CHAPTER 2

LITERATURE REVIEW

The literature for the research is organized in three phases. These phases are described as follows:

1. Assessing customer preferences, requirements and perceptions of co-operative dairy
2. Achieving competitive advantages for co-operative dairy through market planning
3. Minimisation of distribution cost in using vehicle routing problem

2.1 Assessing Customer Preferences, Requirements and Perceptions of the Co-operative Dairy

Customer preferences and requirements are key points for every product and organization in the current competitive market. Understanding customers' requirements and preferences are dynamic and developing. This encourages the customer centric perceptive in the initial phase of product development (Rosenthal and Capper, 2006).The benefits of individual marketing-based approaches over segmentation have been greatly exaggerated. Any organisation must be carefully deliberate the diversity of consumer individual differences such as the customers' knowledge and the stability of their preferences, as well as their types of purchase and the presentation format of these (Simonson, 2005).

Consumers' preferences are always a necessary thing to know to increase product sales. Lakshmi et al., (2017) proposed consumer preference should be taken into the account during product preparation. The study suggests that people awareness should be increased through advertisements. It gives an idea of the importance of brand positioning. Rajagopal and

Rajagopal (2017) studied the fashion industry of Mexico and concluded brand image, marketing/promotions and market-knowledge/ brand awareness are important causes that can persuade consumer buying behaviour.

The attractiveness and packaging of products is also an important method of marketing. Consumers consider factors of packaging like ease of handling, colour, and shape. The research concluded that good packaging is a better way to advertise product (Raheem et al., 2014). Additionally, other research has concluded that packaging can be a good way of communicating between an organization and consumers (Ghosh, 2016). The present generation is influenced by brand name and packaging. Also, they give some attention to attractive packaging (Souček et al., 2015). Another study Valajoozi and Zangi (2016) also found that packaging attractiveness has a significant impact on consumers' preferences.

2.1.1 Assessing Customer Preferences

Deng et al., (2010) showed that customer satisfaction can be strengthened by the quality of the product, customer preferences, customer perceptions, customer values, and the services provided to the customers. Such attributes can escalate the demand for, and hence the profitability of, an organization.

Zhang and Zhang (2018) concluded that consumers' personal preferences are one of the major inductions that influence them to buy a product. To increase the sales of milk products, companies should be innovative and careful in terms of food safety. Consumer buying behaviour can be affected by various factors, so the literature suggests that consumers should be approached with the appropriate information. To survive in the market, consumer satisfaction should be the primary objective of any organization (Kurajdova and Taboreck, 2015).

Customer's preferences depend on taste, fat content, information label and quality perception (Li et al., 2018, Bakke et al., 2016, McCarthy et al., 2017, Yun et al., 2005, Robb et al.,2007). Yayar (2012) shows that income, socioeconomic and demographic factors affects the buying behaviour of consumers. Presently, consumers are willing to pay for traceability labels, quality certifications and preferable brands. Also, consumers' have different perceptions towards health and price. The price conscious customers' do not concern about food safety and health. Whereas the health-conscious customers' have less focus on money (Wu et al., 2020, Kumari et al., 2020).

The Indian dairy market is divided into two parts: organized dairy and unorganized dairy. Milk is an essential and irreplaceable product for every household in India. For milk, every consumer has their own preferences in terms of brand, availability, and affordability (Dutt and Mallah, 2015). Consumer buying behaviour or purchase intentions can be influenced by advertisement and attractive packaging. Advertisements make product evaluation and brand recognition easier for consumers. The research also illustrates that advertisements have a significant impact on consumer buying behaviour and preferences (Bharathy et al., 2015) .

The difficulty lies in extracting concrete customer requirements from non-specific preference description by customers, also called voice of the customer (Jiao and Chen, 2006). The problem is more complex in case of food products (Furst et al., 1996). Packing (Gelici et al., 2013), perceived health benefits (Jones et al., 2008), expiration-date based pricing (Theotokis et al., 2012) and various other factors are involved in influencing customer preferences (Boniface and Umberger, 2012). It is, therefore, important to gather data on customer opinion and analyse it to draw conclusions about customer preferences.

2.1.1.1 Voice of the Customers

Customers' opinions about their requirements and expectations for a product are known as the voice of the customer (VoC). This has evolved to become a methodology where customer input is gathered with the intention to use it to improve existing products and develop new ones. Since listening to the VoC is an essential first step in every product development process, a lot

of research has been done in this area (Blocker et al., 2011; Carulli et al., 2013; Fuchs and Schreier, 2011; Kapoulas et al., 2004; Mahr et al., 2014; Van et al., 2010). There are many ways to gather data from customers. Group interviews and one-on-one interviews are two methods. Griffin and Hauser (1993) carried out a comparison of these two methods and found that one-on-one interviews are more cost-effective. They also make some important observations about the number of customers needed to be interviewed to gather all the requirements. Cooper and Dreher (2010) reviewed methods used to find new product ideas and concluded that VoC methods produced the best results.

2.1.1.2 Significance Testing

Statistical techniques have been used to test the confidence of conclusions drawn from customer surveys. These include the chi-squared test, the R-squared test, the F-test, and the G-test. This is known as statistical significance testing and has been widely used for marketing research purposes (Casparis and Vaz, 1973; McDaniel and Gates, 2005; Sawyer and Peter, 1983). The basic idea is to see how well the observed data fits an assumed probability distribution, also known as null hypothesis testing. Recently, null hypothesis testing has come under criticism for being uninformative in most cases (Masson, 2011; William, 2000). The Chi-Squared Value test is particularly popular among marketing researchers and has been used since the 1970s (Casparis and Vaz, 1973; Chen and Chang, 2008; Holt et al., 1980), although it has also been misused (Franke et al., 2012). Fisher's exact test and the G-test have been suggested as alternatives (Bolboacă et al., 2011; McDonald, 2014).

$$\chi^2 = \sum_{k=1}^{n} \frac{(O_k - E_k)^2}{E_k}$$

Equation 1 Chi-Squared Value

$$G = 2 \sum_{k=1}^{n} O_k \,.\, ln \frac{O_k}{E_k}$$

Equation 2 G-Test Statistic Value

where χ^2 = Pearson's Chi-Squared value,

G = G-Test Statistic Value

O_k = Number of observations of type k,

E_k = Expected (theoretical) count of observations of type k,

2.1.2 Functional Requirements from Customer Preferences

Processing customer needs and translating them into functional requirements that can then be used to improve existing products or design new ones is an important and complex part of product development. For this purpose, a variety of methodologies have been used. Kaulio (1998) did a review of seven methods for product development. Software product line development uses various feature models to reduce the variability between products (Benavides et al., 2010).

2.1.2.1 Quality Function Deployment

Quality Function Deployment (QFD) is the best-established quality improvement and product development method. Originating in Japan in 1966, it gained attention in 1972 as a result of the quality control chart created and shared by Mitsubishi Heavy Industry (Akao and Mazur, 2003). ISO 16355-

1:2015 defines QFD as “an approach for ensuring quality throughout but not necessarily at each stage of the product development process, starting with the initial product concept” ("ISO," 2015). Quality Function Deployment has been studied extensively and numerous resources are available. It has been used for customer requirements analysis (Askin and Dawson, 2000; Brian and Teo, 2001; Chien and Su, 2003; Dijkstra and Bij, 2002; González et al., 2004; Killen et al., 2005; Wu and Shieh, 2006), product development (An et al., 2008; Cauchick, 2005; Cheng, 2003; Delice and Güngör, 2009; Kaebernick et al., 2003; Lagrosen, 2005; Vatthanakul et al., 2010; Zhai et al., 2009), quality management(Andronikidis et al., 2009; Dikmen et al., 2005; Sahney et al., 2006; Thakkar et al., 2006) and planning at various stages of the product lifecycle (Ahmed et al., 2003; Eldin, 2002; Helferich et al., 2005; Killen et al., 2005; Tan et al., 2004). The general nature of QFD has made its application possible in numerous industries including construction, education, healthcare, and software. A positive feature of using QFD is that the matrices can provide a link between quality characteristics as demanded by the consumer and the actors in the production chain (Benner et al., 2003). Chan and Wu (2002) did a thorough research on QFD, and in their review paper they gave brief history of the development of QFD. The paper also found that the functional fields of QFD are product development, quality management, customer needs analysis, product design, planning, engineering, decision-making, management and teamwork, timing, costing.

Costa et al., (2001) applied QFD to the food industry and concluded that QFD (in its standard format) seems to be more suitable for food ingredients and food packaging than for food manufacturers. Costa et al., (2001) aimed to describe the use of QFD in the context of the food industry and to discuss the benefits, drawbacks, and challenges of QFD's application to the food R&D industry. Quality Function Deployment (QFD) is the dominant approach that assures that customer requirements actually do guide product development and offer an approach that supports structuring and the representation of information on customer requirements, and especially how to link customer requirements to design characteristics (Vatthanakul et al., 2010).

A variation of QFD is Fuzzy QFD where fuzziness is applied to capture vagueness in the responses of people (Bevilacqua et al., 2006) and apply an agility context (Bottani, 2009). Kano's model has also been integrated into QFD (Matzler and Hinterhuber, 1998; Kay and Pawitra, 2001; Kay and Shen, 2000).

2.1.2.2 House of Quality

Although there are many variants of QFD, one commonly used tool is the House of Quality (HoQ) (Adiano and Roth, 1994; Bech et al., 1997; Bolton and Drew, 1991; Hauser and Clausing, 1988; Kazemzadeh et al., 2009; Köksal and Eğitman, 1998; Park and Kim, 1998; Ramaswamy and Ulrich, 1993; Thompson, 1989; Vairaktarakis, 1999). The House of quality helps with managing and prioritizing functional requirements based on customer needs. It encourages collaboration between teams across the company, including marketing, design and manufacturing, to ensure that customer's needs are satisfied. The HoQ consists of several matrices joined together that look like a house, hence the name. In QFD's four-phase approach,

the HoQ is the first matrix, also known as the Product Planning Matrix. Each sub-matrix in an HoQ is called a 'Room'. The first room in HoQ is the 'Voice of the Customer'. This room is filled with customer requirements gathered from market research with the relative weights assigned. Next, the planning room is filled with data on current customer perceptions of the company's brand and of its competitors' brands. This helps in identifying future opportunities and investment priorities. Now, the Voice of the Company room can be filled to understand how the customer requirements will be incorporated into the product while helping the company achieve its goals. The relationship room is then filled to indicate how each customer requirement is related to each product feature. Finally, the technical priorities room is filled to show the overlap between the current and the desired product. All these rooms together help in determining how much each of the desired product's features are worth. Based on the information provided by the HoQ, the product quality team can in collaboration with other teams select the most important features which will be carried over to the next phases of QFD. There are case studies in literature in which QFD and HoQ have been applied to the food industry. Costa (1996) used it for a tomato ketchup product, and Viaene and Januszewska (1999) used it for the chocolate industry.

2.1.3 Brand Value Measurement

Part of the planning room in HoQ is a comparison of the brand value of the company and its competitors. More precisely, it measures brand equity, or customers' perceptions of the brand (Moor and Lury, 2011). There are several ways to measure brand equity, including the following:

- Stock Prices Movement – Stock value may indicate future trend of brand value (Simon and Sullivan, 1993).

- Value to Acquiring Company – Financial value to acquiring firm indicates brand value (Mahajan et al. , 1991).
- Consumer Preference Rating – Measuring consumer knowledge of products and consumer preferences (Cobb et al., 1995).

There are other ways to measure brand equity but there is no agreed upon preferred method.

In an article by Chris Blank, it was stated that the intention of the buyer is to determine the points that initiate the consumer's buying behaviour. The three consumer perception areas that can be related to consumer perception are self-perception, price perception, and the perception of a benefit to quality of life (Blank, 2012). Jin and Gu (2005) worked on a model that integrated four consumer characteristic variables: price consciousness, value consciousness, perceived quality variation, and consumer innovation. Jin and Gu (2005) compared categories of food products and home appliances. The findings for the food products category were significant for price and value consciousness, whereas for the home appliances category, the findings for price consciousness and the relative importance of perceived quality variation were insignificant.

Consumer preference and knowledge-based brand equity measurement has seen considerable usage in the literature as shown by Christodoulides and Chernatony (2010). "Aaker (1991) identified the conceptual dimensions of brand equity as brand awareness, brand associations, perceived quality, brand loyalty, and other proprietary brand assets such as patents, trademarks and channel relationships" (Christodoulides and Chernatony, 2010). Park and Srinivasan (1994) explained a method to measure brand equity based on customer surveys and define brand equity as "the difference between an individual consumer's overall brand preference and

his or her multi-attributed preference based on an objectively measured attribute." The statistical process used by Park and Srinivasan (1994) is complex and ,therefore, not easy for marketers to use.

2.1.3.1 Brand Value Comparison

Comparing brand value helps a company know its position among competitors. Multidimensional scaling (MDS) is a widely methodology for this purpose (DeSarbo and Hoffman, 1987; Green, 1975). Multidimensional scaling is a class of methods that provide visualizations of the similarity of sets of data. Since there are various attributes that contribute to brand value, MDS is a good fit for visualizing brand value comparisons. Borg and Groenen (2003) provide a good overview of MDS method types.

Multidimensional scaling is an advantageous technique for market researchers because it produces an invaluable "perceptual map" revealing like and unlike products, thus making it useful in brand similarity studies, product positioning, and market segmentation (Cowles, 1989). Multidimensional scaling can be helpful to identify market competition structures and characteristics of products by which consumers' wants can be understood. Also, through MDS, market opportunities can be determined by analysing consumers' ideal points and competitor brands' relative positions based on which marketing strategies can be established (Jeong and Kwon, 2016). Many different models of MDS have been used by marketing researchers, depending on the factors they want to account for. For example, DeSarbo and Hoffman (1987) used a gravity-based MDS model to account for the effects of existing market share on brand value.

2.2 Achieving Competitive Advantages for Co-operative Dairy through Market Planning

Marketing is a technique to communicate with customers and advertisement is a tool for marketing to reach a maximum number of customers. According to the American Marketing Association "Marketing is an organizational function and a set of processes for creating, communicating, and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stake holders" (Kotler and Keller, 2006). Marketing can be defined as giving customers what they want, at the right price, at the right location, and with the right kind of promotional information (Burgess and Steinhoff, 1993).

The effectiveness of any marketing or business can be judged by their loyal and satisfied customers. A change in market conditions and competition is persistent, so effective communication and commitment to customers should be measured correctly(Aktepe et al., 2015).

In customer satisfaction, the competitive advantages and reputation mediate the firm's performance and corporate social responsibility (Saeidi et al., 2015). Currently, for effective market communication and creating strong brands, Internet use is adapting by companies and electronic word-of-mouth (eWOM) is considered valuable for marketing decisions. It is used as a channel to provide information to customers and to connect stockholders. It can be done via digital or interactive firms, thereby maintaining, or reinforcing high levels of digital marketing usage and various kinds of social media interaction to increase the usage of digital marketing. All efforts in this domain should lead to greater engagement, stronger relationships with customers, and greater subsequent customer engagement. Therefore, social interaction affects customer satisfaction and experiences (Nieto et al., 2014; Srivastava and Kaul, 2014; Tiago and Veríssimo, 2014).

At present, advertisement can be divided into two categories: first, the traditional way (TV, print, radio, public transport, radio), and second, the advanced way (social media, web, e-mail, blogs, FM radio) (Zolfani et al., 2012). Television commercials are a mode of advertisement that influences consumer buying behaviour in a crucial way. Four variables – trust, repetition, message, and consumer mood – have direct and indirect effects on consumers' buying behaviour (Khuong and Nguyen, 2015). Due to frequent changes in technology, there are lots of ways to know consumer buying behaviour. Promotion through various market channels, availability of the product in the market, and a high degree of awareness can establish a positive perception of a product (Sumathi, 2015).

Social media like Facebook, Instagram, Twitter and YouTube are gaining popularity in every age group, and much time is spent browsing such applications. Google ads are another medium to advertise products, services, and applications. Currently, campaigning via sharing and tagging a message in different platforms is common with large organizations (Rutsaert et al., 2013). There are other advertisement mediums too, like billboards (Lindstädt and Budzinski, 2011; Rothschild, 2004; Schönböck et al., 2008), newspapers (Kaplan et al., 1991; Khatri, 2016; Lindstädt and Budzinski, 2011; Mogaji, 2015), and public transportation ads (Amine and Cavusgil, 1983; Veloutsou and O'Donnell, 2005).

Advertising is one of the most common marketing tools, and several studies have been done on its effectiveness on sales. The advertisement of a product's quality and its promotion often play a critical role in the success of product on the market. Several studies (Crosby, 1985; Deming and Edwards, 1982; Kalish, 1985) have considered the relationships among basic strategic variables such as quality, price, profitability, market share, advertising expenditures,

and customer services. Kalish (1985), introduced a framework for innovation that includes price and advertising. In judging the quality of a product, consumers use information from advertising, price, and brand name (Olson, 1977).

Advertisement greatly affects consumers as consumers perceive exceedingly advertised brands as better (Chioveanu, 2008). Consumers perceive a correlation between advertising expense and quality in some markets (Kirmani and Wright, 1989). Kirmani and Wright (1989) found that perceived advertising expense affects quality expectations. They examined the role of advertising expenditures as signals of quality. In his research Piga (2000) said that it is necessary to consider the combined effect of product quality and advertising, in determining how a brand can improve its quality but, at the same time, limiting a drop in price by investing in advertising.

Upcoming sub-sections discuss the literature on the methods used in Chapter 4. Delphi methods, Analytic Hierarchical Process (AHP) and System Dynamics (SD).

2.2.1 Delphi Method

The Delphi method is a widely used and well-established method in research for classifying a problem and selecting the outcomes through a decision-making process (Chan et al., 2001; Meyrick, 2003; Hsu and Sandford, 2007; Yousuf, 2007).

In the late 1940s, the RAND corporation considered expert opinions for a study. The corporation published the study, valuing the reasoning of a group of experts (research area) over individuals (Kaplan et al., 1949). To accomplish the primary purpose of the Delphi method, an exhaustive questionnaire was interspersed with feedback to get a consistent consensus of a group of experts (Dalkey and Helmer, 1963).

The Delphi method can be used to get constructive input from a group of experts and organize their communication to identify the solution to a problem (Linstone and Turoff, 1975). The Delphi process is a repetitive process and questions can be asked more than once to get the final consensus of the experts. Anonymity must be maintained by the group coordinator to avoid negative influences and conflicts. The feedback of the questionnaire should be rechecked to eliminate redundancies and irrelevant input (Landeta, 2006).

The Delphi method has been used extensively in various field for more than 50 years. It is a versatile tool for research (Okoli and Pawlowski, 2004; Sumsion, 1998), forecasting (Chou, 2002; Rowe and Wright, 1999, 2001; Weaver, 1971), and strategic management (Brouthers et al., 1998; Ginter and Duncan, 1990; Loo, 2002).

Application of the Delphi method can be observed in supply chain management (Akkermans et al., 2003; Lummus et al., 2005; Seuring and Müller, 2008), health care (Adler and Ziglio, 1996; Meyrick, 2003; Oranga and Nordberg, 1993), tourism (Chen, 2016; Konu, 2015; Lin and Song, 2015; Taylor and Judd, 1989), the food industry (Birdir and Pearson, 2000; Gevers et al., 2014; Henson, 1997; Wentholt et al., 2009), and marketing (Borden et al., 2017; Kerr and Patti, 2015; Warner et al., 2016).

The modified Delphi method, where participants are not required to work face to face, is a new version. The use of a modified Delphi is also found in healthcare (Eubank et al., 2016; Rognstad et al., 2009; Uphoff et al., 2012) and other industries like fashion and pharmaceuticals (Brinkman et al., 2018; Chiu et al., 2018)

The Delphi can also be used with the AHP (Byun, 2001; Kim et al., 2013; Tang et al., 2014; Vidal et al., 2011), the fuzzy analytical hierarchical process (FAHP) (Cho and Lee, 2013; Hsu et al., 2010; Tang et al., 2014), and the AHP with a technique for order of preference by similarity to an ideal solution (TOPSIS) (Emovon, 2016; Liang et al., 2018; Sekhar et al., 2015).

From the literature, it can be understood the Delphi is a proven tool for decision-making. Therefore, in our study, the combination of Delphi with AHP seems suitable for the selection of low-cost advertisement channels.

2.2.2 Analytic Hierarchical Process (AHP) Method

The Analytical Hierarchy Process (AHP) is one of the most widely used analytical techniques for complex decision-making problems. It was developed by T. L. Saaty in 1980. It is a multi-criteria decision-making method that decomposes a decision-making problem into a system of hierarchies of objectives, attributes (or criteria), and alternatives.

Its usage has increased over the years due to its ease of application. The AHP is composed of three basic steps: decomposition, comparative judgments and the synthesis of priorities (Ossadnik et al., 2016) and it can be done by first decision problem modelling/structuring, then valuation and aggregation of weights and finally sensitivity analysis (Ishizaka and Labib, 2011).

The complexity of the decision problem controls the number of levels of main criteria and evaluation criteria. In AHP hierarchy can have as many levels as needed to fully describe any decision situation. Several functional characteristics make AHP a useful methodology. This includes the ability to handle decision situations involving subjective judgments and, multiple

decision makers, and the ability to provide measures of consistency of preference (Triantaphyllou, 2000).

The use of AHP has been found in different areas of research. It is used in real-world applications like e-commerce (Yu et al., 2011; Zhang et al., 2012), industry (Barbosa and Gomes, 2015; Shen et al., 2015), health (Hillerman et al., 2017), waste management (Kim et al., 2013), supplier selection (Awasthi et al., 2018; Mani et al., 2014; Peng, 2012), risk management (Dong and Cooper, 2016), renewable energy (Balo and Şağbanşua, 2016; Kaya and Kahraman, 2010) ,water resources management (Karahalios, 2017; Xiao, 2010), sustainability assessment (Barbosa and Gomes, 2015), and marketing management (Durmuşoğlu, 2018; Riahi and Moharrampour, 2016) .

Delphi-AHP has also been used in number of studies of waste management (Kim et al., 2013), reverse logistics(Bouzon et al., 2016), industry (Delbari et al., 2016; Tang et al., 2014; Vidal et al., 2011), product evaluation(Cho and Lee, 2013), project evaluation (Vidal et al., 2011), and technology selection (Hsu et al., 2010). Although there are other selection methods, AHP is better in terms of identifying the priority of group of alternatives with relative importance to the attributes (Wei et al., 2005).

2.2.3 System Dynamics Modelling

In the 1960s, Jay Forrester developed a branch of system dynamics that focused on organizational change. It was the starting point of associated systems thinking within the context of an organization. He identified that all complex systems contained feedback loops. The decisions being made were within the context of those feedback loops. This was the start

of a completely new discipline: systems dynamics (Forrester, 1968). Hence, the fields of systems dynamics emerged.

System modelling is another framework for system dynamics methodology. JW Forrester analysed a traditional Supply Chain and observed how a small change in a customer's demand pattern amplified as it flowed through distribution, production and replenishment processes. Often, it comes out that a simulation model may reproduce some aspects of the reference behaviour and other pieces of evidence but not all of them. In that case, the model, and perhaps the dynamics hypothesis itself, must be revised and tested again and again until it is found to be fully consistent with available evidence and logical considerations (Homer, 1996).

Coyle (1977) considers a case of a company having two departments: Distribution and manufacturing. The former holds a stock with which to meet sales and replenishes the stock by placing orders to the manufacturing department. The manufacturing department adjusts its productions against the backlog of unfilled orders, delivering the finished goods to the distributor's stock after a delay.

Sharma and Mohapatra (1985) worked to design a new policy with which the desired behaviour can be improved in "Policy Design in System Dynamics Models". Another study Lee et al., (1997) identified how sales related demand distortion due to the Forrester effect or Bullwhip effect was amplified even more because of the following effects which may even show simultaneously in the Supply Chain: order lotting, product price fluctuation, rationing and a lack of finished products. The combination of these four elements leads to the amplification of the variance in the product demand. This amplification of demand,

which increases further from the end customer and into the Supply Chain, is called Bullwhip effect.

Lee et al., (1997) studied demand information flow and proposed, a theoretical framework for the effects of systematic information distortion through the Supply Chain. The ability of system dynamics simulation to handle soft variables has been demonstrated repeatedly, and across a remarkable breadth of applications in management (Forrester et al., 1976).

The system dynamics approach can be used in marketing (Graham and Ariza, 2003; Hibbert and Wilkinson, 1994; Rand and Rust, 2011), policy decision (Coyle, 1985; Ghaffarzadegan et al., 2011; Mohapatra and Sharma, 1985) , the supply chain (Angerhofer and Angelides, 2000; Georgiadis et al. 2005; Vlachos et al., 2007), tourism (Bonetti et al., 2006; Pattersonn et al., 2004; Selin and Chavez, 1995), healthcare (Brailsford, 2008; Lane et al., 2000; Samuel et al., 2010) and manufacturing (Baines and Harrison, 1999; Ghalayini et al., 1997; Sabuncuoglu and Hommertzheim, 1992).

2.3 Minimisation of Distribution Cost Using Vehicle Routing Problem

In the introduction it is described that operations in the market of the co-operative dairy under study were reduced gradually, for over 35 years. The total sales declined from 20,000 to 8000 litres per day from 2010 to 2017. The literature in this section deals with the minimisation of distribution costs using the Vehicle Routing Problem (VRP) method.

In the supply chain, improvement in supply chain performance and supplier-buyer integration is an important aspect. This aspect can be enhanced by finding an optimal route for distribution. Such problems are dealt with using the Vehicle Routing Problem (VRP) method. The primary

focus of VRP is to identify the routes of vehicles for the distribution of goods, to meet customers' demands at minimum cost. Traditionally VRP introduced by Dantzig and Ramser (1959) the algorithm was a generalization of "Travelling-Salesman Problem (TSP)".

The final step in the lifecycle of consumer goods is the delivery to consumers, retailers, and distributors. The aim is to keep distribution and delivery costs at a minimum since they affect the per-unit product cost. This problem is dealt with in the larger research area of Supply Chain Management (SCM), specifically in the area of logistics. There is some confusion about the similarity of SCM and logistics management, so we will go over the definitions of both.

2.3.1 Supply Chain Management

Mentzer et al. (2001) defined SCM as "the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole." As per this definition, SCM includes marketing, R&D, Production, Procurement, Sales, Logistics, and several other parts of the business.

2.3.2 Logistics

The Council of Logistics Management (CLM) defines logistics as the "part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point-of-origin to the point-of-consumption in order to meet customers' requirements" (Lambert and Cooper, 2000).

The importance of logistics comes from the fact that everyone wants their products as soon as possible. An efficient and flexible logistics system can help a company gain an edge over its competitors. Contrary to the belief of some people, increasing the performance of logistics does not necessarily mean increases in operational cost. Logistics performance can be improved without increasing total cost by minimizing non-value-add activities (Stewart, 1995).

Cost savings through improving logistics has been studied widely and applied to dairy industries all over the world. Cegiella et al., (1986) used a Vehicle Scheduling Problem (VSP) model to optimize milk collection systems for Polish dairies. Coltman, Schnitkey, and Miranda (1994) showed that rescheduling milk collection itineraries can result in cost savings. These are different ways of optimizing vehicle routes and have been studied extensively due to their importance in most industries. This is commonly known as the Vehicle Routing Problem, in which the best route to visit a set of locations has to be found.

2.3.3 Vehicle Routing Problem (VRP)

The Vehicle Routing Problem (VRP) is a generalization of the Travelling Salesman Problem (TSP). The goal is to find a set of shortest routes to visit a given set of locations using a fleet of vehicles. It is the most widely studied problem in combinatorial optimizations. Exploring all possible sets of routes to find the cheapest ones is not feasible for many locations. For example, there are 87,178,291,200 ways for a single vehicle to visit just 14 locations. This was formulated by Dantzig and Ramser (1959) who called it the Truck Dispatching Problem.

Exact methodologies to solve VRP can be classified into the following categories (Laporte, 1992) :

- Direct Tree Search Algorithms

- Dynamic Programming
- Integer Linear Programming:
    - Set Partitioning Formulations
    - Vehicle Flow Formulations
    - Commodity Flow Formulations

Exact methods involve intensive formulations and the algorithms used explore all possible solutions to find the most optimal one. Since the VRP problems are NP-Complete, the computational complexity increases exponentially. Depending on the dimensionality of the problem, the computing time might range from minutes to days. For problems with more than 50 customers, exact methods fail to consistently find the optimal solution.

Due to the high cost associated with exact algorithm, several heuristics methods have been used to solve VRP (Clarke and Wright, 1964; Fisher and Jaikumar, 1981; Gillett and Miller, 1974). Recently, meta-heuristic methods have gained popularity. Meta-heuristic methods trade computation time for accuracy. They usually start with an initial sub-optimal solution and iteratively optimize it to obtain an optimal solution, which may not be the best solution. Some popular ones are:

- Tabu Search Algorithm (Sabuncuoglu and Hommertzheim, 1992)
- Simulated Annealing (Kirkpatrick et al., 1983)
- Genetic Algorithm (Thangiah et al., 1991)
- Ant Colony Optimization Algorithm (Dorigo and Caro, 1999)
- Arc Routing (Dror, 2000)

SCM: As the world progress, the complexity of supply chain is also getting complex. Presently, researches are also focused towards sustainable supply chain. Sustainable Supply Chain Management (SSCM), integrates environment, social and economic concerns to organisation's supply chain process (Koberg and Longoni, 2019; Rajeev et al., 2017; Varsei, 2016). Gurtu et al., (2017), discussed extensively about sustainability in global supply chains i.e., the influences and benefits of sustainability in supply chain with the factors affecting the sustainability of supply chain.

Logistics: Logistics works different for food supply chain, Sharma et al., (2019) analyses the challenges of sustainable food supply chain. Jouzdani et al., (2018) did a study on dairy industry with Robust Supply Chain Network Design (RSCND) considering multiple products, transportation modes, time-window, cost, demand and supply.

VRP: The VRP is NP-hard (Lenstra and Kan, 1981) which means it is at least as complex as the most complex problems in NP. The complexity of a brute force solution would be O(N!) and therefore it is not practical to use it for solving large-sized VRP problems on commodity computer hardware due to the amount of time it would take to find a solution. This has led to evolution of 3 classes of methods, exact, heuristic, and approximation. While exact methods guarantee to find the best solution of a given VRP, heuristic methods, sometimes also referred to as approximate (not to be confused with approximation) methods Laporte (1992), try to find an optimal solution. Approximation methods, although like heuristic methods they find an optimal solution, they also guarantee that the solution will be within a known range around the best solution.

Approximate methods for solving VRP are relatively limited in number due to the complexity of VRP. These algorithms often place some restrictions on the VRP to be able to provide an approximation range and polynomial order runtime (Van and Slugina, 2020; Gupta et al., 2012). Some approximate algorithms are:

- Christofides-Serdyukov Algorithm
- Double-Tree Algorithm
- Randomized Algorithms

There are several variations of the VRP, such as Vehicle Routing Problem with Time Windows (VRPTW), Vehicle Routing Problem with Pickup and Delivery (VRPPD), Capacitated Vehicle Routing Problem (CVRP). Each real-world case of VRP has many restrictions and VRP models must be adapted to accordingly. For example, there can be restrictions on time window, vehicle capacity, distance per vehicle, vehicle count and vehicle type; and there can also be multiple depots within the same distribution network. Computational complexity increases with these real-world restrictions. In the case of perishable goods like fruits and dairy, time is a very important factor and, therefore, heuristic and meta-heuristic methods are preferred for large distribution networks with hundreds of delivery locations or more.

Haimovich and Rinnooy (1985) used Region Partitioning (RP) to solve CVRP. The benefit of partitioning is that it can reduce computational complexity and produce better results. Several hybrid strategies have been developed that combine local search algorithms with TSP solution algorithms (Aarts and Lenstra, 2009).

Courier companies have to deal with CVRP with variable delivery and pick demand. Bertsimas and Ryzin (1993) studied several a priori strategies for this type of CVRP and found that static vehicle routing methods can be adapted to get near-optimal results for dynamic vehicle routing problems. Pavone et al., (2009) used partitioning with Voronoi diagrams to solve dynamic CVRP.

The cheapest-link algorithm (CLA) is also used for solving the VRP. This algorithm involves a graph with numbers assigned to the edges(Larsson and Patriksson, 1995). The numbers represent the weights of the edges. This algorithm leads to a Hamilton circuit. In this research, the VRP was solved using the CLA.

The CLA is defined as an idea to piece together a tour by selecting the separate links of a tour by cost. It does not matter if the links in the intermediate stages are all over the place. If one is careful, the links all come together at the end and form a tour. This algorithm works by choosing the cheapest edge of the graph, whichever edge it may be, after which the next cheapest edge of the graph is selected. From there the process of selecting the cheapest edge available continues. This step is completed while ensuring that a circuit does not develop at the very end and that no three edges converge at a vertex (Tannenbaum, 2013).

2.3.4 Vehicle Routing for Perishable Products

Items that have a short life before they become unfit for use are referred to as perishables. Dairy products, fruits, and blood are some examples of perishable items. The restrictions related to the delivery of perishable products can be characterized by Capacitated Vehicle Routing Problem with Time Windows (CVRPTW). Federgruen et al., (1986) and Malandraki and Daskin (1992) formulated these restrictions. Several heuristic algorithms have been proposed for routing pickups and deliveries of perishable goods (Chen et al., 2009; Govindan et al., 2014; Hiassat et al., 2017; Hsu et al., 2007; Le et al., 2013; Osvald and Stirn, 2008; Prastacos, 1984; Song and Ko, 2016; Soysal et al., 2015).

Clustering has been used extensively for CVRP with simultaneous pickup and delivery (CVRPSPD) (Ganesh and Narendran, 2007; Min, 1989; Salhi and Nagy, 1999; Savelsbergh and Sol, 1995). Min (1989) used a three phased approach: cluster customer locations, assign vehicles to clusters and construct the route of each vehicle. Dondo and Cerdá (2007) used

customer clustering for the multi-depot heterogeneous fleet vehicle routing problem with time windows.

2.3.5 Capacitated Clustering Problem

In the past decade, several heuristic and assignment techniques have been developed to solve the Capacitated Clustering Problem (CCP). Mulvey and Beck (1984) suggested a heuristic approach and used arbitrarily produced cluster centres as a solution to the CCP. Koskosidis and Powell (1992) expanded on the work of Mulvey and Beck (1984) by suggesting an iterative algorithm that was found to be more operative than other empirical algorithms. This algorithm does not require the specification of seed clients, as other algorithms do. Mulvey and Beck (1984) developed a distinct algorithm for seed selection instead of random seed generation. The iterative heuristic approach uses a self-correcting structure in three stages:

a) greedy assignment,
b) seed relocation, and
c) local exchange.

Thangiah and Gubbi (1993) used an original algorithm to attain a suitable cluster of customers for the HVRP with a 'cluster first and route second' algorithm. Bujel et al., (2018) used Density-Based Spatial Clustering of Applications with Noise (DBSCAN) clustering to solve the CVRP. Other researchers Osman and Christofides (1994) proposed using the tabu search and hybrid simulated annealing approaches to solve the CCP. Shieh and May (2001) applied the genetic algorithm to crack the CCP. In this algorithm, binary coded strings are used to symbolize the chromosomes, which eradicates the incidence of infeasible solutions. The chromosome is split into two fragments: one signifies

the consumers, and the other denotes the seeds of the clusters. To handle the capacity constraints, an adaptive penalty function is applied, which improves the convergence and quality of the solution. França et al., (1999) created a novel adaptive tabu search method to solve the CCP, using two neighbourhood generation methods of the local search experiment: insertion and pair-wise interchange. K-means algorithm that achieves accurate clustering does not require pre-assigning of the exact number of clusters (Žalik, 2008). In this paper, the clusters are created using the k-means clustering algorithm for solving CCP. This method seems competitive and straightforward as compared to others.

The k-means clustering method, first proposed by Mac Queen in 1967, is the most commonly used method of clustering. Hugo Steinhaus had a similar idea in 1957, and Stuart Lloyd first suggested the standard algorithm for pulse-code modulation in the same year. Scholars refer to this concept as Lloyd-Forgy because, in 1965, E. W. Forgy also published the same method. Later, Wang and Su (2011) presented an improved k-means clustering algorithm, addressing the imperfections of the conventional k-means clustering algorithm. Geetha et al., (2009) used improved k-means clustering for the CCP for better optimisation results. The algorithm develops density-based detection methods based on the characteristics of noise data by adding the discovery and processing steps of the noise data to the original algorithm. The data is processed to eliminate this noise data before clustering data sets, resulting in a significant reduction of the noise data and a significant improvement of the clustering results. Singh (2015) stated that the run-time of the k-means clustering algorithm is favourable and used several approaches to improve the k-means clustering method.