contributes to the researched area of operations and SCP in the dairy sector by connecting the cycle between the data collected and the three relevant theories. It provides answers to 'what to measure?' and 'how to measure it?'. This is represented in the proposed performance measures (KPIs) within a framework that adds to the literature review and the empirical evidence on the Egyptian dairy sector. Thus, it compiles and updates the scattered performance measures from the literature and the top producers and tailors them to create a best practice framework that suits the Egyptian dairy sector. Moreover, it reflects a comprehensive operational and SCP assessment framework to provide the dairy producers with a guide for safe and secure dairy production.

The selected cases confirmed their conformity to the proposed framework throughout the empirical work of the research process. They approve the application eligibility of the proposed best practice performance framework with the KPIs by the Egyptian dairy sector. According to the secondary data collected from Euromonitor and CAPMAS along the period of this thesis.

There is an increasing number of emerging producers aiming to match the selection criteria to join the competition in the near future. That will make them eligible to adopt the proposed best practice framework. Consequently, the proposed framework will guide those producers to enhance their performance and improve the Egyptian dairy sector's productivity of sufficient amounts of safe and secure dairy products.

This section suits both academics and practitioners. The first subsection includes the theoretical and methodological contribution towards each of the five RQs. The second subsection summarises a guide to practitioners in the Egyptian dairy sector to assess their performance with the proposed framework, which represents a best practice extracted from the large Egyptian dairy producers’ current state.

7.2.1 Theoretical and Methodological Contributions

This section reviews the contribution in answering the RQs. It proposes a best practice SCP framework from the lens of the RBV, network, and institutional theories to view the capabilities by conducting the in-depth detailed cross-case analysis. That allowed the researcher to understand the operational capabilities, CCPs, and KPIs for the first time in the dairy sector in Egypt. That gives value to the academic foundation of this thesis and links to practitioners who are seeking guidance to improve their operational and SCP. This clarified the increasing importance of adopting the qualitative research methodology in supply chain research.

Proposing a best-practice framework including KPIs will help the Egyptian dairy producers to assess and control their productivity of safe and secure dairy products against the SC risks by reducing the time and cost. It reflects the number of emerging constructs relevant to the theories in previous literature for each RQ for the dairy sector in the scope of developing countries. That shed the light on new sub-elements to be added to SCOR attributes compared to (Moazzam et al., 2018: APICS, 2018: Mishra and Shekhar, 2016) when researching performance measurement for developing countries. Those elements are focused on developing the suppliers, the health and safety, and the people elements in the SC and developing trust and transparency among the SC members to enable traceability. This prelude to a significant contribution to performance measurement theory (Gunasekaran et al., 2001), namely the operational level of it by following SCOR. The performance measurement theory can be considered for further exploration in future research, including its financial dimensions. This remains out of the scope of this thesis because the identification of the elements is the first step to assessing and measuring the performance.

No previous authors have done cross-case qualitative methodology with this level of detail with in-depth investigation of the dairy industry. That enabled the researcher to understand with clarity what the performance measures are. That was achieved by including both practitioners from the dairy companies with governmental ministries and food safety authorities along with the suppliers to provide this holistic framework feasible for applicability by other Egyptian dairy producers. Thus, this thesis utilised an in-depth case-study methodology and conducted within and cross-case qualitative data analysis to compare the findings of the six cases participating in this thesis to look for common patterns to represent a best practice to the Egyptian dairy sector. That helped in shaping the answers to the RQs by visiting the companies to conduct the interviews and observations which enabled the researcher to explore the operational capabilities and performance practices.

Due to the lack of research applicability to the research topic in the developing countries and Egypt specifically, this left areas for development for literature review research covering the dairy sector in Egypt as one of the promising developing countries in the dairy industry. That has been notably emerging through the past six years where Egypt is striving to increase its exports of milk products. In 2020 Egypt recorded 1% increase in milk products exports, equals to 51 million US dollars, and -9% decrease for white cheese equals 58 million US dollars, compared to the year 2019 (Euromonitor, 2020: Eldawy, 2021).

This thesis specified explicit definition and clear explanation of the proposed operational capabilities, CCPs, and performance measures (KPIs) proposed in this thesis to eliminate any source of confusion or lack of clarity for the reader, either academic or professional in the dairy sector context. There was ambiguity in specifying the key operational capabilities needed to improve the milk products' production. In addition to the confusion in defining the CCPs in previous literature. Some research identified CCPs as random elements of production and some tests. However, they are the checkpoints that ensure the product's safety during production. Moreover, there was a lack of KPIs identification for the scope of the dairy production in Egypt. That clarifies the role of this thesis toward the dairy sector's contribution to the Egyptian economy which extends beyond the research by (Ammar, 2017: El-Gendy, 2010).

Both operational capabilities and CCPs collaboratively determine the performance of the dairy producers. Accordingly, the provision of these detailed lists, especially customised for the dairy producers generically and the Egyptian market exclusively, adds to the applicability of the RBV to the modern literature context and the dairy sector. According to the determined selection criteria for literature, it seems that the literature recorded a lack of applicability and coverage for dairy producer's performance assessment, especially in Egypt. Egypt is known for its high level of agricultural resources and their contribution to the exports. Thus, this thesis fills this gap by introducing an operational and SCP best practice guide.

The CCPs in the literature are very generic and do not reflect the checkpoints at the processing stage. It shares only the heat temperature in common with the validated CCPs. This represents another key contribution. This is the first time to provide a detailed classification of CCPs for milk products production to the literature. It will help Egyptian dairy producers to maintain their production of safe and secure milk products and ease the tracking of the KPIs. This will achieve the reliability, responsiveness, cost, and asset management of the SCOR attributes. Accordingly, it represents a key contribution to knowledge and practice.

This thesis calls for action from the government to introduce the proposed best practice framework for applicability by the dairy producers to improve their food standards. That can be done through training programs for practitioners in the Egyptian dairy sector.

This thesis utilised the mix between the RBV, the institutional and the network theories to answer the RQs. Relying on the mimetic approach under the institutional theory contrast the operational capabilities, the CCPs and the KPIs from the top six dairy producers to create a best practice framework feasible for applicability by other Egyptian dairy producers to improve the productivity of safe and secure dairy products to sustain and improve the Egyptian dairy producers' performance. Although the selected six cases are performing on a satisfactory level, they struggle to maintain their performance in terms of the provision of safe and secure dairy products using their existing capabilities.

Three producers have a specific list of KPIs and risk management plans. But others still struggle to adapt to such situations because they do not have a structured list of KPIs. That might force those producers to quit the competition. Therefore, phase one of the empirical part of this thesis presented the current state of the Egyptian dairy producers. Then, the results of phase two introduced a best practice framework with a standardised set of KPIs that would help the dairy producers with reporting, assessing, and benchmarking their performance. That represents the future better state of performance assessment for the Egyptian dairy sector (Figure 7.1). Accordingly, Egyptian dairy producers should ensure the existence of the listed operational capabilities, CCPs and monitor their operational and SCP by the proposed KPIs. This will ensure their sustainable performance and periodically detect any deficiencies that might impact their performance in terms of the five SCOR attributes. These KPIs were validated by FGs including three managers from three different dairy producers and key informants from governmental and food safety authorities. In addition to, two of the most critical suppliers in the dairy sector in Egypt, TetraPak and an agent for Fonterra, the international powdered milk supplier. They emphasised on the KPIs related to the suppliers' traceability and the employees' morales. These two KPIs will add to the agility and the asset management attributes of SCOR. Also, these six cases belong to the private sector. That highlights the capital invested to make such improvements practical. Besides, the vertically integrated SCs probably have more control, transparency and can be more efficient.

A key finding is the lack of applicability of the performance measurement theory through the applicability of the SCOR model in the developing countries compared to the developed ones as embedded in the literature. Thus, the researcher is using an in-depth investigation to the dairy supply chains by relying on multiple data collection methods following the qualitative research approach which resemble a contribution to research in the area of SCP. The three theories to understand what's going on and concluded a metric of KPIs within a best practice framework covering the 'source' and 'make' of the dairy SCs was inspired by the SCOR metric 11.0 level 1, which has recorded very few applications in the literature related to the dairy sector. Therefore, it adds to the current literature by customising the SCOR attributes on the Egyptian dairy sector. That extends the institutional and the network theories by validating the answers of key stakeholders who have the power and the impact on the success of the Egyptian dairy sector.

This thesis noted a dual relationship between the operational capabilities and the SC attributes and their impact on the SCP. This was proven by evidence quoted from the participants in the interviews held in phase one. Therefore, as mentioned in the answer to RQ4, the proposed KPIs metric should direct the Egyptian dairy producers to monitor, assess, and detect points of failure and deficiencies to improve their performance. The successful fulfilment of KPIs especially productivity, quality, delivery, and HSE is related to monitoring the CCPs from the early stages of receiving and processing the milk at the factory level.

Collaboration between the SC members (i.e., vertical integration) achieves the successful application of SCOR attributes represented in agility, reliability, responsiveness, cost, and asset management. This can be achieved by government support and partnering with white-listed suppliers only to ensure the quality of raw milk and supplies to ensure the production of safe and secure dairy products. Supporting this by financial support from the government to small farmers and milk collection centres to improve their practices and provide the dairy producers with better quality raw milk. Additionally, the NFSA is supporting the farmers, milk collectors, and producers with the appropriate food safety training and tools needed to ensure hygiene and safety within the process. This can be achieved by establishing the milk hub. Achieving all this will improve and sustain the performance of the Egyptian dairy producers. That was supported by quotes from several participants in both empirical phases by diversified informants from the dairy SC, not only producers.

7.2.2 Practical Contributions

There has been noted a lack of research applicability on the dairy producers' performance in Egypt in well-ranked journals in the area of operations and SCP. Also, the literature review findings highlighted a gradual increase in the use of theories in performance research in recent years. This exploratory thesis develops a practical operational and SCP best practice framework from an Egyptian dairy sector's context.

SCOR model is one of the top documented performance measurement concepts in literature with the BSC but is not well implemented in practice, particularly in the dairy sector in Egypt. It is a very good model, but it is not adopted until now in Egypt. This distinction appeared in its applicability in the developed countries, but it is not well documented in the developing countries yet. That is achieved in this thesis by linking to the RBV theory to explore the operational capabilities and practices and the practitioners' knowledge about the performance measures.

This is the first time to establish unified measures that have been developed for the Egyptian dairy sector. That is one of the major contributions to practice. It is a detailed operational and SCP measurement best practice. It is also the first time to provide a clear view of applied CCP where they have been defined and located within dairy producers' production lines (Figure 4.6). That can be summarised by identifying operational and SC KPIs within a best practice framework, including the proposed KPIs Metric. This framework reflects the possible improvement scenario that suits the Egyptian dairy sector in terms of the operational capabilities and the risks that might affect the processing of safe and secure dairy products by controlling the CCPs and monitoring the KPIs (Figure 5.14).

The researcher found new performance measures as sub-elements to be considered, those are represented in supplier traceability, employees' morale, and health and safety, which was lacking in the SCOR model metric 11.0. But it might appear in other theories like the performance measures theory. Nonetheless, people are key to the success of the dairy sector. It should be considered for this sector. Ultimately, other models are more inclusive than the SCOR model to include the supplier, the financial element, the customer, and the internal assessment. Thus, SCOR needs to add the people to strengthen the 'make' metric and extend the CCPs application to the 'supply' side.

This framework is validated by participants from the dairy SC. That validates its applicability by the Egyptian dairy producers. This validation step highlighted the dairy producers' willingness and eagerness to adopt a performance assessment guide to optimise their SCP. Besides, the support of the governmental authorities and ministries to ease the application of the framework and provide support for dairy producers. The framework is based on the SCOR attributes proposed by (APICS, 2018: Moazzam et al., 2018) and validated in developed countries like New Zealand. The KPIs will assist practitioners in the Egyptian dairy sector to identify what to measure and how to measure it. In addition, how to monitor and improve their performance. That is represented in the provision of sufficient amounts of dairy products fulfilling the local demand. This should fill the mismatch between supply and demand in the Egyptian dairy sector according to (Euromonitor, 2018). That was reinforced by the FG participants' positions. It assisted in shaping future contributions for the Egyptian dairy sector. For example, the head of NFSA is a pioneer researcher who has the authority in monitoring food safety in the Egyptian dairy sector.

The following section reflects the limitations the researcher faced during the preparation of this thesis and could be covered in future research.

7.3 Research Limitations

According to the data collected and analysed in this thesis, the Egyptian large dairy producers' function on a moderate satisfactory level compared to what is found in the literature. That proves that there is an opportunity for improvement for them, and for the remaining percentage representing the small and medium dairy producers to fulfil the local demand by taking SCOR as a guide.

As each research has its strengths and weaknesses, this thesis is limited to the large dairy producers dominating the Egyptian dairy sector. This restricted the data collected to only seventeen interviews and two observations due to the sample scope of the top six large dairy producers dominating the market. However, this will set a base for future research to include other dairy producers if they fulfil the criteria of operational capabilities and safety and security measures to enhance their performance of providing safe and secure dairy products. Generalizability was not the target in this qualitative thesis, but the in-depth exploration of the phenomenon inside those six cases.

The researcher faced some practical limitations represented in the lack of access to statistical records for their current performance measures and their performance targets. That could help in achieving a benchmark model with exact minimum and maximum values for each KPI. For example, under the CCPs, the exact heating temperature, holding time, and the bacterial count. Same for the KPIs; the stock levels, labor and machine productivity per hour, and ordering times. Also, the Egyptian dairy producers seem to be restrained by the lack of financial flow for the dairy producers to own their farms and control their supply side of raw milk supplies from the farms. This led some of them to have a slightly loose controlling strategy to adapt their performance according to the proposed framework.

7.4 Recommendations for Practitioners and Future Research

This section summarises areas for future research to build on the findings of this thesis based on the comparative case-studies held on the top large six dairy producers in Egypt. Further research is needed to focus on enhancing the small farmers' milking practices (the supply side of the dairy SC). It has a direct impact on the dairy producers' sustainability and success in the market. Because the small farmers control most of the raw milk supplies.

There are opportunities in opposition to every challenge in the market. Therefore, it is recommended to collaborate internationally and benefit from other stakeholders' expertise, resources, and capabilities. This will enable them to seek further value expansion through the supply chain applicability and best practice concepts. E.g., resources optimisation, reduction of costs, faster delivery to access the global market. Qingbi et al. (2020) proved the negative impact of COVID-19 on the dairy sector in China and the USA. Thus, applying a best practice operational and SCP framework can ease the impact of unpredicted risks like the COVID-19 pandemic on maintaining their production and avoid the SC disruptions like the shortage of supplied raw milk.

This thesis spotted the light on areas of improvement which serve the interest of practitioners and governmental authorities to focus on future research in this area to develop the dairy sector performance from different aspects.

7.4.1 For Practitioners

The researcher had a common note on all the interviewed dairy producers. They work on a satisfactory productive level; however, it is not well structured and does not optimise their use of available operational capabilities. Therefore, this thesis used the RBV theory to understand the operational capabilities, CCPs, and KPIs on a very deep level in the Egyptian dairy producers. Accordingly, the data analysis provided a detailed performance metric will help them assess their capabilities and their overall SCP. Applying the best practice framework will help the Egyptian dairy producers to structure their SC practices and minimise their SC risks and challenges to function smoothly in providing safe and secure products (Figure 5.14).

Governmental support is inevitable. They should start speeding up and facilitating the process of imported materials' entry to the country, supported by precise application of the safety measures at the receiving point in the port of destination, Egypt. In addition to facilitating the legislation supporting the small farmers with licensing and incentives to sustain their supply to MCCs or the milk hub and the dairy producers, improve the digital communication infrastructure to enable the application of suppliers' traceability. That will enhance the collaborative aspect which reflects the applicability of the network theory. That reflects strong ties between the dairy SC stakeholders.

Even though the Egyptian dairy sector lacks huge investments which are needed for development, there is a huge opportunity for the Egyptian dairy producers to improve their performance if they:

- Relied more on mechanisation more than automation to reduce and eliminate human error. Mechanisation involves high technology equipment supported by smart manufacturing solutions which allows traceability for the products and the historical data. This will lead to reducing the production cost and achieving efficient production.
- Relied on the hired full-time workers rather than the part-time seasonal workers who work daily. This reflects higher commitment and responsibility from the workers to maintain the quality of their productivity.
- Developing the labours' qualification and awareness with safety requirements training and the good manufacturing practices (GMP) ensures the production of safe and secure dairy products with less chances of waste.
- Assign experienced engineers and technicians at the factory during the production, to manage any equipment breakdown and maintenance issues. This can improve the overall equipment effectiveness (OEE). Also, maintenance scheduling obviates any production delay for more than five minutes.
- Achieve traceability in terms of collaboration between the SC members. It is key to achieve a sustainable business model for food safety specially for sudden risks like the COVID19 pandemic. Taking Company-A, C, and D as examples for contingency plans. This is represented in controlling the supplier selection and applying the proposed KPIs for them, which is an essential decision in controlling the SCM sustainability. In addition to the owned trucks to trace and control the shipping conditions in terms of tracking,

hygiene, temperature, or adulteration. That can be achieved by investing in a fully integrated cold chain. By doing this, dairy producers will ensure the best quality of raw milk supplied if they have their own farms as proved by three of the cases interviewed Company-B, C, and F.

- Consider partnership with international SC members like suppliers for raw materials and packaging materials. As there are other elements that prioritize the value appropriation within the SC, like the services accompanying the product and the collaboration between the SC members, that is the key to any SC success.
- Collaborate with other SC members by vertical integration. It opens opportunities to expand the products' portfolio of the company by taking advantage of the milk production wastes like, cream, whey, or fat. Such wastes are major components of other dairy products like butter, yoghurt, or cooked cheese. So, the waste of one dairy producer can benefit another producer in their production of different products other than milk.
- Ensure their products comply with the international food safety standards. That is essential to sustain their participation in the global market according to the Food and Drug Administration (FDA), HACCP, and ISO. Such certification, either local or international, is essential to ensure the safety and security of the products.
- Invest in adopting the idea of establishing a milk hub to enhance the quality of dispersed small amounts of raw milk from small farmers. It is the advanced version of a milk collection centre. It should include veterinary services, training programs, hygienic milking and handling tools, and supervision from the government and the health and quality authorities. At an advanced level, they can consider enhancing the livestock of goats and buffalo to increase the raw milk supplies.
- Search for foreign investments to enhance their capabilities. Also, it will help them overcome risks related to the currency devaluation and the uncertainties accompanied by imports of materials included in the production

7.4.2 For Future Research

There is a noticeable interest in this researched area in the dairy sector. Therefore, a validated best practice operational and SCP framework for the Egyptian dairy producers was provided. This was achieved through exploratory research to fill the gaps in previous literature and adds to the existing theories in the context of the dairy sector on Egypt as one of the developing countries.

The proposed framework will act as a guide to set the basics for future research, by considering a larger sample size to include medium and small dairy producers and different research approaches. It identifies the capabilities and the performance measures for the practitioners to enable them to measure and manage their performance efficiently and effectively.

The proposed operational capabilities and KPIs can assist fellow researchers to set boundaries to frame their research scope. Also, having an existing measurement is beneficial for sustainable performance and overcoming any sudden risks and challenges. This encourages future research to assess performance from a financial perspective by using the stakeholder theory and the performance measurement theory.

It is beneficial to the SCP to enhance traceability among the SC members with on-time detailed data sharing about the raw milk supplied by farms or MCCs. That was suggested by practitioners and government officials. Such data may include the raw milk temperature, amount, or bacterial count in the exact moment where it is stored or transferred from one member to another. This can be further explored in future research by investigating the feasibility of adopting blockchain technology to provide detailed data for the SC member when needed.

There is a chance to apply the same research design and approach to include the distribution side of the SC 'deliver' for "fresh dairy products with short shelf life". Such products are prone to many risks. Those were not included in this thesis because they are not currently taking a large share of the market. Besides, the same research approach can include companies producing other dairy products than milk and white cheese.

Also, quantification of the proposed framework can be applied by using AHP or data envelope analysis (DEA) to assign a weight for each element. The researcher did not adopt such linear programming tools because the focus of this thesis was to identify the constructs and the elements compatible with the Egyptian dairy sector. This can be utilised in future research to build on the base which this thesis provided. Accordingly, generalizability can be achieved by including the medium-sized dairy producers who obtain the listed operational capabilities. That will increase the sample size.

Last, although this thesis noted these limitations, still, it points to several significant contributions to the body of knowledge related to operations and supply chain performance.

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Appendix 1 **Consent Forms**

Informed Consent form
(to be completed by researcher and signed by participants)

I, .[redacted]................................ of ..... Company A

Hereby agree to participate in this PhD research to be undertaken for a one and a half to two hours of interview to take place in your company.

By Sama Gad

and I understand that the aims and purpose of the research is ***to assess the operation and supply chain management activities in the entitled dairy company in order to propose a conceptual performance management framework to be adopted by the large dairy producers in Egypt to enhance their operational activities.***

By signing this consent form are agreeing to your participation in this research process and to the collection of the material. Participants have the right to withdraw from participation in the research process at any point and materials collated from them up to that point will be removed.

I understand that

1. Upon receipt, my interview will be coded and my name and address kept separately from it.
2. I understand that parts of our conversation may be used verbatim in future publications or presentations but that such quotes will be anonymized upon my request.
3. Any information that I provide will not be made public in any form that could reveal my identity to an outside party i.e. that I will remain fully anonymous.
4. I understand that the interview will be audio/video recorded and I am happy to proceed.
5. Aggregated results will be used for research purposes and may be reported in scientific and academic journals (including online publications).
6. Individual results will not be released to any person except at my request and on my authorisation.
7. That I am free to withdraw my consent at any time during the study in which event my participation in the research study will immediately cease and any information obtained from me will not be used.
8. There are no known or anticipated risks to you as a participant in this study.

Participant's Signature: [redacted] Date: 31-7-2019

The email contact details of the Researcher are:
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Researcher, Business School, University of Hull

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The email contact details of the Supervisor are:
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Dr. Alessandro Creazza a.creazza@hull.ac.uk

NOTE:
In the event of a minor's consent, or person under legal liability, please complete the Research Ethics Committee's "Form of Consent on Behalf of a Minor or Dependent Person".

Informed Consent form
(to be completed by researcher and signed by participants)

I, ………[redacted]……… of Company B

Hereby agree to participate in this PhD research to be undertaken for a one and a half to two hours of interview to take place in your company.

By Sama Gad

and I understand that the aims and purpose of the research is *to assess the operation and supply chain management activities in the entitled dairy company in order to propose a conceptual performance management framework to be adopted by the large dairy producers in Egypt to enhance their operational activities.*

By signing this consent form are agreeing to your participation in this research process and to the collection of the material. Participants have the right to withdraw from participation in the research process at any point and materials collated from them up to that point will be removed.

I understand that

1. Upon receipt, my interview will be coded and my name and address kept separately from it.
2. I understand that parts of our conversation may be used verbatim in future publications or presentations but that such quotes will be anonymized upon my request.
3. Any information that I provide will not be made public in any form that could reveal my identity to an outside party i.e. that I will remain fully anonymous.
4. I understand that the interview will be audio/video recorded and I am happy to proceed.
5. Aggregated results will be used for research purposes and may be reported in scientific and academic journals (including online publications).
6. Individual results will not be released to any person except at my request and on my authorisation.
7. That I am free to withdraw my consent at any time during the study in which event my participation in the research study will immediately cease and any information obtained from me will not be used.
8. There are no known or anticipated risks to you as a participant in this study.

Participant's Signature: [redacted] Date: 29/08/2019

The email contact details of the Researcher are:
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The email contact details of the Supervisor are:
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NOTE:
In the event of a minor's consent, or person under legal liability, please complete the Research Ethics Committee's "Form of Consent on Behalf of a Minor or Dependent

Informed Consent form
(to be completed by researcher and signed by participants)

I, [redacted], Manufacturing Planning and Control..... of .. Company C

Hereby agree to participate in this PhD research to be undertaken for a one and a half to two hours of interview to take place in your company.

By Sama Gad

and I understand that the aims and purpose of the research is *to assess the operation and supply chain management activities in the entitled dairy company in order to propose a conceptual performance management framework to be adopted by the large dairy producers in Egypt to enhance their operational activities.*

By signing this consent form are agreeing to your participation in this research process and to the collection of the material. Participants have the right to withdraw from participation in the research process at any point and materials collated from them up to that point will be removed.

I understand that

1. Upon receipt, my interview will be coded and my name and address kept separately from it.
2. I understand that parts of our conversation may be used verbatim in future publications or presentations but that such quotes will be anonymized upon my request.
3. Any information that I provide will not be made public in any form that could reveal my identity to an outside party i.e. that I will remain fully anonymous.
4. I understand that the interview will be audio/video recorded and I am happy to proceed.
5. Aggregated results will be used for research purposes and may be reported in scientific and academic journals (including online publications).
6. Individual results will not be released to any person except at my request and on my authorisation.
7. That I am free to withdraw my consent at any time during the study in which event my participation in the research study will immediately cease and any information obtained from me will not be used.
8. There are no known or anticipated risks to you as a participant in this study.

Participant's Signature: [redacted] Date: 3.9.2014

The email contact details of the Researcher are:
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Informed Consent form
(to be completed by researcher and signed by participants)

I, [redacted].................... of . Company D [redacted]

Hereby agree to participate in this PhD research to be undertaken for a one and a half to two hours of interview to take place in your company.

By Sama Gad

and I understand that the aims and purpose of the research is ***to assess the operation and supply chain management activities in the entitled dairy company in order to propose a conceptual performance management framework to be adopted by the large dairy producers in Egypt to enhance their operational activities.***

By signing this consent form are agreeing to your participation in this research process and to the collection of the material. Participants have the right to withdraw from participation in the research process at any point and materials collated from them up to that point will be removed.

I understand that

1. Upon receipt, my interview will be coded and my name and address kept separately from it.
2. I understand that parts of our conversation may be used verbatim in future publications or presentations but that such quotes will be anonymized upon my request.
3. Any information that I provide will not be made public in any form that could reveal my identity to an outside party i.e. that I will remain fully anonymous.
4. I understand that the interview will be audio/video recorded and I am happy to proceed.
5. Aggregated results will be used for research purposes and may be reported in scientific and academic journals (including online publications).
6. Individual results will not be released to any person except at my request and on my authorisation.
7. That I am free to withdraw my consent at any time during the study in which event my participation in the research study will immediately cease and any information obtained from me will not be used.
8. There are no known or anticipated risks to you as a participant in this study.

Participant's Signature: [redacted]

Date: 26-8-2019

The email contact details of the Researcher are:
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Dr. Alessandro Creazza a.creazza@hull.ac.uk

NOTE:
In the event of a minor's consent, or person under legal liability, please complete the Research Ethics Committee's "Form of Consent on Behalf of a Minor or Dependent

Informed Consent form
(to be completed by researcher and signed by participants)

I. [redacted] ...... of ...... Company E

Hereby agree to participate in this PhD research to be undertaken for a one and a half to two hours of interview to take place in your company.

By Sama Gad

and I understand that the aims and purpose of the research is ***to assess the operation and supply chain management activities in the entitled dairy company in order to propose a conceptual performance management framework to be adopted by the large dairy producers in Egypt to enhance their operational activities.***

By signing this consent form are agreeing to your participation in this research process and to the collection of the material. Participants have the right to withdraw from participation in the research process at any point and materials collated from them up to that point will be removed.

I understand that

1. Upon receipt, my interview will be coded and my name and address kept separately from it.
2. I understand that parts of our conversation may be used verbatim in future publications or presentations but that such quotes will be anonymized upon my request.
3. Any information that I provide will not be made public in any form that could reveal my identity to an outside party i.e. that I will remain fully anonymous.
4. I understand that the interview will be audio/video recorded and I am happy to proceed.
5. Aggregated results will be used for research purposes and may be reported in scientific and academic journals (including online publications).
6. Individual results will not be released to any person except at my request and on my authorisation.
7. That I am free to withdraw my consent at any time during the study in which event my participation in the research study will immediately cease and any information obtained from me will not be used.
8. There are no known or anticipated risks to you as a participant in this study.

Participant's Signature: Date: 4-9-2019

[redacted]

The email contact details of the Researcher are:
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Prof. David B. Grant david.grant@hanken.fi
Dr. Alessandro Creazza a.creazza@hull.ac.uk

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In the event of a minor's consent, or person under legal liability, please complete the Research Ethics Committee's "Form of Consent on Behalf of a Minor or Dependent

Informed Consent form
(to be completed by researcher and signed by participants)

I, [redacted], Material Management Manager of Company F

Hereby agree to participate in this PhD research to be undertaken for a one and a half to two hours of interview to take place in your company.

By Sama Gad

and I understand that the aims and purpose of the research is ***to assess the operation and supply chain management activities in the entitled dairy company in order to propose a conceptual performance management framework to be adopted by the large dairy producers in Egypt to enhance their operational activities.***

By signing this consent form are agreeing to your participation in this research process and to the collection of the material. Participants have the right to withdraw from participation in the research process at any point and materials collated from them up to that point will be removed.

I understand that
1. Upon receipt, my interview will be coded and my name and address kept separately from it.
2. I understand that parts of our conversation may be used verbatim in future publications or presentations but that such quotes will be anonymized upon my request.
3. Any information that I provide will not be made public in any form that could reveal my identity to an outside party i.e. that I will remain fully anonymous.
4. I understand that the interview will be audio/video recorded and I am happy to proceed.
5. Aggregated results will be used for research purposes and may be reported in scientific and academic journals (including online publications).
6. Individual results will not be released to any person except at my request and on my authorisation.
7. That I am free to withdraw my consent at any time during the study in which event my participation in the research study will immediately cease and any information obtained from me will not be used.
8. There are no known or anticipated risks to you as a participant in this study.

Participant's Signature: [redacted] Date: 7 February 2021

The email contact details of the Researcher are:
Ms. Sama Gad
Lecturer, College of International Transport and Logistics, AASTMT
Researcher, Business School, University of Hull
Phone: +20 1003089088
s.gad@2016.hull.ac.uk
sama.hossam@aast.edu

The email contact details of the Supervisor are:
Prof. David B. Grant david.grant@hanken.fi
Dr. Alessandro Creazza a.creazza@hull.ac.uk

NOTE: In the event of a minor's consent, or person under legal liability, please complete the Research Ethics Committee's "Form of Consent on Behalf of a Minor or Dependent Person".

Appendix 2 **Semi-Structured Interview Questions**

Your company has been chosen for the investigation of this study to represent one of a group of applied case-studies in the Egyptian dairy sector. You are being invited to participate and be a contributing part of this research. Before starting the interview, you need to understand what this research is about and why it is being done. It is a comprehensive study on investigating how the operational capabilities and activities influence the dairy supply chain performance and eventually affect the product quality standards of safety and security.

The interview is intended to take about one and a half hour. The questions are intended to be as an outline for the interview as it will be semi-structured interviews with individuals who shared similar roles in the operations and supply chain department. It will not be necessary to cover every question in detail in the interview, but as much information is welcomed as you can provide as the time permits. Any data is convenient to have on hand at the interview is also appreciated. The researcher will follow up on the leads you can provide.

Participant's/ Interviewee's Details:
Interviewee Name: ……………………………
Company: ………………………………………….
Mob. #:…………………………………………………
e-mail: ………………………………………………
Position: ……………………………………………….
Date: ………..………………………………………….

1. Tell me about your job and the work environment.
2. For how long do you work for this company?
3. In which category do you classify the plant of your company?
    a. Small plant- less than 100 sqm
    b. Medium plant- from 100 to 300 sqm
    c. Large plant- more than 300 sqm
4. How many dairy products' production lines do you have? And what are they?
5. Do you have your own farms, or you deal with suppliers?
6. How many suppliers do you have?
7. Do you face lack of resources or any other kind of risks? In case yes, how does it impact the operations/production?
8. If you have your own supplier(s) specify the cleanliness measures applied to ensure the quality of raw milk.
9. How do you describe the criteria of safe and secure dairy products? What are the quality and safety security measure do you apply, or certificates do you have? Including your suppliers.
10. What are the Critical Control Points (CCPs)?
11. What are the operational capabilities in the company?
12. What and where are the risks affecting the previously determined operational capabilities?
13. What is your perspective on the relationship between operations and SCM?
14. How do you measure the supply chain performance in your company?
15. What Key Performance Indicators (KPIs) do you have?
16. Does any of these measures focus on the operations and SCM? Do you recommend any further measures?
17. What are your future plans for improving your SC performance?

18. On a scale from 1 to 5, rank your supply chain performance in terms of a safe and secure supply of milk products, where (1) is very low performance and (5) very high performance.

SCOR Attribute	1 (Very Low)	2 (Low)	3 (Neutral)	4 (High)	5 (Very High)
Reliability					
Responsiveness					
Agility					
Cost					
Asset Management					

Appendix 3 **Data Collection Permission**

UNIVERSITY
OF HULL

Ms Sama Gad

Egypt

Faculty of Business, Law & Politics
Research Office
University of Hull
T +44(0)1482 463536
E h.carpenter@hull.ac.uk

Ref: HUBSREC 2018/35

23 July 2019

Dear Sama

Research Title: An Empirical Performance Assessment of the Operational and Supply Chain Management Practices and Hazards of the Large Size Dairy Producers: A multiple case study analysis in Egypt

Thank you for your research ethics application.

I am pleased to inform you that on behalf of the Faculty of Business, Law and Politics Research Ethics Committee at the University of Hull, Dr Matt Beech has approved your application on 23 July 2019. You now have permission to proceed with the research.

I am advised by the committee to remind you of the following points:

- You must comply with the Data Protection act 1998;
- You must refer proposed amendments to the committee for further review and obtain the committee's approval prior to implementation (except <u>only</u> in cases of emergency where the welfare of the subject is paramount).
- You are authorised to present this University of Hull Research Ethics committee letter of approval to outside bodies in support of any application for further research clearance.

On behalf of the committee, I wish you every success with your research.

Yours sincerely,

Hilary Carpenter
Secretary,
Research Ethics Committee
Faculty of Business, Law and Politics

Faculty of Business, Law and Politics
University of Hull
Hull, HU6 7RX
United Kingdom

http://www2.hull.ac.uk/Faculties/fblp/hubs.aspx

Appendix 4 **Invitation form**

Dear Sir/Mam,

I am a lecturer in the Arab Academy for Science, Technology and Maritime Transport in Alexandria, Egypt, and a PhD researcher at the University of Hull in Hull, UK. I would like you to consider participating in this research we are conducting at University of Hull with Prof. David B. Grant and Dr. Alessandro Creazza. This invitation sheet provides further information about this research and your involvement in the research.

The research title is:
Developing a 'Best Practice' Supply Chain Performance and Operational Framework for Dairy Producers: A multiple case study analysis in Egypt

The aim of the project is:
***to investigate how to improve the operational and supply chain performance of the Egyptian large sized dairy producers to ensure the production of safe and secure products against the different supply chain risks*.**

The project will focus on: the operational activities of producing the dairy products, and discussing the sources of raw milk used in their production.

Participation in this study is voluntary. It will involve an interview of one hour and a half to two hours maximum in length to take place in your company.

You may decline to answer any of the interview questions if you so wish. Furthermore, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher(s).

With your permission, the interview will be audio/video recorded (according to your convenience) to facilitate collection of information, and later transcribed for analysis. Shortly after the interview has been completed, we will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish.

All information you provide is considered strictly confidential. Your name and your organisation's name will not appear in any thesis or report resulting from this study, however, with your permission anonymous quotations may be used.

Data collected during this study will be retained on a secured hard drive with a secured password. Only researchers associated with this project will have access.

There are no known or anticipated risks to you as a participant in this study.

Should you have any concerns about the conduct of this research project, please contact the Secretary, Faculty of Business, Law and Politics Research Ethics Committee, University of Hull, Cottingham Road, Hull, HU6 7RX; Tel No (+44) (0)1482 463536.

We hope that the results of my research will be of benefit to the Egyptian dairy producers directly involved in the study, as well as to the broader similar research community.

We are looking forward to speaking with you and thank you in advance for your assistance in this research.

Yours Sincerely,
Sama Gad

Name and email of Supervisors:
Prof. David B. Grant david.grant@hanken.fi
Dr. Alessandro Creazza a.creazza@hull.ac.uk

Appendix 5 **Focus Group Protocol (with Arabic Translation)**

Title:

Developing a 'Best Practice' Supply Chain Performance & Operational Framework for Dairy Producers: A multiple case study analysis in Egypt

"Review the main elements and sub-elements of the framework and the relationships between them"

العنوان:

تطوير إطار "أفضل ممارسة" لأداء التشغيل وسلسلة التوريد لمنتجي الألبان: تحليل دراسة حالة متعددة في مصر
"راجع العناصر الرئيسية والعناصر الفرعية لإطار العمل والترابط فيما بينها"

Purpose:

The purpose of this focus group is to refine and confirm the proposed framework and ensure that all the elements and sub-elements are identified and linked to introduce a best practice framework, introducing a list of operational capabilities, critical control points (CCPs) and key performance indicators (KPIs).

الهدف:

الهدف من مجموعة التركيز هو تحسين وتأكيد الإطار المقترح والتأكد من تحديد جميع العناصر وترابطها لتقديم إطار أفضل الممارسات، وتقديم قائمة بالقدرات التشغيلية، ونقاط التحكم (CCPs) ومؤشرات الأداء (KPIs).

Participants:

The focus group will be composed of operations, procurement, quality, and supply chain management practitioners in addition to other supply chain members contributing to the performance of the dairy supply chains like governmental authorities, suppliers, distributors, or retailers.

المشاركون:

ستتألف مجموعة التركيز من مهنيين من قسم التشغيل والمشتريات والجودة وإدارة سلسلة التوريد بالإضافة إلى أعضاء آخرين في سلسلة التوريد الذين يساهمون في أداء سلاسل توريد منتجات الألبان مثل الهيئات الحكومية أو الموردين أو الموزعين أو تجار التجزئة.

Focus Group Procedures:

The focus groups will take the semi-structured interviews form with an open-ended question(s).

إجراءات مجموعة التركيز:

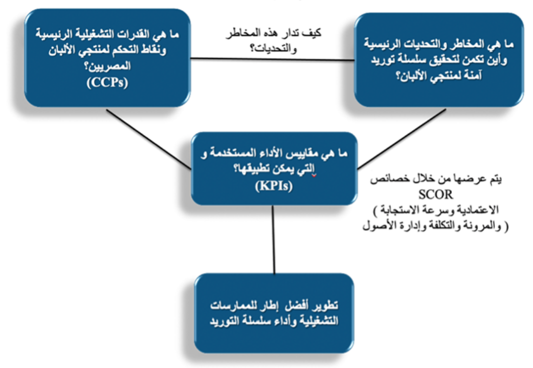
مجموعات التركيز سوف تكون في شكل مقابلات بأسئلة مفتوحة.

Introduction:

First, I would like to thank you for participating in this research. I have gathered you all together so we can review and assess the proposed framework to ensure that this framework has a clearly identifiable elements and effectively correlated, which can be applied on any similar producers in the dairy sector. The discussion will take approximately 60 minutes to observe the key findings of what you are noting in this framework. Please note that all the information provided during this meeting will be kept confidential without declaring your names.

مقدمة:

أولاً، أود أن أشكركم على المشاركة في هذا البحث. لقد جمعتكم جميعًا معًا حتى نتمكن من مراجعة وتقييم الإطار المقترح للتأكد من أن هذا الإطار يحتوي على عناصر محددة بوضوح ومترابطة بشكل فعال، والتي يمكن تطبيقها على أي منتجين مشابهين في قطاع الألبان. ستستغرق المناقشة حوالي 60 دقيقة لمراقبة النتائج الرئيسية لما تدون في هذا الإطار. يرجى ملاحظة أن جميع المعلومات المقدمة خلال هذا الاجتماع ستبقى سرية دون الإفصاح عن أسمائكم.



يجمع الجدول التالي البيانات التي تم جمعها من مقابلة 6 شركات من كبار منتجي الألبان في مصر.

The following table compiles the data collected from interviewing six of the top Egyptian dairy producers.

القدرات التشغيلية Operational Capabilities	نقاط التحكم (CCPs) Critical Control Points	مؤشرات الأداء الرئيسية للمصنع Plant KPIs 'Make'
كفاءة خط الإنتاج / فعالية المعدات الإجمالية (OEE) Production Line Efficiency/ Overall Equipment Effectiveness	UHT درجة حرارة UHT Temperature	فعالية المعدات الإجمالية (OEE) Overall Equipment Effectiveness
مرونة خط الإنتاج Production Line Flexibility	العدد الإجمالي للبكتيريا Bacterial Total Count	نسبة التالف من العملية التشغيلية Loss in Process
سعة التخزين Storage Capacity	بقايا المضادات الحيوية Antibiotic Residues	الإصدار الأول (FTR) First Time Release
نظم قدرة التشغيل Operating Capacity System	UHT فلتر UHT Filter	الشكاوى لكل مليون وحدة (CPMU) Complaints Per Million Unit
نظم التتبع Tracking System	UHT وقت UHT Time	مرافق الإنتاج Production Utilities
التعبئة والتغليف Packaging	درجة حرارة البسترة Pasteurization Temperature	الالتزام بالخطة أو الوفاء بالطلب Plan Adherence or Order Fulfilment
كفاءة العمال Labour Competency	اختبارات التعبئة والتغليف Packaging Tests	مستوى خدمة أصحاب المصلحة Stakeholders' Service Level Agreement
المهلة الزمنية Lead Time	تركيز بيروكسيد الهيدروجين Hydrogen Peroxide Concentration	المخزون (نسبة نفاد المخزون) Inventory (Out of Stock Percentage)
	وقت التحضين Holding Time	إنتاجية العمالة Labour Productivity
	التحاليل الميكروبيولوجي Microbiological Tests	الجودة Quality
	التحاليل الكيميائية Chemical Tests	التالف لكل مليون وحدة (DPMU) Defect Per Million Unit
		السلامة Safety
		التكلفة Cost
		الوقت Time
		عدد الموردين Number of Suppliers
		مؤشرات أداء الثروة الحيوانية Livestock KPIs 'Source'
		متوسط الإنتاج لكل بقرة Average Production per Cow
		إنتاجية المزرعة سنوياً Annual Farm Productivity
		الدخل فوق تكلفة التغذية Income Over Feeding Cost

Questions:

Please discuss the following questions in the same sequence:

1. **Does this table clearly identify the elements related to the operations and the supply chain management performance dimensions?**
2. **In your opinion, how do these elements benefit the dairy producers' supply chain performance?**
3. **Given your experience, what elements does this table lacks?**
4. **How do dairy producers overcome these supply chain challenges and operational risks and what does good look like in terms of reliability, responsiveness, agility, cost, and asset management?**
5. **What is the direct impact of applying these performance measurements (KPIs) on the dairy producers?**

الأسئلة:

يرجى مناقشة الأسئلة التالية بنفس التسلسل:

1. **هل يحدد هذا الجدول بوضوح العناصر المتعلقة بعمليات التشغيل ومحددات أداء إدارة سلسلة التوريد؟**
2. **في رأيك، كيف تفيد هذه العناصر أداء سلسلة التوريد لمنتجي الألبان؟**
3. **وفقاً إلى خبرتك، ما هي العناصر التي يفتقر إليها هذا الجدول؟**
4. **كيف يتغلب منتجو الألبان على تحديات سلسلة التوريد والمخاطر التشغيلية وما هو الشكل الجيد من حيث الاعتمادية وسرعة الاستجابة والمرونة والتكلفة وإدارة الأصول؟**
5. **ما هو التأثير المباشر لتطبيق محددات الأداء (KPIs) على منتجي الألبان؟**

Conclusion:

To summarize, I can conclude from what you were saying that………, do you confirm that? have I missed anything which needs to be considered and concluded, not picked up by the interviews or this focus group?

Thank you for your collaboration.

الخاتمة:

للتلخيص، يمكنني أن أختم ما كنت تقوله ………، هل تؤكد ذلك؟ هل لديك اي تعديلات او اضافة؟

شكرا لتعاونك.

سما جاد/ محاضر في كلية النقل الدولي واللوجستيات- الأكاديمية العربية للعلوم والتكنولوجيا

للتواصل: 1003089088 20+

Sama.hossam@aast.edu S.Gad-2016@hull.ac.uk

Sama.hossam@gmail.com

Appendix 6 **Word Frequency Table**

Word	Length	Count	Weighted Percentage (%)
Milk	4	370	2.71
Production	10	318	2.33
Supply	6	194	1.42
Chain	5	168	1.23
Quality	7	162	1.19
Product	7	142	1.04
Line	4	116	0.85
KPIs	4	112	0.82
time	4	106	0.78
factory	7	102	0.75
safety	6	98	0.72
materials	9	96	0.70
products	8	96	0.70
suppliers	9	92	0.67
lines	5	78	0.57
farm	4	70	0.51
food	4	68	0.50
equipment	9	64	0.47
process	7	64	0.47
cost	4	60	0.44
farms	5	60	0.44
company	7	58	0.43
plan	4	58	0.43
demand	6	56	0.41
ensure	6	56	0.41
responsible	11	56	0.41
supplier	8	54	0.40
department	10	50	0.37
packaging	9	48	0.35
performance	11	48	0.35
related	7	48	0.35
operations	10	46	0.34
temperature	11	46	0.34
produce	7	44	0.32
also	4	42	0.31
based	5	42	0.31
CCPS	4	42	0.31
cheese	6	42	0.31
system	6	42	0.31
terms	5	42	0.31
control	7	40	0.29
dairy	5	40	0.29
fresh	5	40	0.29
material	8	40	0.29
part	4	40	0.29
first	5	38	0.28
productivity	12	38	0.28
standards	9	38	0.28
tests	5	38	0.28
large	5	36	0.26
supplies	8	36	0.26
years	5	36	0.26
example	7	34	0.25

yogurt	6	34	0.25
final	5	32	0.23
HACCP	5	32	0.23
high	4	32	0.23
risk	4	32	0.23
called	6	30	0.22
different	9	30	0.22
Egyptian	8	30	0.22
many	4	30	0.22
market	6	30	0.22
might	5	30	0.22
resources	9	30	0.22
critical	8	28	0.21
need	4	28	0.21
procurement	11	28	0.21
specific	8	28	0.21
according	9	26	0.19
capabilities	12	26	0.19
capacity	8	26	0.19
impact	6	26	0.19
improve	7	26	0.19
management	10	26	0.19
planning	8	26	0.19
safe	4	26	0.19
test	4	26	0.19
another	7	24	0.18
labor	5	24	0.18
level	5	24	0.18
overall	7	24	0.18
pasteurization	14	24	0.18
three	5	24	0.18
around	6	22	0.16
efficiency	10	22	0.16
hygiene	7	22	0.16
juice	5	22	0.16
long	4	22	0.16
manufacturing	13	22	0.16
national	8	22	0.16
number	6	22	0.16
operational	11	22	0.16
size	4	22	0.16
start	5	22	0.16
take	4	22	0.16
things	6	22	0.16
amount	6	20	0.15
cleanliness	11	20	0.15
daily	5	20	0.15

Appendix 7 Interview Transcription Coding Sample

Classification: Interviews

Interview 7 Company C

3 September 2019

Manufacturing, planning and control.

Sama: Let's go. Safety wise. Okay. Where do we start? I know that you're Engineer: [redacted]

Yes, [redacted]

Sama: Tell me your position

Currently I'm responsible for
responsible for the new Manufacturing techniques.

Sama: Perfect. How long have you been here?

I've worked here for 12 years.

Sama: I'm going to talk about Dairy. Milk, specifically. And please clarify if there's anything related to dairy. According to online published documents, there are three dairy factories.

Yes. "Masrya", "Egy Food" and "Juhayna"

"Juhayna for Food Productions" is the old factory. It has two lines of cheese productions. That was the first factory for COMPANY C. It had all the products. Then more factories were built, each for a specific purpose.

Sama: Which factory is specialized in Milk?

"Al-Masrya"

Sama: So there's basically 4 factories?

No, we're six factories.

Sama: For dairy?

No, there are only three for dairy. Juhayna. Al-Masrya. Egyfood.

Sama: So we're talking "Juhayna", "Al-Masrya" and "Egyfood". Specifically, "Al-Masrya" for milk productions.

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Egyfood has specifically one production line. COMPANY C has two production lines for milk and one for cheese.

Producing 10 milk products, i.e. stock keeping units (SKUs) produced by 20 production lines.

Sama: What's the difference between the production line for milk in Egyfood and Juhayna?

The production line in Egyfood produces in 1-Liter and 0.5-Liter sizes. Juhayna only produces the small 125ml.

Sama: And "Al-Masrya"?

Literally everything else! Except for "Al-Masrya" They have only a 1-Liter milk production line.

Sama: I have one question though. Why is it split like that?

Look. After a period of time you'd usually want to increase the capacity of production. And introduce new production lines. And we started moving production lines from the Juhayna factories to the other factories. So, now Al-Masrya factory is fully utilized.

Sama: So if we want to categorize each of these factory area size-wise. Are we talking bigger than 300 square ft?

Of course!

Sama: So how many production lines are there?

Around 20 (production lines).

Sama: And how are they categorized? Does each product have its own production line? Or can it be the product of two production lines?

It differs. "Bekhero" for example. The 1-Liter product has only one production line of its own. And another for the 0.5-Liter. They're all fixed production lines. Juhayna Milk is the same production line with the change of the packaging and the actual milk.

Sama: So it's the same production line and it stays consistent for the full-cream, half-skimmed... Etc?

Yes. They're the same production line. Producing full, half and zero-skimmed milk.

Sama: So the difference in the production line is based on demand?

Yes, exactly.

Sama: About supplies and the farm. Tell me more about that.

What do you need to know exactly?

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Sama: How many suppliers are there? Do you have your own farms?

Yes. We have our own farm. "Mandisha" it supplies around 15% of the dairy supply. And the other 85% is brought from different farms we have a contract with.

Sama: So you have contracts with many other farms. How many exactly?

They're around 30 farms.

Sama: Great. So these are all Grade-A milk? No milk is brought from milk collectors?

Right now, we use milk collectors in only yogurt, not UHT Milk.

30 Farms including the collectors.

Sama: So, MCCs are mainly for yogurt.

Yes. We don't use it for UHT dairy. Except for certain MCCs where they improve their quality performance and they can provide milk with decent TBC so it can be classified as Grade A milk standard so it can be used in UHT.

Sama: Perfect. Do you have other supplies? It's obviously not milk and water. What else is there?

There's powder.

Sama: Arla and Fonterra?

Yes. Arla and Fonterra and there are other suppliers as well. But Arla and Fontera are the main suppliers for full-cream or skimmed milk. WMP (Whole Milk Powder), SMP (Skimmed Milk Powder) and AMF (Anhydrous Milk Fat).

Sama: What is AMF used for?

It's a replacement for fat. Anhydrous Milk Fat.

Sama: So it can keep the fat level in the product?

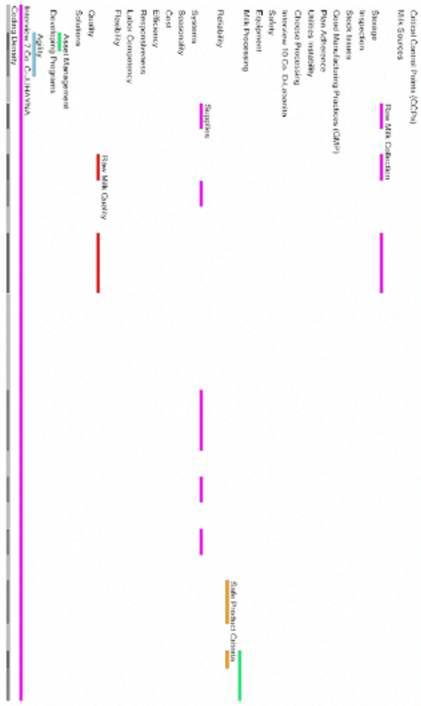
It's (Anhydrous Milk Fat) mostly restricted its use for the production of Bekhero milk only.

Sama: why?

Due to the standards. Because we can't use other materials than fresh raw natural milk in COMPANY C milk brand. It is 100% milk only.

Sama: yes, that what I mean. So, COMPANY C **branded milk isn't whole milk…**

Yes. It's just pure milk. It doesn't even have added water. It's standardized milk. Brought from the farm with 3.5% fat for example. We remove the excess fat and turn it down to the 3.1% fat



standard. And we take those 0.4% fat to use in other creamy products. So we just do the standardization process, nothing else, no powdered milk, AMF, water, or anything.

Sama: So in this current season. Isn't there currently a low supply?

Yes. Bekhero is the only product where we can use powdered milk.

Sama: And if the highest demand is COMPANY C?

We scale down production. For example, last August we didn't fulfill our plans due to the shortage of supplies.

Sama: So you don't substitute that with powdered milk?

We used to do that three years ago. Then COMPANY C decided to change that concept for the customer and turn to 100% pure milk. So we're now obliged to provide pure milk for the COMPANY C brand. We can't go back once we've made that promise.

Sama: So that was three years ago by the end of 2016. With the devaluation and everything that happened you started to make a change of plans.

Exactly.

Sama: Is that because you're committed to the Egyptian market?

To delight the customer. I have the right to use powder. But once I restricted myself and promised the customer 100% Pure Milk on the package. I can't add powder to the product or any other ingredients.

Sama: Is that also made this way for exports? Or is it irrelevant?

It's irrelevant. We used to export in both cases. With powder and without powder. There are certain customers that have certain requirements others don't mind and care more about the demand. But it wasn't the main factor. The main affecting factor was to improve the customer experience as a premium COMPANY C customer that gets a premium product.

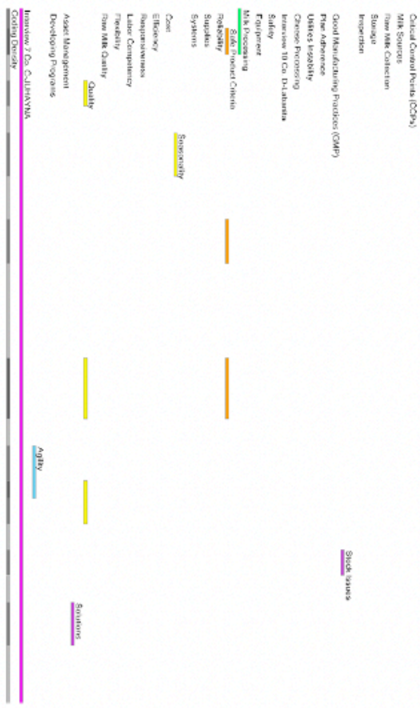
Sama: Okay. So we agree that supply shortages do happen?

Of course (shortage of supplies). Especially in August, September and October.

Sama: So what happens when the demand is specifically high for COMPANY C?

What we can do is try to do extra resourcing or extra contracting with other farms. To be honest, it doesn't solve the issue all that much though.

Sama: Because they have the same issues?



Sama: You can force/accelerate the current suppliers based on your current partnerships?

Exactly. That's basically everything regarding the supply challenges. Everything else relies in the operation side of things.

Sama: Do these challenges impact operations and production intensively?

Of course.

Sama: About cleanliness measures that are enforced on the suppliers. Whether farms or MCCs. Tell me more about those.

There's a farms development management department. This department has veterinary doctors.

Sama: Where does this department belong?

It belongs to the COMPANY C financial management department. Because most of its work is based on contracting. It has veterinary doctors. Their role is going on periodical visits on all of the farms to make sure that all the procedures are according to the guidelines. For example, that there aren't any acid additives or antibiotic additions. That the cows are being treated properly. To also make sure that the tools are sterilized and clean.

Sama: Who dictates these guidelines?

The Farm Development Department in COMPANY C.

Sama: Is there certain criteria they follow?

Of course. They have specific details for these criteria which I don't have right now. But it's mainly just like I said. They dictate the milking techniques, the chilling unit standards in the farm, whether the cow food has hormones or not and whether they take antibiotics or not. These are the first measures. There are also counter measures because these doctors aren't present every day. These are tests that are made in the factory to check for antibiotic usage, whether acids were added to balance the PH level, etc. There's also a system for dealing with farms if there are repeating violations the contract is terminated and it's blacklisted. Mainly, the EMPA farms are perfect.

Sama: What are the EMPA farms?

The EMPA farms belong to an Egyptian union. They're very high quality farms and they have no violations. Most violations are in smaller farms who have challenges in operations, hygiene, and grain prices increase. So they're forced to violate the rules to stay consistent. But all of that is detected in our tests when the cargo arrives at the factory and everything is 100% checked and nothing is skipped. We never take these things for granted.

Sama: What are the certificates for the safety and security for the dairy sectors?

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There's currently an unannounced audit in the factory on OHSAS.

Sama: The 18001?

Yes, 18001. We also have the FSSC 22000.

Sama: You also have ISO22000?

Yes. We have ISO22000, ISO14001. And we're currently working on 50001 which is an Energy Management System to enhance the energy efficiency. And it's under development. We took it in the Juice factory and we're working on it here.

Sama: Perfect. What are the CCPs for milk?

It's mainly the pasteurization point and the holding time. Those are the main CCPs for milk processing.

Sama: What are the operational capabilities for COMPANY C **specifically?**

Mainly the efficiency of the production lines. It's measured with something called OEE (Overall Equipment Effectiveness). So the OEE of the production line is the main factor when deciding whether the production line performance is good or bad. That's one of the challenges we're currently facing with the amount of production lines and pressure on maintenance this season. We're forced to delay machine's maintenance often when we shouldn't do that. But it's the only solution when we have huge demand. But that's at the risk of decreasing efficiency. So, you will always face this challenge, shall I drop two to three days for maintenance, these days will impact the sales badly to fulfill the market and the machines are on hold.

Sama: So that's different from CIP?

CIP is basically cleaning. It happens every 24 hours. 20 hours of productions and 4 hours of cleaning.

Sama: Four hours? Really?

Of course. What did you think?

Sama: I was thinking about how you're operating your production line. Because you use the same production line in full-cream, half-cream and skimmed.

We have to stop after 20 hours. Sterilize the machine and start CIP cleaning then sterilize again before getting it started for the next 20 hours.

Sama: So it never happens that you start CIP between producing full-cream, half-cream and skimmed?

We never do that. Or for example if we have to. I'll start with producing half-cream then push full-cream after it. But we can't be producing full-cream and push half-cream. That'll affect the quality and fat percentages.

Sama: About lead time. The time starting when the milk arrives at the factory until it becomes the final product. How long does that take?

This fluctuates very often. It's not consistent. But the average is 8 hours.

Sama: What does that mainly rely on?

It relies on the operational rate. We receive the milk in the morning when the production is already on-going. It's added to the silo tank, moving on to the pasteurization and sterilization. It then moves on to filling and finally to the warehouse. But that's of course not for distribution. It's held for 6-7 days for quality assurance waiting for microbiology results.

Sama: What do you call that period here?

It's called quarantine.

Sama: Because it's sometimes called release time.

Yes. Or release time. But sales people call it release time because they don't understand the process. But in an operational terminology it's called quarantine time to test the TBC and micro results. It takes 6 days on average.

Sama: yes, like other companies from 6 to 8 days.

Sama: What else do you do when there are late orders? The factory dependability. It definitely happens in a season like this, no?

We were just in a fight yesterday, actually! Look, starting in winter we're usually predicting what will happen in August, September and October.

Sama: How often do you forecast? A year, 6 months or 5 years?

In this coming October, 2019 we'll be putting a plan for October, 2020. So it's basically an annual plan forecasting for the whole year-2020. There are certain figures that change though the weeks. We have changes in the figures and data. So these changes need to reflect on the forecast… the raw materials… for the MRP cycle to be consistent.

Sama: What do you do when that happens?

In a case like this, we have several options. We can change the yogurt recipes. Consuming less raw milk and more powdered milk. Or we check if we can source from more farms.

Sama: Is there an option to surpass the current 30 farms you're already contracted with?

Yes, of course. But that'll end up giving us a surplus in the winter. So that'll affect with a backflush. We will have unneeded amount of milk during which I do not need. But we sometimes take that risk because we need the resources right now. Sometimes we give up, and this is what we can do.

Sama: Going back to Mandisha. That's your owned farm. Are there any plans for development?

We were planning for an expansion. But that was in-complete with the devaluation. We stopped all the investments.

Sama: So it's difficult right now for you to expand enough so you can cancel other farm contracts.

Regardless of how big we expand. It's impossible to reach 100%.

Sama: Definitely.

So, our farm gives us 15% if we double the farms, it'll be 30% still. Especially when there's yearly growth.

Sama: About flexibility. Tell me more about that.

Of course there are no compromises regarding milk quality. There's no flexibility there. We can't receive raw milk with an exception from a farm. In our plan we try to be as flexible as much as we can. Based on the amount of the milk I'm receiving we try to maneuver the plan. If I have large supply of raw milk, I will direct it to the production of COMPANY C UHT milk. If the raw milk is limited, I will direct it to Bekhero, as it has lower percentage of raw milk. So, I have flexibility as a plan. But regarding quality flexibility we're all completely against that.

We try to be flexible if we have any spikes in the plan. For the packaging materials for example, the procurement department work with the suppliers to buy the required materials. So, yes we apply flexibility in different aspects but not for the quality.

Sama: So flexibility regarding changing between production lines happens daily and even mid-day?

Yes.

Sama: When you start developing a new product, and this already happened and is most likely happening right now. How long does that take?

It depends on what exactly the new product is. There are certain things that are "new to the world" completely new, no one has worked on it before not only in Egypt.

Sama: "World" as in Egypt? Or worldwide?

Both. Worldwide and in Egypt.

Sama: In Egypt such as zero fat for example.

Yes. Or Zabadoo in the early days. For example, in 1998 there was nothing such as a yogurt drink. It was considered crazy that people would drink yogurt. Even though it was present abroad. Or for example lactose-free products. That's the closest example. It took a long time for development. Especially choosing the enzyme type that works with milk that splits and breaks lactose into glucose and fructose.

Sama: This happens in-house or with suppliers?

Neither. R&D takes milk samples and starts developing it.

Sama: Where does he get the samples? From all the regular sources?

Yes. Because he doesn't need a specific type of milk. It's all the same for their experiments and trials. But there are also earlier procedures regarding marketing research and seeing whether the market will accept such a new product. They do SWOT analysis, detect the opportunities and calculate the expected revenues.

Sama: Another question. Regarding all those products like Zabadoo, Zero and Lactose-free. Are they all on the same already existing production lines? Or did they need specific new equipment? Because this will affect both capacity and storage.

Only Zabadoo needed new equipment. Because it didn't exist before. But as for lactose-free and zero, they were pushed on the same production lines.

Sama: Perfect. About operational capabilities cost, does it affect all this?

Of course.

Sama: Regarding rules and regulations, exchange rate, or…?

As cost, we have the standard operational cost.

At the factory, we designed that this production line will be operating with specific cost and specific energy consumption, to produce specific product. That is our standard cost.

Once we have any deviation in any parameter we used to calculate the cost. It obviously affects it automatically. For example, if we have a batch that's supposed to be produced in 6 hours ending up being produced in 8 hours. That means we worked for an extra two hours. So that means more energy consumption and more operational cost. So that reflects on the price to cost and it affects the factory KPIs.

Sama: and consequently impact the warehousing and the warehousing cost…

Of course, and they will need to rent equipment to work extra hours at night to overcome any delays.

Sama: About production and packaging technology and quality. Tell me more about that.

We're mainly Tetra Pak. Milk Tetra Pak, includes the processing, filling and packaging are all Tetra Pak.

Sama: What type of contracting do you have with Tetra Pak? Are they present in the factory? Or only when you need them? Or they provided you with training or what?

Yes. They're always present on-site in the factory for maintenance. Because we have many production lines. So we need a minimum number of engineers present to intervene if need be. We also have our own maintenance team for easier issues and problems. And there are certain cases where expert engineers need to fly in for bigger kinds of issues like change in the spare parts. But at some cases, we need experts to come from abroad when our Tetra Pak team are not capable to solve it.

Sama: But for COMPANY C**, Tetra Pak is always present on-site, correct?**

Correct.

Sama: the packaging quality is Tetra Pak so it is guaranteed.

Yes.

Sama: Nothing packaging wise is locally produced?

Only the outer packaging (locally produced). The external cartoon containing the milk packs.

Sama: Everything's with the same standard? For all products?

Yes. You have two types of packaging; the pouch bags for Bekhero milk and Juhayna Tetra Pak.

Sama: For yogurt, who produces the packaging?

Some of them are produced locally. For example, plastic caps. These are made locally.

Sama: Is there a considerable difference between milk and yogurt in CCPs?

It's a different process. But it's similar at certain points. For example, it's all dependent on pasteurization point, holding time, etc. They're different numbers between the processing of yogurt or the processing of milk, but that's mainly it. But for yogurt, it's more concerned with preparation time and preparation temperature, these are extra processes than the milk.

Sama: And cheese?

Cheese is mainly reliant on fridges. They're packaged and packed in fridges. There's no preparation period. We weren't mainly experts on cheese because we're mainly concerned with dairy. But when we started learning how to make cheese we collaborated with Arla's engineers. We discovered that cheese production is overwhelmingly manual. We thought it was very automated. But CCPs for cheese is also pasteurization point for recombined milk because it doesn't have raw natural milk, it's mostly skimmed milk powder. And also holding time just like the rest.

Sama: As for labeling flexibility. Is there anything different for COMPANY C?

No. The packaging is standard.

Sama: As for storage regarding quality, capacity and technology. Tell me more about that.

As for storage quality for UHT milk. We have to maintain a certain temperature in the warehouse. Nothing higher than 30c. There's a very high level of pest-control system. And a high level of hygiene. Especially inside the warehouse. That's for the quality.

As for the capacity in the factory, we can hold for two days in the factory.

Sama: So you have your own warehouses?

Yes. There are also distribution centers across the country including Tiba. Around 30 distribution centers.

Sama: 30 DCs and also one in each factory of the ones we discussed?

Exactly. And as for quality as well. Al-Masrya factory has a system called Radio Shuttle System. It's an advanced system for storage. It is not like manual raking; we also have a fully automated warehouse. A one of a kind in the middle east in our juice factory.

Sama: which software you are using for it?

SAP, and it is connected with COMPANY C's SAP and ERP as well. They take the order and transmit it to the warehouse, then they get the products, prepare it, sort it, make it ready for release.

Sama: you are not considering applying it for the milk or the dairy in general?

It takes a very high investment.

Sama: why only juice?

It was a bit of luxury to apply it and being the first to use it. Besides, we have a large assortment of juice which requires w massive storage capacity. You have 3000sqm and you want to absorb

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the most storage capacity with the least surface area. That's why you have to rely on this solution. That's for the juice. For the milk, the situation is not that complicated.

Sama: As for transportation technology and quality. Tell me more about that.

We have different means of transportation. But it's mainly the COMPANY C fleet. It's owned by COMPANY C. The heavy fleet delivers from the factories to the distribution centers. That's the first step in transportation. And from distribution centers it depends on different channels in distributors. There's bulk, distributors, Modern Trade, Hurrica, etc.

Sama: Who does this distribution, COMPANY C **or…?**

We have distributors and also COMPANY C distribute its own products. We distribute for Modern Trade and Hurrica and also for retail and traditional markets. But all the fleet is owned by COMPANY C. Tiba, i one of the biggest supply chains in Egypt right after Pepsico. We cover all areas of Egypt with many branches, which facilitate covering the whole country in no time.

Sama: do they need any technology?

They also have handhelds to submit all the sales on the system. They connect everything on SAP.

Sama: That also serves as tracking for you!

Exactly.

Sama: Perfect. Besides the challenges we already discussed. Are there any other risks that affect operational capabilities?

There's something that happens that's called "Heat Wave". It's also called "Three-Days Fever".

Sama: What's that?

The Three-Days Fever affects cows in the summer in intense heat waves. And it makes them sick for three days and unable to produce milk. So if it happens for a whole farm, it's a disaster. But it happens.

Sama: it will impact all the suppliers not only your farms?

Of course. But some farms are very well cooled, so even the sun doesn't affect it all that much. But some other farms have poor ceilings and are heavily affected. Or they keep the cows for two to three hours at the sun, so it impacts the productivity. So it differs.

Sama: So what are other challenges? Even in the factory itself. Labor-wise, machine-wise... Etc.

The performance of the machines is the most crucial for us. We always regularly tackle that issue. There's an engineering team in every factory for continuous improvement that works on

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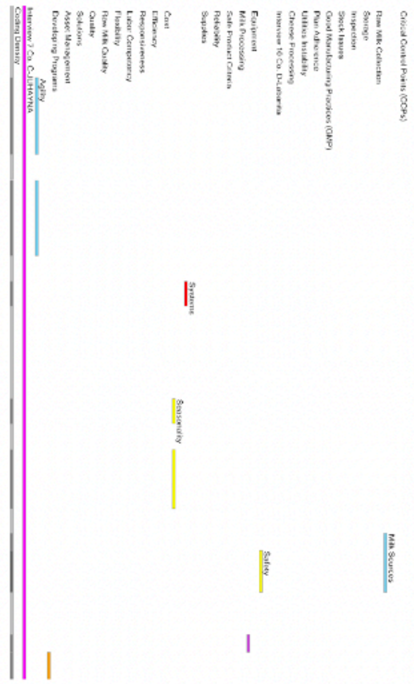

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developing that constantly to improve performance, improve the process within the factory and lower cost.

Sama: This is independent of Tetra Pak?

Yes. The continuous improvement team is a COMPANY C team they are not related to Tetra Pak. They monitor production line efficiency. And they have initiatives to solve any issues and come up with solutions to improve that efficiency. It is different than the maintenance.

Sama: So Tetra Pak is mainly present for maintenance.

Yes.

Sama: Any other challenges? Since you're present in the factory.

Power fluctuations. If there's any kind of power fluctuation it causes fluctuations in pasteurization machines so the PLC that reads that power thinks that all of the milk is pasteurized and it completely ruins the batch and it gets drained.

Sama: the whole batch of milk?

No, only the part in the pasteurization process gets drained. I can't do the pasteurization twice. It's a loss.

Sama: So it happens in a tough summer season like this?

Yes, it happens in the summer season. Heat causes issues for the power company and it definitely causes fluctuations in power. There's also challenges regarding off-days.

Sama: To my knowledge, all dairy factories never stop production...

Of course. But there are also tough cases. Such as Eid holidays. We're forced to ask the operators to come and work but they also need these off-days. But it happens that we have issues in productions because some of them don't show up. So that's a tough challenge to manage.

Sama: So there are certain times where you can't operate fully utilized by both labor and machines?

Definitely. There are also business challenges. Cost of currency fluctuation and its effect on investments. And how it affects production costs. So you're forced to buy support because you are facing competition in the market. And that affects the revenue of the company as opposed to obtaining market share or maintaining market share. But that's generally regarding the finance, sales and marketing departments.

Sama: Anything else?

No. We definitely covered everything regard the challenges.

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Sama: Should we briefly go over the whole supply chain? Do you think there's a relation between operations and supply chain?

Of course.

Sama: How do you measure supply chain performance?

First thing we measure forecast accuracy. Secondly, we watch bias towards demand. As in, do I always get a demand plan always higher than what sales need or always lower than what sales need? So that's the second thing we measure in the supply chain. We also watch the loading plan everyday between the factory and the distribution centers. How much we achieve that every day to achieve 100% of the plan.

Sama: What's that called?

It's called the Distribution Plan (DRP). That's regarding the supply chain. Another part is the procurement. That we don't have any shortages of any materials. Either raw materials or packaging material or auxiliary material. So that's also one of the things we use to measure supply chain performance. Custom clearance also belongs to the supply chain.

Sama: Custom clearance regarding what exactly?

Packaging, powder and spare parts for the machines. All these things need custom clearance. The faster it happens and spends less time in customs, the less it affects us. And it makes failure rates less.

Sama: So those are the KPIs…

Yes. Those are the supply chain KPIs which are related to the operations.

Sama: And regarding supply chain quality?

You mean the quality of service? When the supplier provides me with the materials it is called service quality. For example, the customs clearance it is kind of a service.

Sama: I'm talking about quality as a company and as COMPANY C.

Everything arrives according to specs. And quality checks on these specs. The quality process mainly relies on our factories. And report any NCR if quality is out of specs from the supplier.

Sama: we discussed the internal performance, the process quality, the delivery decisions and the responsiveness.

Sama: Perfect. About responsiveness?

Sometimes there happens spikes or drops in the market. Therefore, you have to respond very fast to these changes. Not to lose any sales opportunities. That's obviously a headache.

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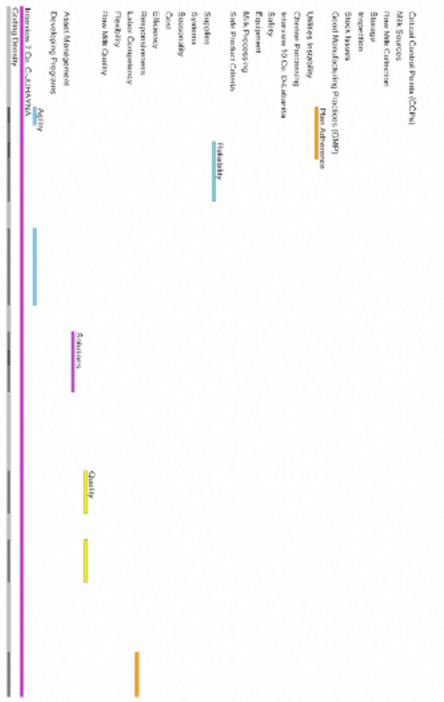

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Sama: Trying to avoid lost sales…

Exactly.

Sama: You try to avoid reaching that point in the first place.

Yes.

Sama: Perfect. What are future plans for improving business performance?

We're currently applying methods for continuous improvement in manufacturing in Kaizen, Lean, and 6-Sigma.

Sama: Quality tools mainly.

Exactly. When we improve the production performance that allows us to get more output from the machines at the same time. Consequently, it allows us to perform maintenance at any time without pressure and without affecting efficiency as long as the machine is performing according to the plan and the designed efficiency. We as COMPANY C considered applying the continuous improvement to enhance our performance.

Sama: Are you using a tracking system?

Yes.

Sama: Do you need it? Or would it change anything if it's applied?

Of course. It's currently working in our warehouses.

Sama: for the dairy products?!

Yes

Sama: really?

Of course.

Sama: you mentioned it for the juice only.

You mean the automated warehouse?

Sama: yes.

I'm talking about the tracking system. We already have it in the Radio Shuttle to track and get a product from the warehouse. But the difference between this and the automated warehouse in our Juice factories and warehouses, it's a fully automated warehouse. We do not do anything manually. We just select the order and the shuttle make it ready and from this point the tracking

starts. But in our dairy warehouses, we don't need it that much. I already know where every batch is and the free-in free-out working properly. So, I don't need it much.

Sama: FIFO?

Yes.

Sama: How many farms are there in Egypt?

I don't know exactly.

Sama: And MCCs?

A lot. A lot.

Sama: Do you do training, awareness, etc? For managerial staff or labor or hygiene else...

We were just doing training for the operators in the factory. Just right now. The training included the continuous improvement, and what are the types of waste, what 5S means, what OEE means, what it means to problem solving, ishikawa fishbone analysis, etc. That's what we're doing on the spot right now. And the plan is to train all the manufacturing sectors. All blue collars in the factories will be trained by the end of 2019.

Sama: who are the blue collars?

Operators, technicians, workforce... all are included in the training plan.

Sama: Who does this training?

Us. COMPANY C, our continuous improvement team. We developed our teams to provide this training programs to cut cost.

Sama: Perfect.

As for white collars, managerial level, that's also HR. They have an annual plan to train staff for soft skills, or technical skills. Whatever's needed.

Sama: Are there plans to launch new products?

Yes.

Sama: check this figure, these are the operational capabilities that we just brainstormed-- Did you hear about the score model?

No.

Sama: The supply chain operations reference model?

No.

Sama: It's prevalent. No one here in Egypt applies it.

Of course.

Sama: Why so sure?

Because I've never heard about it!

Sama: Because I already talked to other companies with those who are concerned with the academic field and they said that it's too costly and it won't add much benefit to their operations.

It's very apparent from its name that it's extremely important!

Sama: If you want to restructure the supply chain or re-engineer a certain part. It redesigns the supply chain for you and improves it. So the five elements of the supply chain are plan, source, make and deliver. So when we discuss the "make" part, the operational part. Then we're discussing reliability, responsiveness, agility and cost. And also asset management. But after I sat with academics. They suggested replacing asset management with quality.

But asset management is extremely important. The warehouses are an asset, including how to manage our warehouses. The fleet is an asset. And how to manage those and utilize them as efficiently as possible is very important.

But the idea is that why is the quality a part of the supply chain?

Sama: It's included in every part of the supply chain.

Because what I understand about quality is that someone measures the services provided from one party to the other. Or the certain specs of a certain thing.

Sama: The specs of the product…

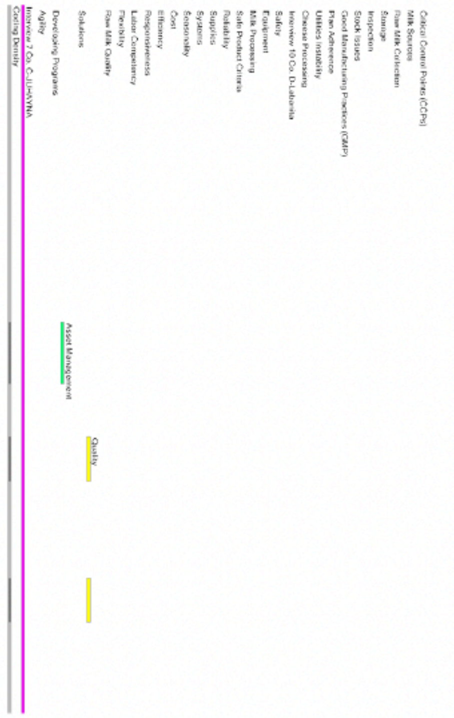
Exactly.

Sama: That's exactly the point. Because I want to improve the business performance from a product perspective.

Perfect. So why do we measure product quality in the supply chain? It's measured in the factory. And when it reaches the distribution centers, the quality also measured there.

Sama: So you think that quality should be part of the operational capability and that asset management stays as part of the supply chain.

Of course.



Sama: Perfect.

Wasn't it already like this?

Sama: Yes. Asset management instead of the quality under the supply chain.

That's perfectly correct.

Sama: One more thing. Does the relationship with operational capabilities affect supply chain performance? Or does the supply chain assets and performance affect it the other way?

It goes both ways, of course "double way".

Sama: And if both are improved. That will, of course, affect business performance.

Of course.

Sama: So do you have a long term plan? For example, a 5 year plan?

Yes. And it's communicated with everyone with visual management literally everywhere.

Sama: What would you like to achieve?

We're planning to double the revenue.

Check this billboard and what's written on it "X2"

Sama: what is "X2"?

It (X2) means double the revenue.

Sama: How are you going to achieve that?

By cascading the business roles and categorizing the objectives and handing it to each department for them to achieve it. So everything is aligned for achieving that big goal.

Sama: And from your own perspective as planning and manufacturing?

First thing, as manufacturing, we're going to improve the performance to get the best utilization from the assets we have. That's the first thing. Second thing, we're going to enhance the 5S system. Once we fully implement that into our production, that'll improve a lot in the performance.

Sama: What's 5S?

5S is a Japanese system. It's applied in manufacturing shop floors. They're five words that start with S. Sort. Set-in-order. Shine. Standardize. Sustain.

Sort, to remove all the un-needed items in the workplace.

Set-in-order, to start listing where to assign everything.

Shine, to make my workplace shining and clean to reach the sparkling.

Standardize, to make a standardized system for the machine layout, the labor motion.

Once the system is settled, you can sustain it with all the factories and you can audit it with a score sheet and apply the 5S and monitor if I'm following the standard or not.

All of this reduces waste. Because in the end, the main goal is the waste. We're tackling waste.

Sama: In order to be green.

Exactly. That's beside that we tie waste to the cost. If we have no waste, then we have no extra cost. We try to improve the value added activities and reduce the non-value added activities.

Sama: yes, it is considered as part of the core of the SCOR model.

Sama: There are a couple of guidelines or principles in a BRC-British report about dairy products. Some of them you already discussed. And some I'll review for you and see whether we'll agree. So your team of veterinarians-farm development department, do they do awareness programs for animal welfare?

Of course. There's an annual meeting with everyone. And they also go on training sessions on the spot. And some training sessions provided by experts to some farms. Either we group them together at some place and provide them with the training or we visit each farm and give them the training there, if it is something like TOT.

Sama: Will COMPANY C get more stakeholders?

We have stocks in the stock market. So anyone who buys stocks is recognized as a stakeholder. There's also an investor relations department. It's responsible for promoting these stocks to attract the investors to buy our stocks.

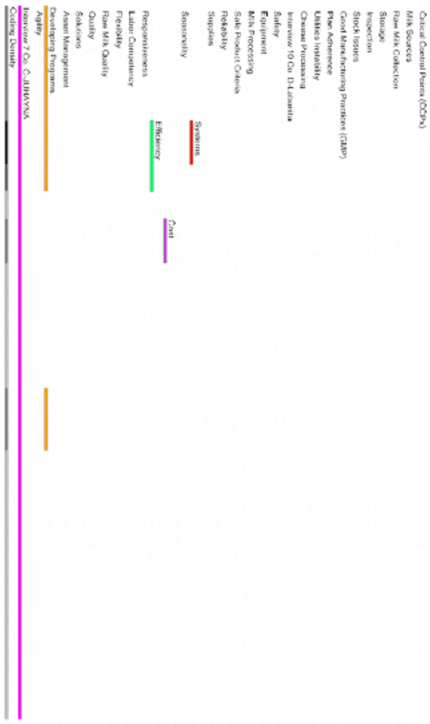
Sama: Perfect. And you already invest in new technologies and business models. Is there anything else you're developing and can you tell me anything about them? Something like the Lactose free…

Of course there is. Yes, the R&D responsible for that.

Sama: can you tell me more about it?

I'm sorry I can't share it.

Sama: Okay, I don't want the details, but do you invest in business models?



Yes. Yes.

Sama: and the nutrition…

Yes.

Sama: and you already told me about the technology you are using…

Yes

Sama: What about transparency across the supply chain? With the farmers for example, or you both just abide with the contract and that's it?

Farms don't know our plans. We start contracts with them and that's it. And they don't ask for it because they don't benefit from it.

Sama: That's what I meant. Whether they'll benefit from it.

I don't think so, no.

Sama: And about nutrition preferences, you know that from the market research of course.

From market research, yes.

Sama: and according to that you start to function...

Yes.

Sama: That was all. Thank you!

Continuing notes.

I'm responsible for the production planning and control continuous improvement.

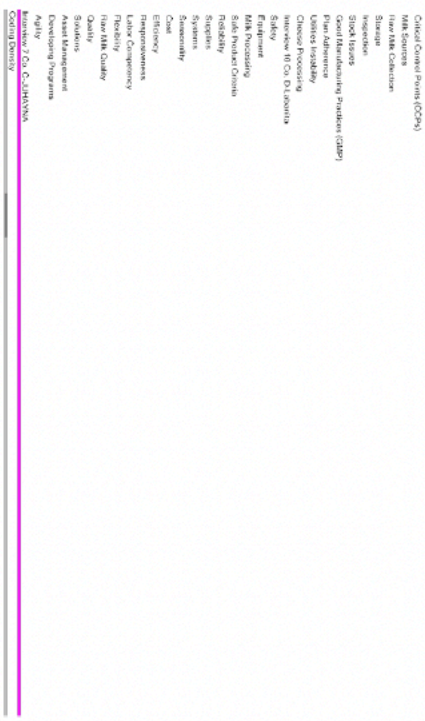
Responsible for Manufacturing, Continuous Improvement, Planning and Control Department at Company C food industries all Plants, Roles includes but not limited to,

- Setting Production Planning Policies to ensure full alignment with Demand Planning and to ensure Optimum Assets Utilization and Resources Consumption

- Setting Master Production Schedule "MPS" Standards for Production Planning Activities

- Monitor, Control and Analyze Manufacturing Reporting System and KPIs to be aligned with Company C Manufacturing Goals

- Setting, Leading Company C's Continuous Improvement Transformation by Applying Lean Manufacturing Techniques Through Kaizen Events, Six Sigma Statistical and Problem Solving Tools in all Company C Manufacturing Facilities



- Conduct Continuous Improvement Training to Manufacturing Employees to Build Capabilities and Provide Technical Tools, allowing them to Start Generating Cost Saving Ideas.

Company C have 2 production lines producing cheese (Puck) in collaboration with Arla, and one production line for milk producing the 125 milliliter milk product.

For further quality assurance, the vets do tests for the received raw milk at the factory. Testing the PH level if any acids is added, antibiotics. We have the right to refuse the milk if it does not comply to our quality standards. If the farm exceeds 2 times of violation incidents we break the contract with the farm.

Tiba Co. is our partner to distribute our products among the market.

Quality measure in the factory not the overall supply chain. Or if you mean the quality of service provided by the customs authority and speeding the procedures of customs clearance. We report non conformity report NCR for the non-conforming supplies.

We aim to make it a fully automated warehouse using extended warehouse management system EWM-SAP software. It takes the orders produced and transfer the data to the warehouse and give all the racking details and preparation for release to the market. We already applying it at our juice factory. But, it takes high investment but we are keeping it as a plan for our dairy factories. It is useful with large SKUs and make it easier and faster to manage the products and release it to the market.

Sama: On a scale from 1 to 5, rank your supply chain performance in terms of a safe and secure supply of milk products, where (1) is very low performance and (5) very high performance.

SCOR Attribute	1 (Very Low)	2 (Low)	3 (Neutral)	4 (High)	5 (Very High)
Reliability				4	
Responsiveness			3		
Agility					5
Cost					5
Asset Management				4	

22A

23A

Appendix 8 **Focus Group Transcription Coding Sample**

Focus Group 1- 24th April 2021

Participants:
-The head of the national food safety authority in Egypt (NFSA),
-An inspector from NFSA,
-Project manager in Mansour group and the food safety manager for [redacted],
-Quality assurance section head, [redacted] Egypt, and
-Continuous improvement and planning manager at J[redacted]

Sama: Good evening everyone. Our session today will take approximately one hour. I will start with a brief presentation about my research topic and then I have five questions to discuss with you. Each question will take around 5 minutes to discuss. So, each participant will have around one minute to provide his answer and have different point of views to add to the research results. First of all, do you prefer to have the FG in English or in Arabic?

NFSA: anyone here is not Egyptian?

Sama: Until now, all participants are Arabs, however my research supervisor might join us at any time and she's British. So, until she joins, if you feel comfortable to speak Arabic or mix of both languages, feel free and I'll translate it later.

NFSA: Anyway, I have prepared a presentation in both languages Arabic and English because I presented this in many places according to the audience. I can share it with you, the English version, if you want to share it with anyone outside Egypt.

Sama: Thank you very much. Let's take 5 minutes to get to know each other and the research itself. First of all, this research is about developing a best practice model for the dairy producers in Egypt to enhance their operational performance and the overall supply chain performance. The data I'm sharing with you today is the result of primary phase of data collection including 17 interviews with 6 of the large dairy producers in Egypt. Regardless the fact that those large producers are performing on a satisfactory level, they are still facing some deficiencies at some parts of their supply chains. That's why I'm inviting professionals from the national authority of food safety, ministry of agriculture, ministry of trade, and researchers to add to this research. Let's get to know each other before proceeding with the discussion.

NFSA: [redacted], for the area of your interest, I am taking the initiative to create a milk hub for over 10 to 12 years. I have made great efforts in this area conducting many interviews with the farmers. I believe I have the solution to the problem, and I wish someone can adopt this idea for execution. I am very glad to share any information I have to help building this hub, which I'll explain later on.

Sama: Of course, we will hear from you later on during our discussion and hear your presentation.

MA: [redacted]. I have experience of 17 years in the dairy sector. I'm the project manager in M[redacted]p and the food safety manager for [redacted] and I'm currently the manufacturing manager for the food and beverage sector in Mansour group in the field of dairy products and by the way I'm finalizing my PhD in the area of lean management which is part of the supply chain management performance.

Sama: En[redacted]d…are you with me? …. ok we can move to our next participant.

AM: My name is Ahmed Morgan. I am the continuous improvement and planning manager at J[redacted]A in the manufacturing and the production of all our factories. I'm honored to be with

Quality Measures
Asset Management
Operational Capabilities
Consumer Complaints Per Million (CPM)
Responsiveness
Pasteurized Milk Product Quality
Balance Supply & Demand Seasonality
Production Optimization
Manpower Development
Technology
Resources Shortage & Late Deliveries
Raw Milk Scarcity
Cost
Reliability
Raw Milk Quality
Food Safety Standards
Production Critical Control Points CCP's
Substandard Raw Milk
SC Performance Measures (KPIs)
Risks and Challenges
governmental support
Supply Side Control
Supplier traceability
Performance Improvement
SC Members' Collaboration
Coding Density

Suppliers' Awareness Programs

you all and specially with his highness Eng. [redacted]. *he laughs*… I got shocked when I saw him, it's a great honor to be with him in the same discussion.

Sama: Thank you. I selected the top experts in the field to give me the insights and Eng. [redacted] is one of them.

MA and AM: Of course.

Sama: So, our target to combine all your recommendations to improve the dairy sector. In brief, my research scope on the supply side including the farms and the milk collectors and the manufacturing and the risks and challenges in both areas and how to overcome these problems and fulfill the dairy demand in Egypt. I have 5 research questions I need to answer which I already covered by the first phase of data collection. What are the operational capabilities and the CCPs? That should be the specialization of Eng. [redacted] and she inspects the products. What and where are the risks and challenges in the supply chain? Most of the answers where around the shortage of raw milk or the low quality of it. So, by having issues in the source of the supply chain, that will not enable us to fulfill the demand at the end. Then, how to assess the performance and develop a set of KPIs to follow? There is no unified KPIs for the dairy producers in Egypt. For example, in UK and Europe they have reference to follow like the BRC report and else to act as a guide for the dairy producers. As a researcher my reference is the SCOR model to combine the KPIs from the 6 large dairy producers which I am presenting today to validate this framework with the main elements and the sub elements to create a best practice. Eng. MA and AM were 2 of the participants in interviews and mentioned some of these answers, including the production run length, the production line efficiency, and else. For the critical control points were mainly around the bacterial count, the pasteurization temperature for pasteurized milk and the UHT temperature for long shelf-life milk and so on. For the risks and challenges. The most important source of risk is the sources of raw milk. The raw materials, including powdered milk, packaging, then the production risk and the operational risk, which is about the plan itself and the management, the cleanliness measures, the breakdowns, the electricity cutoffs specially for the factories located in the industrial zone, and last the prices fluctuation and the currency exchange rates. Those are the frequently mentioned risks from the interviews.
When I asked the participants, what do you need to improve your performance, most of the participants focused on the need to control the supply side in terms of the feeding of the livestock, increase the productivity by investing in the production lines. To have list of unified KPIs with specific measures and values, many of you mentioned that they do not have access to this type of information, if each company shared their reference with a single source and this information can be shared anonymously this will benefit the dairy producers to enhance their performance. That's what I am trying to do, to set a list of KPIs. I faced a challenge as a researcher to collect such values for each KPI from the participants. Then the emissions and reducing the wastes and the defected products and increase the sales and the number of quality suppliers, and last most of the companies invest heavily in the technology utilization in the factory.
Here are some of the answers covering the KPIs. Some participants mentioned that they apply primitive KPIs, unstructured, overall equipment effectiveness and the distribution plan and the consumer complaints per million, most of the companies mentioned it and else. I'm listing all this in a table which we will review right away. Now I will display the research findings and the 5 questions we need to discuss.
Again, each question will take 5 minutes, and one minute to one minute and a half for each participant. Is the screen clear for you all?

All participants: yes clear.

Sama: those are the main elements and sub elements of the framework which I'm developing. It is extracted from the 6 participated companies. The operational capabilities, the critical control points and the KPIs for the supply side and the manufacturing side. I

Quality Measures
Asset Management
Operational Capabilities
Consumer Complaints Per Million (CPM)
Responsiveness
Pasteurized Milk Product Quality
Balance Supply & Demand Seasonality
Production Optimization
Manpower Development
Technology
Resources Shortage & Late Deliveries
Raw Milk Scarcity
Cost
Reliability
Raw Milk Quality
Food Safety Standards
Suppliers' Awareness Programs
Production Critical Control Points CCP's
Substandard Raw Milk
SC Performance Measures (KPIs)
Risks and Challenges
governmental support
Supply Side Control
Supplier traceability
Performance Improvement
SC Members' Collaboration
Coding Density

realize you will find some duplicated elements… those are the data I extracted from the participants and I'm validating it with you all to finetune the framework with exact classification of each sub-elements. Please take a minute to review the table and then I am ready for your feedback.

AM: for the quality, there is no such thing called quality as a KPI. The quality is subdivided to DPMU, FTR and other things classified under quality. But there is no such thing called quality as a KPI. That's what we have maybe it varies at other companies or they have another definition for it.

MA: I agree with you Eng. AM.

Sama: Have you all reviewed the table before getting into the questions? Do you all agree?

NFSA: No, of course not. I do not agree on the table, but I will postpone my opinion later. For me, I find them interrelated. They need total rearrangement. I will comment at the end.

Sama: Yes, that is the purpose of the FG. If you have any comment before getting into the questions, please do.

NFSA: The idea is not clear yet for me, I'm waiting for you to reach a specific point and comment on it.

MA: Dr. Sama, excuse me, this table includes the operational capabilities, the critical control points for the operation lines, correct?

Sama: yes

MA: and the KPIs for what? the plant as a whole or the operations?

Sama: the first part of the KPIs for the plant and the last three for the livestock which is the supply side.
Eng[redacted], welcome, do you have any comment on the table so far? Would you please introduce yourself?

AA: [redacted] quality assurance section head [redacted] Egypt.

Sama: do you have any comment on the table before turning to the questions?

AA: Just joined the meeting so give me few moments to review it.

Sama: I will keep it for you all and preview the question at the same time. I am sure you will add a lot in the KPIs. Each question will take 5 minutes and 25 minutes in total to finalize our discussion.

1. **Does this table clearly identify the elements related to the operations and the supply chain management performance dimensions?**

NFSA: a very quick answer, no.

Sama: please explain.

NFSA: I do not understand the research aim. The milk chain starts from the farmer until the consumer. All what you spoke about are related to the factories only. If your study is about the factories only so, do not talk about the milk chain. You talk about the factories and what goes on there. The milk chain is different. And those factories you are including are taking only 5% of the milk in Egypt. The remaining 95% of milk in Egypt is not appearing here in your study at all. You barely mentioned it here at the bottom of your table the last 3 points, the livestock KPIs. All the upper part does not resemble a problem. When I take total count less than 50.000 from farms does not exceed 50 farms in Egypt. So, there is no problem in here, the problem in the supply side. Again, the research topic is about the milk production in terms of the sterilization, the pasteurization temperature, there is no problem here, those factories are functioning well compared to any other factory worldwide, they take very high-quality milk and they do not exceed the 5% of the local milk production in Egypt, or they use powdered milk. You did not mention the remaining percentage of real raw milk, its problem and how to improve it? So, either to change the title to focus on specific point in the chain or that is not about the chain.

Sama: the research title specifically about the operations. When I assessed the operations at those companies, they mentioned the challenges they face at the source side of raw milk and specifically in terms of shortage… NFSA interrupted

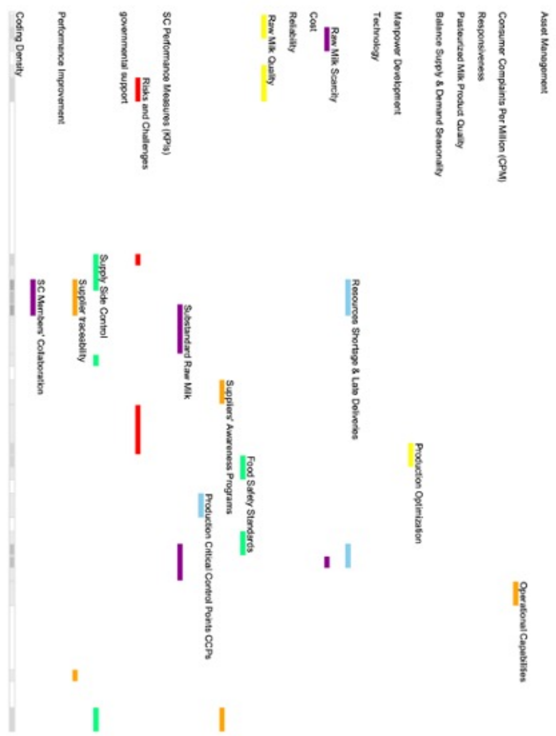
NFSA: That's what I am going to tell you about and its problem.

Sama: Yes, so you will add to the area where we have deficiency.

NFSA: Exactly!!! That's the problem. I agreed to participate in this discussion, when I found you interested in a research area in which it might solve an issue. This table can be rearranged easily, it won't resemble an issue. The whole issue is in the livestock area. I have spotted three words you have mentioned here; the traceability, the suppliers, let's talk about them and specifically the supplier zero, supplier zero is the primary producer, who is the farmer who owns the cow. So, that is the primary problem, this kind of milk brought from this supplier. So, I will link the traceability with the supplier and the milk specifications. The specification of this milk is 7 million bacterial total count in the best cases scenarios, and it might reach up to 50 million bacterial total count. So, you are not including such milk with 30 to 50 million bacterial total count. What can we do to this milk with 7, 10, and up to 50 million? Let's get in depth. Do we have a system for the farmers who owns less than 6 cows? can they compete by any mean and included in the circle? The answer is yes, but with a specific way. That is what I'm going to tell you about. The farmer has three problems, his productivity does not cover his cost, so why does he grow a cow if it will not yield profit for him? It will, by giving birth to another cow but not with the milk. So, the milk productivity is not a source of income for him, but it is a source of a limited daily income, but if he calculated his expenses by the end of the year, he would find himself losing money. Why would he be losing? Because the cost of milking is higher than the cow's productivity of milk. Therefore, we need to increase the cow's productivity and reduce the cost of production. Let's move to the second part, the cleanliness and the hygiene, do we have a hygiene system to produce good quality milk? So, in order to achieve those three points, we need services. Is there anyone who provides the farmer with those services or not? This is the bottle neck we are speaking about. But if you are talking about the CCPs in the factory it is all about the heat temperatures. CCP for milk receival, CCP for pasteurization, and so on… It is a totally different story; I do not mind that you are focusing on the factories at all. Eng. MA and AM are quality controllers at a very reputable companies which we inspect and if they are performing well, we add them to the whitelist, and all goes well. The problem resides in the milk they use. When there is shortage in raw milk, they use powdered milk. In this case the small milk producers are in trouble and they get their milk from laboratories. It is a totally different chain. We have over 40.000 labs for cheese and other products, they receive from suppliers and produce the white cheese and roumy cheese. What is the quality of this raw milk and its bacterial count? You are not talking about the whole milk chain rather than a specific point in the chain.

Sama: now we are speaking about the source of the problem in the milk chain and how to improve it and the services needed.

NFSA: I need to link the supplier with the raw materials and the traceability. Those are the three things we need to talk about if you want. All other elements I agree upon and there are authorities inspect that. The remaining three elements are neglected and are not taking attention from anyone. I started with the milk collection centers to assist them during weekends to get the license before starting the national food safety authority. I was helping them to get investment,



but they are not licensed. There is a movie called 'heen maysara' where there was a random poor guy who couldn't have children and the issues back in the 80s, he said, nobody sees us. What I mean is, nobody is helping and assisting those random farmers who own over 5 million cows around Egypt and produces 90% of milk production. When I spoke with Danone and Almarai from Saudi Arabia and JUHAYNA and many other companies. I suggested to create a milk collection center and provide services to raise the quality of milk from the small farmers. We produce 5 million tons of milk on average from 5 to 6 million cows, each cow produces approximately 1 ton of raw milk. I can produce the same 5 million tons of milk from 1 million cows only, we call this a substituted solution. To produce the same amount of milk with less cows. So, larger productivity with less cost. But this is an insane solution, I can't do it. Because I will exclude 3 to 4 million farmers out of the industry. It is not only an economic system rather than a social system. This cow is considered as a family member to this farmer like his child. He uses both to work and get him a source of income. He takes some of the milk produced by his cow for his family consumption and sells the rest. We need to utilize the 5 million cows with higher productivity. That is the challenge.

Sama: let me take other point of views for the other participants. I am sure you will have great insights to add to the remaining of the questions. I have heard your comments about the table do you want to add anything else to what NFSA mentioned?

AM: NFSA mentioned everything in detail and mentioned the drastic solution for the issue. I don't have anything further to add.

MA: I'm pleased to hear from Dr. Hussein and his guys inspects our factories each two to three months. I wish he prepares a presentation and invite us all to attend and all other professionals in the field. For your research, there is a small point I want to discuss. As we are researchers like each other, we need to determine the research population, apparently you are targeting the companies producing milk, correct?

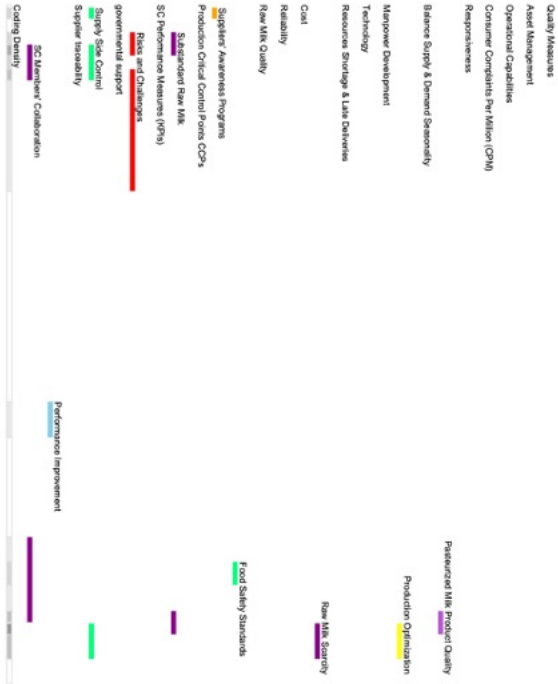
Sama: yes

MA: and you are determining the KPIs and the parameters concerning the operations and supply chain, correct? Ok… so, the milk part is related to the supply chain of dairy companies. So, you are targeting the raw milk KPIs to enhance the supply chain performance and consequently the operational performance. Dr. Hussein explained the raw milk issue very well and he is more experienced in this area, but for the operations this table needs rearrangement. If you can share it with me and I can help you arrange the elements among the columns to get exact KPIs, the operational performance and the parameters impacting all to reach a good result. Also, the part of the livestock and the raw milk needs to get highlighted because it needs a separate PhD study by itself.

Sama: Eng. AA do you want to add anything to the table?

AA: in my point of view, I do not have a problem with the raw milk supply. We as a company we do not take raw milk from collectors or from independent farmers. We take from large farms only. In our case, the problem resides when we do supplier audit to many farms in Egypt to get raw milk from them and we reject them. That led us to shift to self-sufficiency. Our farm used to fulfill 70% of our needs. We have our own milking parlors, we used to cover the remaining 30% from large farms in Egypt and I audit them myself, and I start to take the raw milk with the amounts I need. Currently, we have many problems with them in their quality and the food safety specifically. Therefore, we are currently building a new milking parlor to triple the amount of milking supply on a personal level to suit our quality. That's why I agree that we, as dairy companies, do not focus on the small farmers.

Sama: So, we covered the first two questions.



2 **In your opinion, how do these elements benefit the dairy producers' supply chain performance?**

MA: I want to add one point to my colleagues to the second question, as we are covering all the questions. The most critical parameter is the time from the raw milk getting milked until it reaches the factory to get into the production process. This time resembles an essential issue. We need to reduce it and do process it at specific area either milk collection center or elsewhere as Dr. Hussein mentioned. So, the time parameter is very critical in addition to the quality and small farmers need assistance to improve their milking quality and consequently benefit the dairy producers. This parameter will improve the operations and reduce the cost.

Sama: Eng. AA just mentioned an example of how they overcome such challenge of low quality and quantity of raw milk by improving their own milking parlors or collection centers… let me hear other solutions, DR. Hussein, if you would like to start?

4. **How do dairy producers overcome these supply chain challenges and operational risks and what does good look like in terms of reliability, responsiveness, agility, cost, and asset management?**

NFSA: this solution is not sustainable. It is a solution for an individual company. Not all companies can do that. Not everyone who cannot find a good quality raw milk can build their own farm and control their operation. *All other participant interrupted and approved him* We are speaking about developing a whole country. That is what I mentioned from the beginning not the number of farms. The amount of raw milk the large companies are using is only 5 to 7% from the total raw milk production in Egypt. It is very limited amount. We need to focus on the remaining percent. The remaining percent either it gets wasted or directed to the small companies which accepts a very high bacterial total count and produce low quality product. By the way, I am not speaking as the national food safety authority but as a professor in the milking productivity and development. That is not the specialty of the national food safety authority. Our duty as authority to inspect if the companies are performing well, we will approve them, if not we will close this company. So, what shall we do? Close Egypt?! Close all these companies? I can't. *express his frustration* We need to find a solution to improve this sector and improve the remaining 90% of raw milk in Egypt. How to make a plan to improve it. We cannot leave it to its current state. The national food safety authority inspects the milking parlors and the farms, but still the market has tons of raw milk to utilize.

Sama: How?

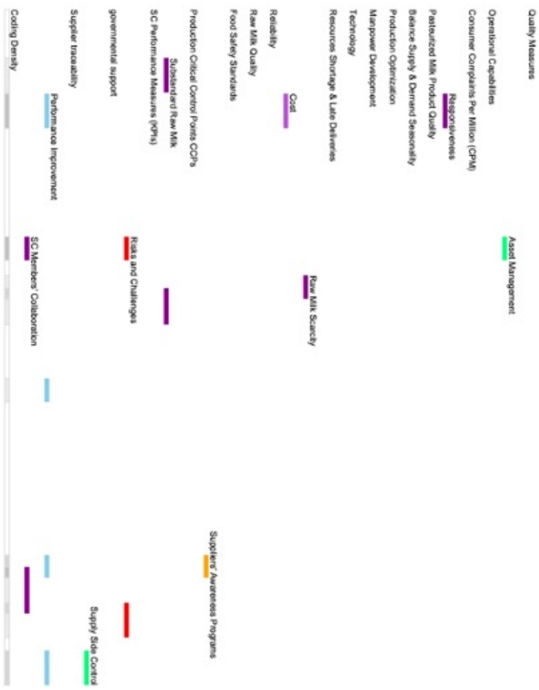
NFSA: would you allow me to share screen?

Sama: Sure, you have access now.

NFSA: I'll leave you the presentation to use it if you need. There are milk collection centers in Egypt since the 60s and it was around 40 collection centers.

Sama and AM: we can't see the presentation.

NFSA: I'm speaking generally about a solution for the raw milk productivity at supplier zero, who is the farmer himself. I was just saying that there were milk collection centers at the 60s and it was 40 collection centers. Those 40 centers disappeared after the privatization of the dairy sector. Only 4 remained and belongs to associations, the remaining totally disappeared and the milk collectors appeared instead. Those operates by using carriages (horse or donkey-drawn vehicle) in the upper Egypt. All Upper Egypt beyond Beni Sweif does not have any milk collection centers. But, Kafr EL-Shaikh has a collection center. It collects 25 tons per day. One person can establish a milk collection center, but what is the difference between what I'll talk about and the milk collection center? I'm talking about 'milk hub'. It means a milk collection center plus services. So, there are services provided through the milk collection center. It's not just about collecting the raw milk from the farmers for whatever fee and regardless all the



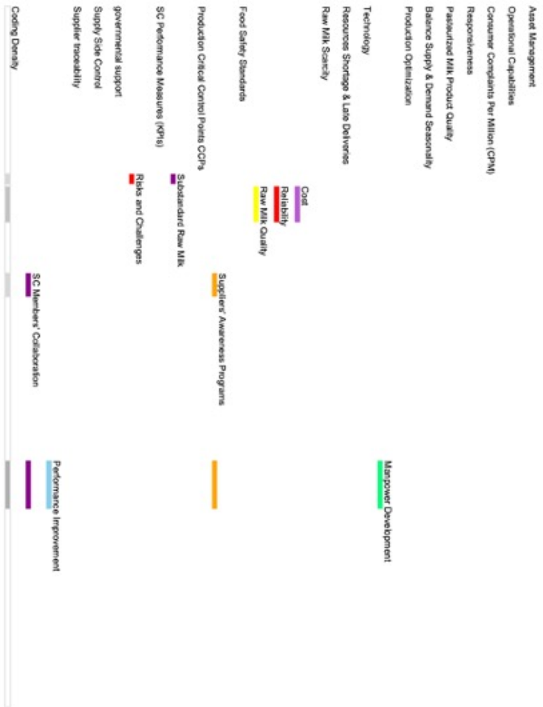
We take samples from the cow's teat, from the farmer's hand, from the container and everything. There is no difference at the end. So, the lack of cleanliness remains the same. We calculated the cleanliness cost and found it equals to 40 pennies per the milking process. So, if I reduced the bacterial total count by applying the cleanliness measures and we sell the milk with better total count, so the farmer will sell the raw milk at higher price. So, he needs to pay this extra expense to sell the raw milk at a higher price. Same applies to the chloroform and the yeast. Here is the program to sterilize the cow's udder in detail, including its cost. We tracked the milk afterwards until it reached the milk collection center. If you can see this cloth, which he uses to filter the milk it records from half a million to 2 million total bacterial count because as you can see the man wash it on the floor without any sterilizer. Take care, this milk collection center processes 25 tons per day. It is considered a large center and capable to operate on a better state.

So, at the end we need to introduce the idea of a milk collection center which provides services and audit the farmer in a sustainable way. For example, we can build this hub at one of the villages and register all the farmers in this hub and provide them with these services. The farmer pays for these services.
I do not want to take any longer, but all this discussed many times with the farmers and all other interested parties, but it needs someone to adopt this idea.

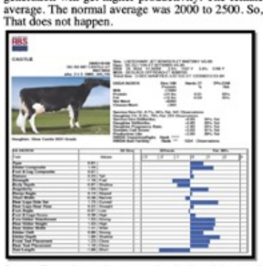
Sama: what is missing to establish this hub? Some of the companies included in this study started to improve and establish their own collection centers. So, as you clarified the difference between the center and the hub, what is missing to establish this hub? Is it fund?...

NFSA: the hub idea is applicable in the vegetables and the fruits sector. There is hub for pomegranate, for strawberry, for inspecting the pesticides in the farm. We have a company exported strawberry to the united states and they found out it contains virus A and this company paid penalty 125 million EGP to the United States. If this company paid only one million Egyptian pounds to create the hub and develop the industry and assigned an engineer to audit the pesticides and the PH and improve the sector.

Sama: can I conclude that we need financial investment or governmental support?



NFSA: No mam, today the central bank of Egypt finances all the financial investments needed with minimal fees. The whole idea is about someone dedicate to adopt this system. If I am a large dairy producer and kept this hub idea in my mind to build it, assign and expert for it and audit it myself, it can be easily done. As I am capable of building my own farm, my own collection center, so I'm capable on creating a hub. I'll provide the farmer with these services and he will provide me more quantities of raw milk. By the way, I spent 3 years to prepare this study. At that time the raw milk was sold for 2.25 EGP and the farms' raw milk was sold for 3.95 EGP. So, if the farmer spent extra 0.5 EGP on the hygiene of this raw milk, it would raise its price with over 1.5 EGP. So, he will be the winner and will earn extra 1.5 to 2 EGP. It's all about transforming the operations to economy. If you witnessed this cow's newborn. This newborn is called 'provencier' Provencher. It means he is tested on many other male and female cows to give better semen on average compared to other cows. we use something like a straw in a container filled with liquid nitrogen, if we injected this semen in the cattle, all the new generation will get higher productivity. The female cattle produce 15.000 liters of raw milk on average. The normal average was 2000 to 2500. So, this new generation has higher productivity. That does not happen.



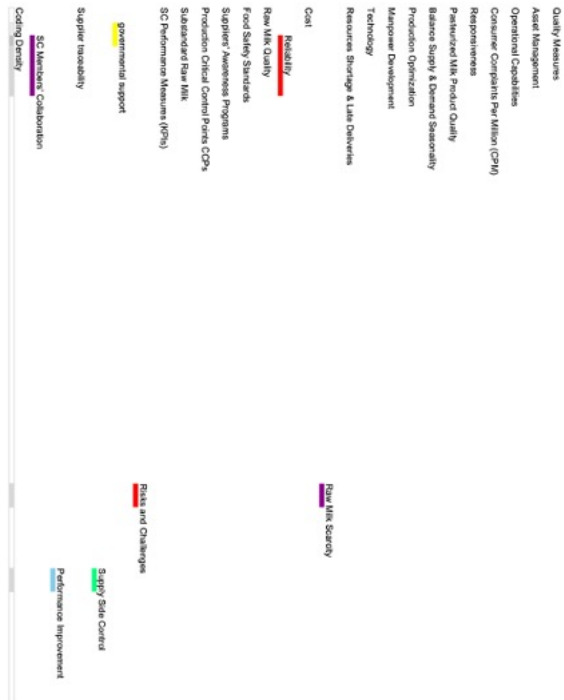
Sama: Some large farms apply similar thing to their cattle.

NFSA: what I'm discussing is not related to the large farms. They resemble only 7% of the milk production in Egypt. I'm speaking about the rest.

Sama: which authority can take this initiative based on your recommendation?

5. What is the direct impact of applying these performance measurements (KPIs) on the dairy producers?

NFSA: There is no such authority to do this. We need someone from the private sector to build this idea. For example, the chicken industry in USA. If I build a farm for chicken in USA, nobody slaughters the chicken at home or at the farm. So, they need to take it to slaughterhouse. This Slaughter investigate the source of the chicken, the auditor… it's not about the government, it is about the know-how, the feeding… All this is the responsibility of the company to raise the milk… Who sell the milk in New Zealand? It's all an association system until the factories. It is all a unified system. The private sector needs to do this. It is not the responsibility of the government. For example, the ministry of agriculture cannot do it and they do not know how to do it.
Being the national food safety authority, I assess the milk after it gets produced from the cattle's udder not inside the cattle itself. We have two options to control this earlier stage; either to blame



the responsibility on the ministry of agriculture, and they won't do anything about it, or we implement it ourselves. By ourselves I'm referring to the dairy producers' community.

Sama: Anyone would like to add to Dr. [redacted]? Or have an idea how to implement this hub?

MA: I agree with Dr[redacted] that the large dairy producers are the only way to implement the milk hub because it requires huge investments and changing the mindset. Currently, the producers are looking for the easy way. For example, as a producer, I build a milk collection center where I need 30 to 40 tons of raw milk. How to get them? I process this raw milk. The collector does not look for investments to gain himself profit on the long run for 100X. So, he created his own small collection center, and he does not look for improvements beyond the collection center. Dr. Hussein is speaking about an inclusive system, and inclusive hub which controls the cattle once born until I receive its raw milk at my factory. I totally agree with him. That it is not the responsibility of the government rather than the large dairy producers who have the knowledge but do not have the will to establish such complete system starting from the cow until the milk gets produced and of course the milk supply chain lacks this point. Because over 90% of the raw milk production is from the small farmers not the large farms and it is directed to the production of cheeses such as mozzarella, roomy, all this considered waste for the milk and it is not controlled. But I find the national food safety authority is expanding its efforts. The solution Dr. Hussein just mentioned is considered a drastic solution to the issue.
I believe the large dairy producers should collaborate to implement this idea and look for the long run rather than the short run.

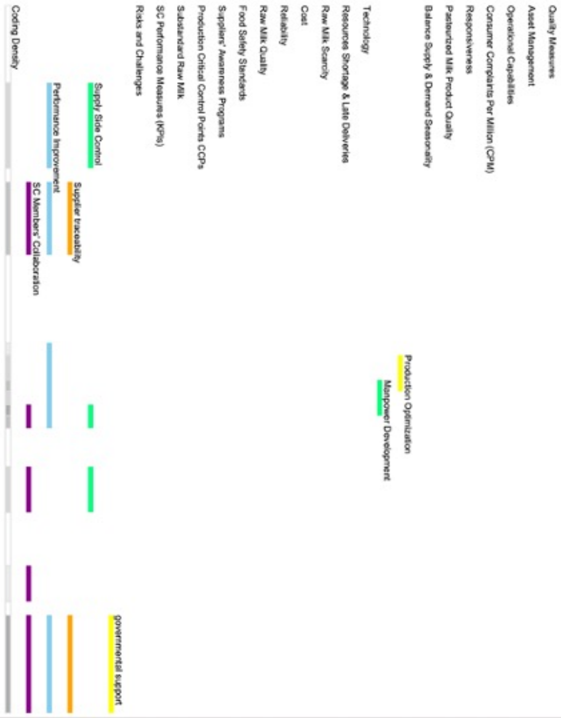
Sama: Engineers AM & AA…

AM: The hub is a great idea, according to my knowledge as JUHAYNA we started to take it from a community perspective rather than an economic perspective. At the end, I want to enlarge my collection center to include the capabilities to supply good quality milk. Such capabilities include cooling system, CIP system to ensure the hygiene of the equipment, training for the workers at the MCC or the farmers themselves. The training includes the GMP and the cleanliness of the equipment to enhance the quality of the milk from 50 or 40 million to at least 1 to 2 million only. We are working towards this goal in integration with hub idea proposed by Dr. Hussein, that will improve the performance for sure.

AA: Not really, I attended this session before for Dr. Hussein Mansour and I totally agree with him on the hub idea. But, if I'm speaking from a producer's perspective, I do not get milk from collection centers from the beginning of establishing the company. We do not accept raw milk from collection centers. We rely only on our own farm's productivity. This option is not valid for everyone. We have enough investment, but it is not an option for other producers. I find the hub idea is brilliant.

Sama: Do you find the Hub idea will benefit the supply chain in terms of reliability, responsiveness, agility, cost, and asset management?

NFSA: This will benefit the milk exchange culture around Egypt as a whole. The TetraPak packaged milk and milk used for production and other large dairy companies takes raw milk from those collectors. Some companies solved their issues and managed their business and that's it, but we are speaking about a whole system. We need to investigate the sources of raw milk used by those laboratories. The supplier zero should be registered at the national food safety authority to enable us to have full traceability from the farm until the products. It is changing in the mindset not only in the milk. For example, we need to trace if the oranges or the strawberry has added pesticides. To know such information, you need to get a step further back. This step will be backed up with some responsibilities. For example, the company will assign one million EGP and a vet to supervise this hub and arrange with a bank. So, the hub will cover its own expenses. I'm not obligating the producer to pay extra for any farmer. In contrary, the farmer will take the service cheaper than before. All he needs is a feeding storage unit with blenders to



composite the feed and make it ready for the farmer to come and buy it. This primary financial push comes from the central bank of Egypt and he approves that. So, on a personal level I support anyone who is willing to adopt the hub idea for implementation.

Sama: So, I can conclude from what you are all saying that the hub idea will solve the dairy chain in general?

MA: I agree, but you are changing the mentality of the people. The hub idea needs an initiative from one producer and the rest will follow. It is a drastic solution to the issue.

NFSA: Eng.MA it will take time, but I'll support you by another way. For instance, the hub creator will take advantage to belong to the whitelist, assist him in the exports and give him other privileges. We will give opportunities at the beginning then goes for punishment for those who do not achieve this. I do not prefer to start with the punishment. It is the last option if someone abstain to improve.

MA: It is really great all what you are saying. But what I am saying, it will yield benefits on the long run. But for the short run the benefits will appear individually on the producer who took the initiative. Like the milk collection centers improved only on the past three years after the currency [redacted]on and the increasing prices of raw materials. All other dairy producers got encourage[redacted]d their milk collection centers. That will change the milk culture. I have visited many centers in the past 17 years. The reality is much worse than the photos which Dr. Hussein is previewing, and the total bacterial count totally changes according to changing the shift operator. One operator understands his job and his responsibilities and the other don't.

NFSA: exactly!

MA: That's why I'm saying this idea is brilliant and realistic and will add to the milk chain.

Sama: anyone else would like to add anything?

AM and AA: No.

Sama: If we assumed there is an investor who will create the hub does it match the application of the proposed KPIs in this table in fro[redacted] we restructured them and consequently their overall performance?

NFSA: Yes, you asked this question several times. And all the times we will answer of course yes. We can summarize the answer in three words: a hygiene source of raw milk at supplier zero. To ensure the hygiene source of raw milk, he should increase his productivity, be economic, belong to economical institution, reduce his cost. So, the ultimate goal is to have a supplier who sells good quality milk. If you are seeking traceability and found a cow drinking from 'masraf', the antibiotics, the bacterial total count, salmonella… by the way we spoke about the total bacterial count only and we did not mention any other problems.

Sama: So, to conclude, we agree that the major source of risk goes around the supply side specifically and the three KPIs indicated in the table with the details we discussed today.

NFSA: in the year 2010 we tried to convince the EU to import powdered milk from the countries they determine for us and we will produce the dairy products and export it back to them, but the EU refused. They said you do not have cattle hygiene. The whole story is not about focusing only on specific part of the chain rather than the full chain.

MA: Again, I want to link it to your study by taking a step back, you are focusing on the operational and the supply chain KPIs for the dairy industry. So, let's focus on the variable cost. The raw milk takes the major percentage of the variable cost. If we are dividing the cost to fixed cost and variable cos, the variable cost takes 80% for the raw milk to produce milk products. So,

we need to solve the major cost issue regarding the hygiene and food safety to solve the milk problems. The second part related to the operations which is included in your table I have few comments to add to rearrange them between the supply chain and operations. One part to solve the raw milk supply issue which will solve huge problem and the second part related to the operations and each one of us will give you his experience based on his specialty. As you know, my PhD research which I'm working on is about the lean supply chain management and its variables related to your topic. So, you can share your table with us to save time and return it back to you with rearrangements.

Sama: Thank you Eng. MA. Based on our discussion today, have I missed anything which needs to be considered and concluded, not picked up by the interviews or this focus group?

AM: Sama, we have not spoken at all about the part after production until it reaches the consumer. Is it at your research scope? I can't note any KPI for this part except traceability.

Sama: As I showed you in the beginning my research scope focuses on the supplies and the operations specifically. I am aware that there are few challenges in the distribution side and specially for the pasteurized milk not the UHT milk.

MA and NFSA: Correct.

AM: So, everything is covered based on your scope. As Eng. MA mentioned, we might need few rearrangements for the factory and each element classified under its own pillar and that's it. Other than that, all seems good.

Sama: Dr. Hussein…

NFSA: All seems great, and you triggered a very important issue in the last part mentioning the pasteurized milk. There is a very limited amount of production of pasteurized milk in Egypt. The majority of milk production is sterilized TetraPak milk. Both are totally different stories. May I leave now?

Sama: Sure.

NFSA: Thank you very much for the invite. I was pleased to meet you all and hope to hear good news from you all.

Sama: Ok, anyone would like to add anything…

MA: Dr. Sama I believe it would be better if you send us the table and let us think about it and send it back to you.

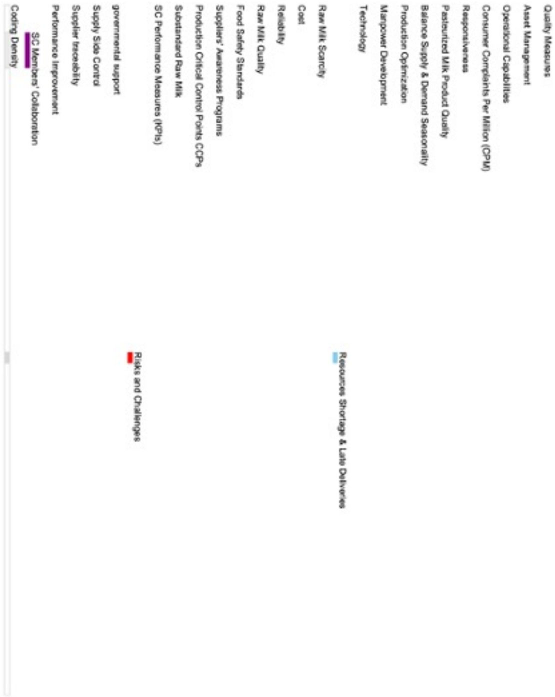
Sama: Sure. I do not want to take any longer of your time more than the hour.

MA: No do not worry about it I can stay for 2 to 3 hours I do not mind. But we could give you better feedback if you shared the table with us. I believe 80 to 90% of us will have a similar arrangement for the table.

Sama: Yes. As I told you earlier, this is the outcome of 17 interviews from different departments, quality, production, supplies. That might lead to mixed answers which I want to refine with you. Who prefers to proceed now and who prefers to send me his feedback later if he do not have the time?

AM: If you send me this table today, I will send you my feedback tomorrow at noon.

Sama: Ok. Thank you.



AA: I prefer to have a look at it later and send you back if I have any addition or modification to the table maximum by tomorrow night.

Sama: Thank you very much for your efforts and your time. 1:15:12
Sama: Eng. MA are you free for few minutes to proceed?

MA: there is KPI called Safety, I do not understand this.

Sama: Some participants explained safety KPI of the products as being free of any defects

MA: Ok, we can call it food safety not just safety. The word safety might be a bit generic. Again, those KPIs for the production process, correct? Cost, time, inventory, stakeholders… Look, production utilities is classified under cost. In my opinion, Cost includes everything. We could remove the production utilities if you mentioned cost.

Sama: May I ask a question?

MA: Of course.

Sama: Some participants classified the OEE under operational capabilities and others under the manufacturing KPIs. How do you classify it better?

MA: It is KPI for sure. OEE is a target for the operation manager to motivate him achieve the degree. He should have this KPI in his evaluation. Production line efficiency is also acceptable. The participants who mentioned this might have the capabilities and referring to the efficient utilization of these capabilities. That is very realistic and the one who mentioned this sound very proficient. So, all the companies have production lines, but they might get defected every day and another or they take long time to produce the product.
Let's take one by one. Production line flexibility what is it?

Sama: it means using the same production lines to produce different milk products or juice. It means having the flexibility to changeover between the products using the same production lines.

MA: OK, agree. What do you mean by operating capacity system?

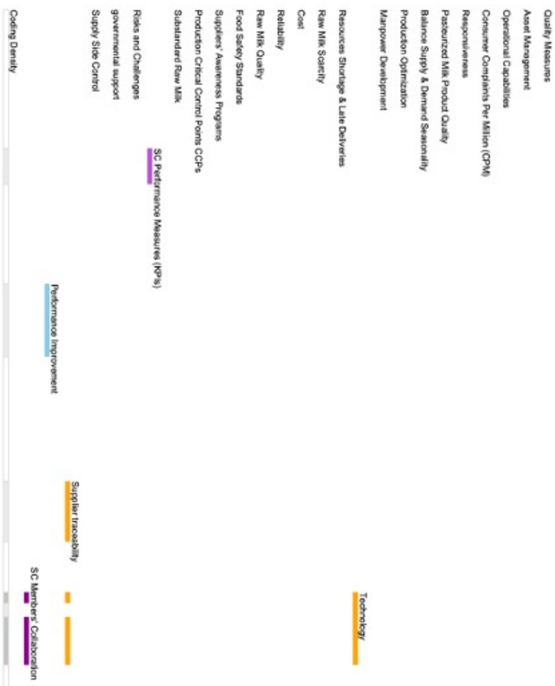
Sama: the software used.

MA: in my opinion it is not clear as an expression. You can call it ERP system or automation system. Let's say the operation capacity includes the operating capacity system and automation system or production line automation system and another point is the ERP system. You know that the ERP system links from the entry point of the raw materials until it gets into a final product state.

Sama: I did not specify the ERP because some participants mentioned ORACLE, SAP, ERP. That's why I left it system only.

MA: The ERP includes all, so you can leave it ERP instead of the operating capacity system. For example, I just installed new water production line in Siwa fully automatic operates with 4 workers only. We can call this, automation system capability. We used the ERP system in Mansour Group and made huge difference. Next, tracking system is essential. What do you mean by packaging? I do not understand it… it is non-negotiable, if I'm producing TetraPak milk we will use the same paper I do not have any interference in this.

Sama: You mean it is the default?



MA: Indeed. If I got other paper than TetraPak I'm not talking about the capabilities anymore rather than the integrity in our production. All the large dairy producers use the same packaging materials using TetraPak from Saudi Arabia or Nigeria. In my point of view, I think we need to remove the packaging from the operational capability. We can't compete based on one producer getting his packaging materials from China and the other one from Sweden. So, we will not be competing in the same market. The labor competency is operational capability for sure. What do you mean by the lead time?

Sama: the time of production from the point we received the milk until it gets produced.

MA: don't you see this related to the OEE? It is and it is related to the production line efficiency. The efficiency means, I'm calculating how many packs produced in specific time with which quality. The OEE starts from the milk entry until it gets out of the factory. I believe the lead time is dragged under the OEE. I can add…. Or remove the Lead time, the packaging, and change the capacity system. I can add something related to the owner or the stakeholders. This is an operational capability. In our case our company belongs to Mansour Group. The large producers in Egypt are JUHAYNA, LAMAR-Talaat Mostafa, Beyti under ALMarai, LABANITA under Mansour, LACTEL under Halawa, all these owners reflect in strong operational capabilities to expand their production lines and shift to fully automated production lines, train their labors and else. One more thing to add here is the strength of the supply chain.

Sama: do you mean the strength of the supply chain under the operational capability?

MA: Of course.

Sama: if I classified the supply chain to reliability, responsiveness, agility, cost and asset management. Which one best suit your terminology the strength of the supply chain?

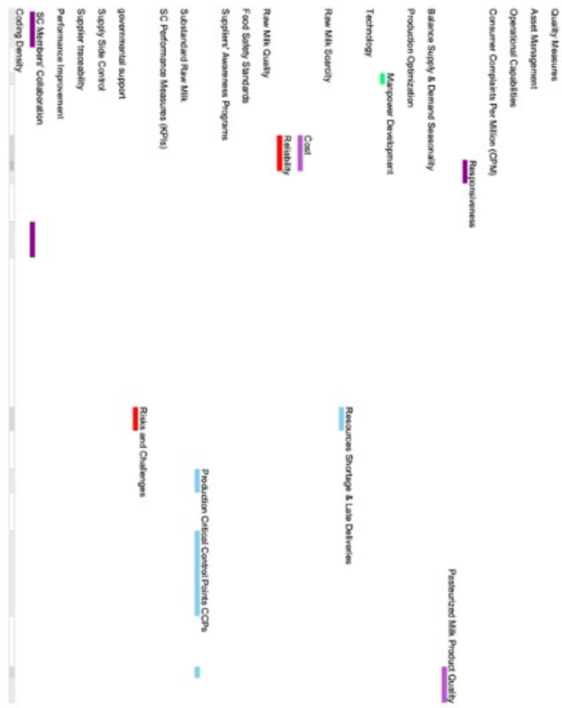
MA: I'm not sure. But you are speaking about the operational capabilities which is related to the delivery of the raw materials, the packaging materials, the services to the production lines, I'm keeping in mind all the issues we faced in the real world in the past 10 years. It happened once that the production line stopped for 15 days because the spare part delayed. Another time the TetraPak papers delayed in the shipping line which led to closing our factory and we went out of the market for a while. For example, the evergreen ship incident which blocked the Suez Canal, we had a ship waiting and delayed due to this incident. If it was delayed for two more days that would expel us again out of the market. What I want to say is the operational capabilities is very much related to the strength of the supply chain. That is the first column.
For the second column, geniuses determined those CCPs. But I want to ask about the antibiotic residues, do you mean it will be rejected as a CCP?

Sama: yes.

MA: So, ok. For the UHT filter you need to reconsult quality experts. It can be classified as OPRP. We have CCPs and OPRP. Both are measured on the production line. If the CCP is rejected this product will not get out of the factory neither reach the market. The OPRP you can note it during your operation but proceed with the production. So, in my opinion the UHT filter is not CCP. Agree on the UHT time and the rest. The holding time agree, do you mean within the UHT? That you are working ultra-heat treatment on over 130 degrees for 6 seconds this is the holding time of the product inside the equipment?

Sama: No, what you just explained is the UHT time. The holding time is the 5 to 7 days of the product before it gets released to the market.

MA: No this is not a CCP for sure. I am a food safety lead auditor but consult a quality expert for confirmation about the holding time and the UHT filter. The UHT time is definitely a CCP and can be renamed as UHT holding time. I will not negotiate about the tests for sure it is CCPs.



For the last column, the KPIs are very extensive but let's discuss them. What do you mean by the first-time release?

Sama: it means the sequential ordering of the first in first out of raw materials and products produced.

MA: So, it will be counted as a KPI for the production manager to measure his efficiency? Again, those are indicators to measure the performance, correct?

Sama: Yes.

MA: So, let's say ok. The CPMU is definitely a KPI. The production utilities are not KPI it can be production utility consumption. All those are indicators which we can measure to assess whether our operations are good or bad. Correct? So, add the word consumption.
What do you mean by stakeholder service level agreement?

Sama: it means how far your local and international suppliers are committed to fulfilling your orders. For example, you as Mansour Group you have your own fleet. So, you do not outsource fleet…

MA: No, we do during Ramadan for example. Yes, I agree in this stakeholder if it is explained.
The labor productivity dragged under the OEE. Again, the OEE we measure it based on the full production line with its labor and the factory manager. For example, this line produces 5 tons per hour, you produced 4 tons and 200, why? Your target which is the OEE should be 4 tons and 800 over the 5000 it means 99 or 98% including the labor, the equipment and everything related to the factory. You can leave it as it is, but in my point of view it is similar to the OEE.
Quality of the final product? Okay agree. The defects per million are inside the factory and the complaints per million which is coming from the market… Okay this is very good and related to the six sigma…. Safety, make it food safety or final product safety. How to you measure the safety?

Sama: the cap instalment the sleeve sealing…

MA: all this related to DPMU. So, the products safety can be measure by the DPMU and the CPMU. So, it is measured several times earlier…. Cost better be written operational cost…. Time, again time is related to the OEE.

Sama: so, the OEE is subdivided into equipment, labor, and time.

MA: Yes, last one the number of suppliers is definitely a KPI for the factory. Do you consider the supply chain is part of the operation?

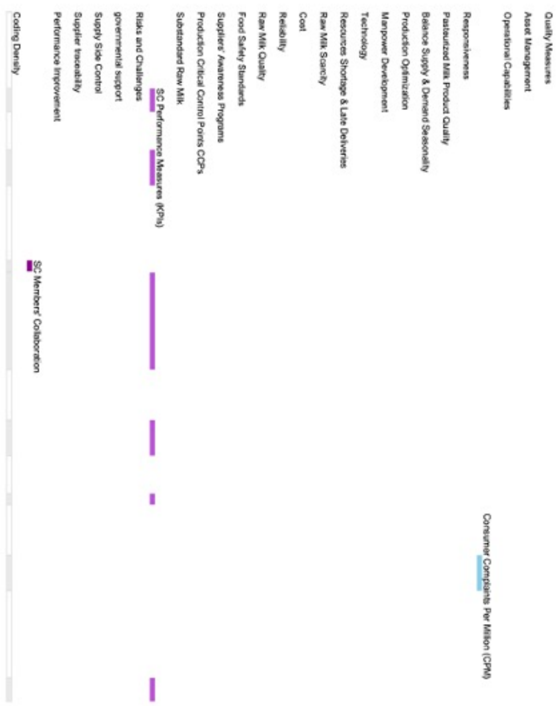
Sama: I find them interrelated.

MA: okay, so they are related. And I just told you the operations are positively correlated to the supply chain so of course anything in the supply chain will benefit the factory if I have 10 suppliers instead of only 2 that would make a difference…. Anything related to this column? The livestock, we discussed already.

Sama: anything else you want to add?

MA: anytime… if you need anything else, please let me know.

AA Whatsapp Feedback 25/4/2021:
Under the Plant KPIs, Loss in Process and Defect Per million Units are both dragged under the production waste. Part of this waste happens in the processing and calculated per liter and the



other happen in the packaging which calculated by the package. Both dragged under the same element for us.
The second column, the five highlighted elements are not CCPs, but we use them to measure the CCP. Bacterial Total Count, Antibiotic residues, Packaging tests, microbiological tests and chemical tests. For example, the packaging test is not a CCP. The CCP is the package sealing itself which we audit. Another example, the UHT temperature leads to the sterilization, so I'm monitoring the temperature by measuring it. That's why measuring the temperature is not a CCP, but the temperature degree itself is the CCP. Same goes for the tests. This is my own point of view.

AM email Feedback 26/4/2021:
Please see below the distribution of KPIs from my point of view

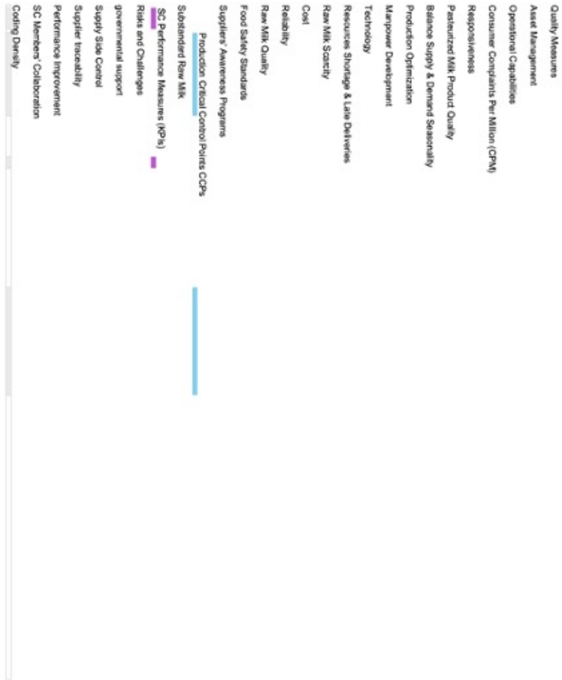
1 Operational Capabilities / Plant KPIs should merge and be like the below Table

HSE	Quality	Productivity	Cost	Delivery	Moral
TCIR	FTR%	OEE %	Material Losses	OTIF%	Leaves %
No. of Incidents	CPMU	Labor Productivity	Energy Cost	MPS Adherence	Ideas Submitted
Specific Consumption of Utilities	DPMU		Manufacturing Expenses	Out of Stock incidents	Training Hours
	Tracking Accuracy%			WH Capacity%	

2 CCPs & Live Stock KPIs are fine with me

*HSE: Health, Safety, and Environment
*TCIR: Total Case Incident Rate
*FTR: First Time Release
*CPMU: Complaints Per Million Units
*DPMU: Defects Per Million Units
*OTIF: On Time and In Full
*MPS: Master Production Schedule
*WH: Warehouse

Sama summary of MA feedback:
CCPs: remove UHT filter and holding time, then amend the UHT time to UHT holding time.
Plant KPIs: amend cost to operational cost including the production utilities consumption.
OEE includes production line efficiency, labor productivity, and time.
DPMU includes the final product quality and the food/final product safety.
Operational Capabilities: production line automation system (ERP), OEE includes lead time.



Appendix 9 **Likert Scale Analysis**

Table presents the calculations of each attribute within each company with the total average to the responses and the verbal interpretation of it.

Companies' SCOR Attributes Averaging

Company	Attribute Responses	Total Average to Responses	Verbal Interpretation	Company's Total Performance Average
Company A	RL= (5+5+5)	15/3=5	Very High	20.98/5=4.196 (High)
	RS= (5+4+5)	14/3=4.66	Very High	
	AG= (4+3+5)	12/3=4	High	
	CO= (4+4+3)	11/3=3.66	High	
	AM= (5+3+3)	11/3=3.66	High	
Company B	RL= (4+5+4)	13/3=4.33	Very High	22.32/5=4.464 (Very High)
	RS= (5+5+4)	14/3=4.66	Very High	
	AG= (5+5+5)	15/3=5	Very High	
	CO= (3+4+5)	12/3=4	High	
	AM= (3+5+5)	13/3=4.33	Very High	
Company C	RL= (4+4)	8/2=4	High	22.5/5=4.5 (Very High)
	RS= (3+4)	7/2=3.5	High	
	AG= (5+5)	10/2=5	Very High	
	CO= (5+5)	10/2=5	Very High	
	AM= (4+5)	9/2=4.	Very High	
Company D	RL= (4+4+4)	12/3=4	High	20.33/5=4.066 (High)
	RS= (3+3+3)	9/3=3	Moderate	
	AG= (5+5+5)	15/3=5	Very High	
	CO= (4+4+4)	12/3=4	High	
	AM= (5+5+3)	13/3=4.33	Very High	
Company E	RL= (5+3+4)	12/3=4	High	20.32/5=4.064 (High)
	RS= (4+4+4)	12/3=4	High	
	AG= (5+3+5)	13/3=4.33	Very High	
	CO= (4+4+5)	13/3=4.33	Very High	
	AM= (4+3+4)	11/3=3.66	High	
Company F	RL= (4+3+5)	12/3=4	High	18.65/5=3.73 (High)
	RS= (4+4+5)	13/3=4.33	Very High	
	AG= (4+3+4)	11/3=3.66	High	
	CO= (3+2+5)	10/3=3.33	Moderate	
	AM= (3+3+4)	10/3=3.33	Moderate	

The Frequency of Reliability

		Frequency	Percent
Valid	neutral	2	11.8
	high	9	52.9
	very high	6	35.3
	Total	17	100.0

The Frequency of Responsiveness

		Frequency	Percent
Valid	neutral	4	23.5
	high	8	47.1
	very high	5	29.4
	Total	17	100.0

The Frequency of Agility

		Frequency	Percent
Valid	neutral	3	17.6
	high	3	17.6
	very high	11	64.7
	Total	17	100.0

The Frequency of Cost

		Frequency	Percent
Valid	low	1	5.9
	neutral	3	17.6
	high	8	47.1
	very high	5	29.4
	Total	17	100.0

The Frequency of Asset Management

		Frequency	Percent
Valid	neutral	7	41.2
	high	5	29.4
	very high	5	29.4
	Total	17	100.0

Appendix 10 Focus Group (FG1&FG2) Word Count

Word	Length	Count	Weighted Percentage	Similar Words
milk	4	404	4.79%	milk, milked, milking
products	8	173	2.05%	product, production, productivity, products
producers	9	126	1.49%	produce, produced, producer, producers, producers', produces, producing
collection	10	113	1.34%	collect, collected, collecting, collection, collects
centers	7	103	1.22%	center, centered, centers
supply	6	94	1.11%	supplied, supplies, supply
need	4	92	1.09%	need, needed, needs
dairy	5	83	0.98%	dairy
quality	7	71	0.84%	quality
operator	8	67	0.79%	operate, operates, operating, operation, operational, operations, operator
farms	5	63	0.75%	farm, farms, farms'
time	4	59	0.70%	time, times
farmers	7	52	0.62%	farmer, farmers
point	5	52	0.62%	point, pointing, points
egypt	5	52	0.62%	egypt
chain	5	51	0.60%	chain, chains
improve	7	47	0.56%	improve, improved, improvement, improvements, improving
kpis	4	42	0.50%	kpis
large	5	39	0.46%	large
suppliers	9	37	0.44%	supplier, suppliers
development	11	37	0.44%	develop, developed, developing, development
systems	7	35	0.42%	system, systems
powdered	8	34	0.40%	powder, powdered
capabilities	12	34	0.40%	capabilities, capability, capable
companies	9	34	0.40%	companies, company, companying
factory	7	34	0.40%	factories, factories', factory
issue	5	34	0.40%	issue, issues
small	5	34	0.40%	small
cost	4	33	0.39%	cost
livestock	9	32	0.38%	livestock
nfsa	4	31	0.37%	nfsa
counts	6	31	0.37%	count, counted, counts
total	5	31	0.37%	total, totally
control	7	30	0.36%	control, controlled, controllers, controls
managing	8	30	0.36%	manage, managed, management, manager, managing
safety	6	29	0.34%	safety
import	6	29	0.34%	import, important, imported, importing, imports
performance	11	27	0.32%	performance, performing
cheese	6	26	0.31%	cheese, cheeses
planning	8	25	0.30%	plan, planned, planning
bacterial	9	24	0.28%	bacterial
ccps	4	24	0.28%	ccps
pasteurized	11	24	0.28%	pasteurization, pasteurize, pasteurized
line	4	24	0.28%	line, lines

Appendix 11 **Focus Groups PowerPoint Summary Presentation**

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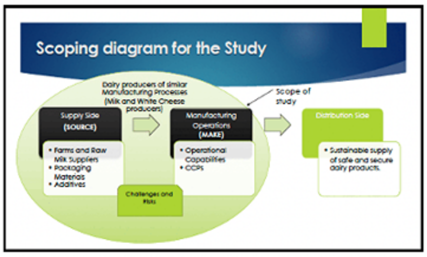

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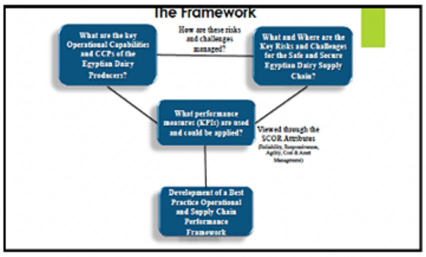

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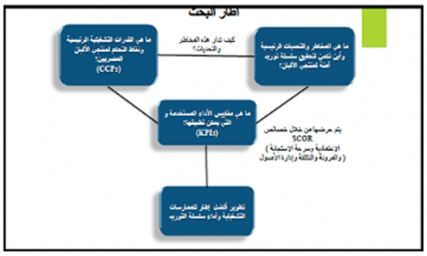

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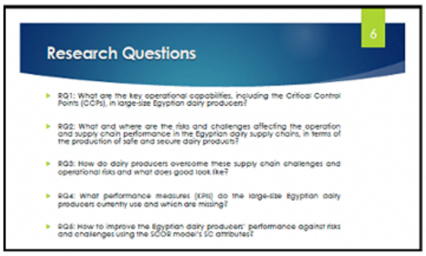

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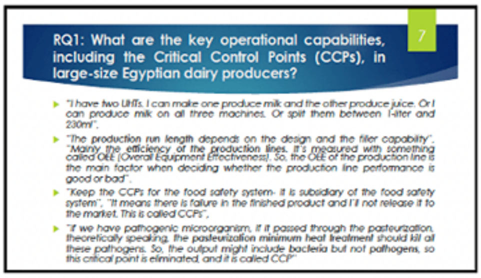

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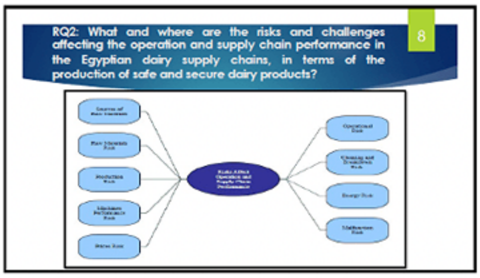

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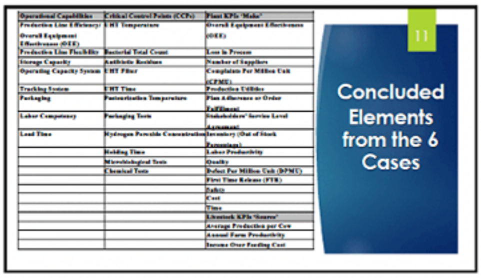

Operational Capabilities	Critical Control Points (CCPs)	Plant KPIs 'Make'
Production Line Efficiency/ Overall Equipment Effectiveness (OEE)	UHT Temperature	Overall Equipment Effectiveness (OEE)
Production Line Flexibility	Bacterial Total Count	Loss in Process
Storage Capacity	Antibiotic Residues	Number of Suppliers
Operating Capacity System	UHT Filter	Complaints Per Million Unit (CPMU)
Tracking System	UHT Time	Production Utilities
Packaging	Pasteurization Temperature	Plan Adherence or Order Fulfilment
Labor Competency	Packaging Tests	Stakeholders' Service Level Agreement
Lead Time	Hydrogen Peroxide Concentration	Inventory (Out of Stock Percentage)
	Holding Time	Labor Productivity
	Microbiological Tests	Quality
	Chemical Tests	Defect Per Million Unit (DPMU)
		First Time Release (FTR)
		Safety
		Cost
		Time
		Livestock KPIs 'Source'
		Average Production per Cow
		Annual Farm Productivity
		Income Over Feeding Cost

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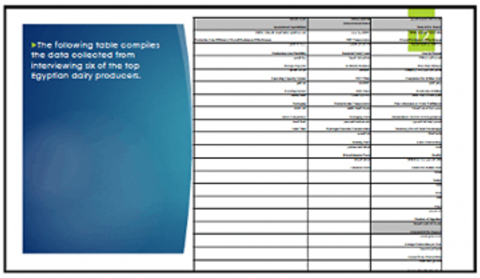

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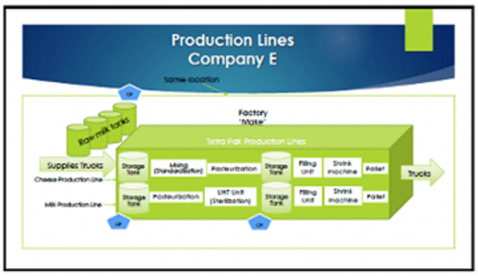
Production Lines
Company E
Same location
Factory
"Make"
Tetra Pak Production Lines
Raw milk tanks
Supplies Trucks
Cheese Production Line
Milk Production Line
Trucks

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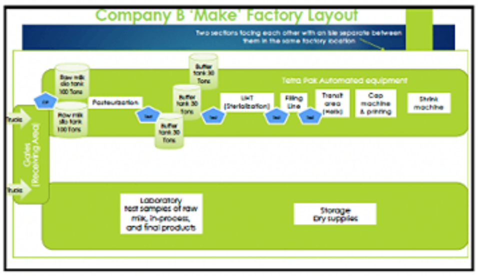
Company B 'Make' Factory Layout
Tetra Pak Automated equipment
Pasteurization
Laboratory
test samples of raw
milk, in-process,
and final products
Storage
Dry supplies

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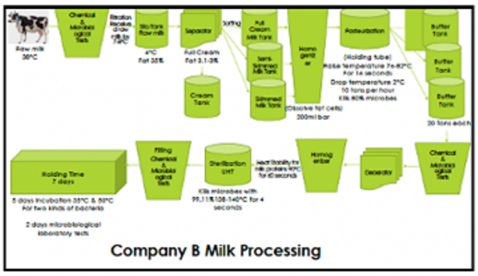
Company B Milk Processing

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