



Master's degree thesis

Choose course code LOG950

Title: Networked Hydroponics technology in Molde
Case Study: Bygartner 1

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Number of pages including this page: 104

Molde, Date 02-06-2020



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Abstract

This dissertation is based on a local hydroponics farm in Molde by name Bygartner 1. This company specializes in the production of some selected vegetables and micro greens in Molde using nutrient salts. The purpose of this dissertation is to judge whether the hydroponics technology in is a disruptive technology in the food and vegetable supply chain in molde and also to investigate if the hydroponics technology is a sustainable means of farming compared to the traditional way of farming using soil. In doing so, we also investigated how the focal company provides value to his customers.

In order to achieve the aim of the research, the researchers conducted an in-depth interview with the focal company (Bygartner 1) and three (3) of his customers. The researchers also had plans to conduct interviews with the competitors (other local vegetable and micro green) to get more information with regards to disruption, but this was impossible due to the outbreak of the COVID-19 pandemic.

After careful analysis of the data from the interviews, the researchers could judge that this technology is more sustainable than the traditional way of farming using soil. Also, with regards to disruption, this technology is still quite new in Norway and for now only best suited for the cultivation of lettuce and some microgreens. For this technology to be a disruptive innovation in the food supply chain of Norway and other areas, it will take some time to research on adapting the technology to the cultivation of other crop types like potatoes, tomatoes and many others which as of now is uneconomical according to our research.

Preface

This dissertation is submitted to Molde university college, specialized university of logistics and supply chain management in partial fulfilment of the requirements for acquiring a Masters (MSc) in logistics and supply chain management. This thesis has been supervised by Professor. Per Engelseth.

Technology, which is ever changing, is bound to bring about significant changes and innovations in different fields not leaving out hydroponics technology. New developments emerge at an ever-increasing pace, and the areas in which this happens are both diverse, yet relevant for almost every business. The intention of this thesis is to guide new entrant agricultural firms on how the sustainable the hydroponics technology is, compared to the traditional way of farming and also, to inform them on how disruptive this technology is to the traditional food supply chain with reference to that of Molde.

In carryout this research, the researchers faced many problems due to the corona outbreak. Amongst the challenges were,

- We could not have access to the library and books for our research. We were limited to online articles and publications, which made the research process very difficult. Even when we found some interesting articles online related to our study, most were paid articles.
- Secondly, due to the law passed by the Norwegian government on “social distancing”, it was impossible to meet our supervisor in person. All communication was online which also was very new to us even though we managed to go through. We strongly believe the work would have been better if we had a face-to-face communication with our supervisor.
- Also, in the course of our research, we planned to carry out a total of 6 interviews; one interview with the focal company (Bygartner 1), 3 with his customers, and 2 his competitors, but, we only succeeded to carryout interviews with the focal company and his customers. All attempts to conduct interviews with the competitors failed due to the Corona virus outbreak.

Acknowledgement.

This dissertation is carried out as our final semester project at Molde university college. We insert our best to accomplish this thesis, but it could not be possible without the help of few individuals.

We thank our supervisor, Professor Engelseth Per (Faculty of Logistics) Molde university college; to whom we are deeply indebted for stimulating suggestions, support, and encouragement in all time of research and thesis writing. We are also grateful to Professor. Svendsvik Berit, for uplifting our morals and for her kind suggestions during this period.

Our utmost gratitude to respected Dean; Svein Bråthen who gave us the opportunity to study at Molde University College. We are thankful to Bygartner 1, the CEO of Bygartner 1 and all our respondents for benefiting us with their knowledge and overwhelming attitude to carry out this research. We appreciate everyone who supported us for completing this research.

We would also like to thank each other for the effort, patience, cooperation, and support for making this thesis a positive learning experience. We express our thanks to the family members of each of us, Kaneez Raza and Nestor F. Nyambod for their love, encouragement, and support for this master thesis.

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List of abbreviations:

FAO	Food and Agricultural Organisation
CEO	Chief Executive Officer
R&D	Research and Development
ROI	Return on Investment
SWOT	Strength, Weaknesses, Opportunities, Threats
TQM	Total Quality Management
E2E	End to End
ERP	Enterprise Resource Planning
SFVC	Sustainable Food Value Chain
VC	Value Chain
HACCP	Hazard Analysis Critical Control Point
SFSC	Short Food Supply Chains
PDO	Publishing Distribution Office
PGI	Post Goods Issue
MVT	Marginal Value of Time
LED	Light Emitting Diode
HPE	Health Professions Education
CO2	Carbon dioxide
PH	Power of Hydrogen
IT	Information Technology
B2B	Business to Business

CHAPTER 1: INTRODUCTION

Various segments of value chains from production to consumption that includes retailing, wholesaling, logistics, processing, and production have witnessed rapid changes over the years. The primary objective of this thesis is to judge whether the hydroponics technology is a disruptive technology in the food supply chain in Molde. A food Supply chain of all industries are collaborating to provide the final consumer with food. The scope of the food supply chain farm stretches from the farm being the origin of the product, to the final consumer. Thus, it connects the agriculture and farming industry (being raw material providers), to the processing industry (which transforms raw materials) to finished products and the distribution industry, which perform their logistics functions. (Farahani, Akkerman, & Grunow, 2011). Today, food supply chains are complex, global networks, creating pathways from farms to consumers, involving production, processing, distribution, and even the disposal of food. Consumers' expectation of year-around availability of fresh food products has encouraged the globalization of food markets.(M. Yu & Nagurney, 2013).

Food supply chains are distinct from other product supply chains. The fundamental difference between food supply chains and other supply chains is the continuous and significant change in the quality of food products throughout the entire supply chain until the points of final consumption. This is especially the case for fresh produce supply chains with increasing attention being placed on both freshness and safety. Clearly, many consumers prefer the freshest produce at a fair price (M. Yu & Nagurney, 2013)

Today, the agenda of food security has prevailed to be a global concern. According to the FAO, the world's population will exceed 9.1billion by 2050 and to meetup with the food demand for the population, the world's food production needs to increase by 70% in the next 40 Years. This growth is parallel to the growth in urbanization which has led to the emergence of new urban cultivation systems of crop; hydroponics, which is seen as a viable solution to the limited land available for crop cultivation (Chow, Lee, Zakaria, & Foo, 2017).

Also, faced with this global challenge, what the world needs for tomorrow to meet the challenges of food security is to develop new approaches to farming and not just improved techniques to existing approaches. It is the blend of innovative scientific methods and techniques, the co-

development of approaches drawing across different academic disciplines, the active collaborative engagement with industry, and the harnessing of new and promising technological development (such as big data approaches) that will drive the new agro-technological revolution BILLION (2017)

This thesis is based on the Supply chain of a local hydroponic farm (Bygartner 1) located in Molde. This study aims at describing the network of this Bygartner1 focusing on logistical flows, from suppliers, within the firm, and to customers. Bygartner 1 is hydroponics dealer based in Molde. hydroponic system is a new cultivation technology that applies nutrient solutions without the soil substrates, but with the presence of artificial supporting medium. It offers the ability to reuse water and nutrients, ease of environmental variability control, higher production yield, and successive prevention of soil-borne diseases and pests (Chow et al., 2017).

Hydroponics technology of food cultivation being a new technology, comes to meet other existing fresh food supply chains. It is therefore relevant to judge if this technology could be a disruptive innovation in the local food supply chain in Molde and to explore other how this technology provides value in the food supply chain of Molde. Also, with the growing environmental concern in the world, it is relevant to judge whether this technology is sustainable. That said, this thesis investigates how sustainable the hydroponics technology is comparing it with the traditional way of farming using soil.

1.1. Relevance of the Study

According to King and Baartartogtokh (2015) in their paper upon review of literature on disruptive innovation, they discovered that despite the theory's widespread use and appeal, its essential validity and generalizability have been seldom tested in the academic literature. This thesis therefore comes to fulfil that purpose.

Also, Lambert et al. (1998) defines supply chain management as “the integration of key business processes from end user through original suppliers that provides products, service, and information that add value for customers and other stakeholders. It is therefore relevant to explore how Bygartner 1 provides value to his customers.

Lastly, over the years, there has been growing public concerns about sustainability due to the operations and impact of modern food systems on the environment such (soil erosion, loss of biodiversity, water degradation, inefficient land use, escalating consumption of natural resources, pollution associated with the production and consumption of food and not leaving out energy use greenhouse emissions(Yakovleva, 2007a). It is thus relevant to investigate the sustainability of the hydroponics system.

1.2. Research Objective

The primary objective of this thesis is to verify if the hydroponics technology in Molde is a disruptive technology in the food supply Chain and how this technology provides value to the food Supply chain in Molde. This work will also investigate the look into the sustainability of hydroponics systems comparing it to the traditional soil-based farming system. To successfully carryout this research, the following research questions have been generated.

1.3. Research questions.

- 1) How does the applied technology provide “value” to the customers?
- 2) How disruptive is the use of hydroponics in the supply chain of Molde?
- 3) How sustainable is the use of hydroponics?

1.4. Conducting a Literature review.

A literature review is crucial for every research. This is done to have a proper understanding of the case under study. Literature in this case will be drawn from online research articles, websites, and books.

1.5. Data Collection

The structure of my research requires both primary and secondary data. Primary data in this case will be obtained from both the CEO of Bygartner 1 and the customers of the company through interviews. This is to enable us to know more about the company and the supply chain. Also, secondary data will mostly be from online research articles, websites, and/or company reports.

Due to competition in this supply chain, we will also conduct interviews with the competitors and customers of of Bygartner 1. Information from this interview will help us know the competitors view about the hydroponics technology and the customers preferences in the food supply chain.

1.6. Data transcription

After conducting the interview and collecting the data through interviewing, the data collected needs to be arranged transcribed before being analyzed. The data analyst must aggregate these different forms of data and convert it into a form suitable for analysis.

1.7. Data type to be used.

In this research, both primary and secondary data will be used. Primary data will be obtained through Interviews, through an in-depth interview, and observation while secondary data will mostly be from online research articles, websites.

1.8. Structure of the research

This thesis is consisting of 6 (Six) chapters with each chapter focusing on different issues. Chapter one (Introduction) introduces the reader to the theme of the study, the purpose relevance of the study, and data type to be used in the research. Chapter two looks into the relevant literature for the study (Literature review), chapter three looks into the method used in the collection and analysis of data (methodology), chapter 4 focusses on background of the Study which informs us about Bygartner 1, his customers, suppliers and competitors. Thereafter comes chapter five which deals with data analysis and chapter 6 discussion and conclusion.

CHAPTER 2: LITERATURE REVIEW

This chapter provides us with the literature relevant to answering our research questions presented in chapter one. For this case, we have chosen several theories and some food supply chain concepts. Two main theories were used i.e. the network theory, relational contracting theory, and disruptive innovation theory while for the concepts, local foods, sustainable supply chain, urban farming, value and utility, and end to end supply chain concepts have been reviewed. The rest of this chapter will review the theories and concepts.

2.1. Hydroponics Technology.

A hydroponics system is a system of growing plants in an aqueous solution including troughs for conducting a predetermined level of nutrient solution. This solution is supplied to each trough by a branch pipe extending the length of the trough and including a plurality of outlets spaced at uniform intervals Wong Jr (1972). According to the author, the nutrients are then dispersed evenly along the length of the trough. Each outlet has an associated aspirator or educator whereby air is entrained by the solution issuing from the outlet thereby providing substantially uniform aeration of nutrient solution.

According to DeMitchell and Tarzian (2011), there are primarily two types of hydroponics systems: static solution culture and continuous flow solution culture. In static solution culture, plants are grown in containers of nutrient solution. The nutrient solution is either changed on a schedule such as once per week, or when the concentration drops below a certain level. Whenever the solution is depleted below a certain level, either water or fresh nutrient solution is added to make the necessary adjustment. In continuous flow solution culture, the nutrient solution constantly flows past the roots.

Hydroponics production is more prevalent in the United States than aquaponics. He reported that hydroponic production has become a considerable commercial production system for vegetables, and that, in 2004, there were over 22,257.7 hectares of hydroponics greenhouse vegetable production worldwide, with more than 404.7 hectares in the United States, with the production of mainly tomato, cucumber, and pepper. Jones Jr (2016)

The advantage of hydroponics system is primarily due to the range of complexity between successful hydroponic systems, as summarized in the following quotation:

“...From a single plant supported above an aerated jar of nutrient solution to thousands of plants supported above a large area of flowing solution in which PH, temperature, and nutrient concentrations are controlled by using a sophisticated computer system and automated chemical analysis”(Dreschel, 2018)

There exist various hydroponics techniques with different range of complexities that can be customized. In that regards, farmers can adopt the technique that addresses their agricultural needs based on the type of product involved, material availability/cost and other factors.



Figure 1: Hydroponics Technology (Author, 2020)

2.2. Disruptive innovation

The Christensen’s theory of disruptive theory of disruptive innovation has gripped business consciousness like few other ideas. The economist called the theory “one of the most influential modern business ideas” King and Baatartogtokh (2015). Other writers argue that the idea is so widely accepted such that it is predictive power I rarely questioned. According to this author,

Christensen and his associates have proposed disruption as a framework for thinking about vexing social problems such as poverty, lack of access to health care, illiteracy, and unemployment.

According to C. Christensen and Raynor (2003) it is absolutely necessary for firms to recognize a disruption when they see one. Incumbent firms often fail to recognize the threat posed by disruptive innovation and that is the reason most of them are overturned. The Christensen theory states that

“traditional companies cannot be disruptive since they are busy keeping their customers and fighting the competition; hence, they will ultimately fail when disruptors take over” Vossen, Schönthaler, and Dillon (2017).

These authors went further to define innovation as a new idea, device, or method. Innovation according to them can be also be viewed as the application of better and more effective solution that meets new requirements, unarticulated needs, or existing market needs. Innovation is related to, but not same as invention. Innovation typically starts with a development of ideas for new services or products or from the recognition or discovery of novel customer needs.

Also, (C. M. Christensen et al., 2015) further to explain that disruption occurs when a smaller company challenges incumbent firms specifically because incumbent firms are focusing on improving their product offered to the most demanding (and usually most profitable) customers. Incumbents firms while doing this, tend to exceed the needs of some segments while ignoring the needs of others. The entrant firm then targets the overlooked segment (unserved customers), delivering a more suitable functionality frequently at a lower price while gaining a foothold. The entrant firm while preserving the advantage that drove their early success, moves up the market, delivering the performance required by mainstream customers as the incumbent is busy chasing higher profits in a more demanding market and not responding vigorously. Disruption is said to have occurred when mainstream customers start adopting the offerings of the entrant firm.

C. Christensen and Raynor (2003) identified two types of disruptive innovation: new-market disruptions and low-end disruptions. According to them, for low-end disruption, there may be little or no market expansion, i.e. the first sales of the product are to customers who would have otherwise purchased the old product, as opposed to buyers in a new market segment. This disruption type encroaches from the low-end upwards and starts by selling to price sensitive low-

end customers. According to this paper, both low-end and new market disruptions result from a diffusion process called low-end encroachment. Christensen and Raynor (2003) suggests that diffusion and substitution of the new product for the old may in some cases be primarily due to improvements over time in the new product's attributes and costs (Schmidt and Druehl, 2005). Low end encroachment is further subdivided into 3 types as illustrated in the table below.

On the other hand, new-market disruption occurs because of the creation of a totally new market. This type of innovation comes up with a new product or technology that current consumers don't value at the beginning (Schmidt & Druehl, 2008). This innovation type considers that which takes into consideration the market segment that has not been served by the incumbent firms while achieving distinct group of favourable results with unclear applications. Twitter can be named as another example for the new-market disruptive innovation which leads to dramatic shift and rises in customer services, tracking and broadcasting (Paetz, 2014)

These two disruption types tend to overlap with each other even though they have separate performances. For instance, although notebooks create a new market for the ones who needs smaller device and wants to pay less money than a laptop, simultaneously notebooks grasp the attention of the least demanding customers in a laptop market (Schmidt & Druehl, 2008)

High end disruption as recognized by Govindarajan and Kopalle (2006) seems to contrast low-end disruption. While low end encroachment describes the scenario where the new product first displaces the old product in the low end of the old product market and then diffuses upward (the new product may open up a new market before encroachment begins), the high-end encroachment progresses in reverse fashion, starting at the high end of the old-product market. According to Schmidt and Druehl (2008) the low end customers consists of customers with the lowest willingness to pay while the high-end of the market is composed of customers with a high willingness to pay

Table 1. Mapping of the Type of Innovation to the Type of Diffusion

Type of Innovation	Type of Diffusion to which It Maps	Description	Example
Sustaining Innovation	High-end encroachment	The new product first encroaches on the high end of the existing market and then diffuses downward.	Pentium IV relative to Pentium III
Disruptive Innovation	Low-end encroachment	The new product first encroaches on the low end of the existing market and then diffuses upward.	
New-Market Disruption	Fringe-market low-end encroachment	Before encroachment begins, the new product opens up a fringe market (where customer needs are incrementally different ^a from those of current low-end customers).	5.25 inch disk drive relative to 8 inch drive
	Detached-market low-end encroachment	Before encroachment begins, the new product opens up a detached market (where customer needs are dramatically different ^a from those of current low-end customers).	Cell phone relative to land line
Low-End Disruption	Immediate low-end encroachment	Low-end encroachment begins immediately upon introduction of the new product.	Discount relative to department stores

* The distinctions between fringe and detached markets and between incrementally and dramatically different preferences are illustrated in the disk-drive examples provided herein.

Table 1: Mapping the type of innovation to the type of diffusion. (Schmidt & Druehl, 2008)

According to Vossen (2017) innovation might come about because of marketing research or just on brainstorming by a company’s research and development department (R&D). According to this same paper, once an innovative idea is fixed the organization forges ahead with a value evaluation based on the SWOT analysis. This analysis takes into consideration the return to investment (ROI), risk of failure and cost of development as well as the competition.

With the coming of globalization, companies now face complex business processes and the complexity changes with changes in the organization and changes in the global marketplace. This companies faced with this situation are there by forced not only to adapt to new customers, markets, business partners and competitors, but also to new requirements in terms of compliance, governance, risk and security management Vossen et al. (2017). Today, big data enhances complex business processes, knowledge about products, services, and customers.

The actual definition of disruptive innovation, despite being used for many years by both managers and academics, there is still unclear understanding of what actually constitutes it Markides (2006). disruptive innovation is any technology whose use significantly changes the way of market and industry functions. It is a means of developing new markets and broadening existing, providing new functionalities and thus, can disrupt the present market linkages D. Yu and Hang (2010).

According to Whitelaw and Garcia-Lorenzo (2017), many firms in order to avoid being disrupted, try to invest in exploring new areas alongside their core business activities and also keeping abreast with the market trend. According to the authors, despite all the advantages of disruption, very few firms have succeeded in exploiting before being displaced by new upcoming firms due to internal tension rather than external factors. Within firms, the internal tension that fosters disruptive innovation is centered on three main themes: cognitive structure, perceived incentive, organizational structure, and routines. With regards to perceived incentive and resource allocation, this refers to tension that stems from the decision-making process. This is when the Firm in question must choose whether to invest in risky new initiatives or invest in predictable sustaining innovations and cost reduction initiatives. According to the authors, a firm's cognitive structure refers to the mechanism the members of the organization use to process and understand information. This causes tensions because firms must pay attention to information that is irrelevant to their strategic imperative to address customers' current needs as well as trade-off exploitation gains to engage in exploration activities. Furthermore, existing firm's structures and routines cause tension because firms in order to implement new ideas, need to use rigid organizational processes and management layers designed to carry out the development of existing products as efficiently as possible based on current competencies.

2.3. Supply Chain Management

Over the years, there has been growing literature on supply chain management with different authors coming up with different definitions. According to Davis (1993), good supplier management does not constitute a good supply chain management without a concurrent effort to manage the rest of the supply chain. In that regard, James and Stefanie in their article "Developing a consensus definition of supply chain management" in 2009 reviewed 170 different definitions to supply chain management and found there major themes that reoccurred : Activities, benefits and components with each having a sub theme(Stock & Boyer, 2009). These sub themes were as shown below.

-Value creation

-Customer Satisfaction

- Constituent or component parts
- Network of relationship (both internal and external)
- Material, finance, service, and information flow.
- Creates efficiencies

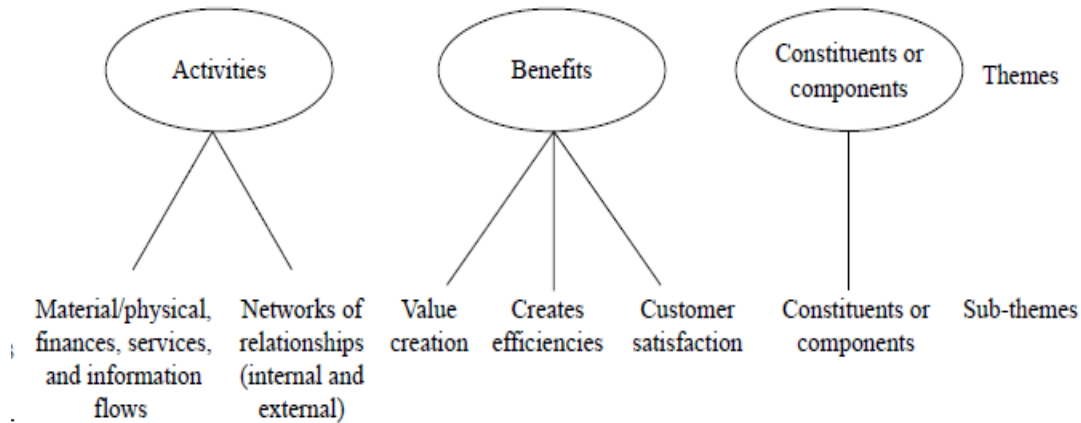


Figure 2: Major themes and sub-themes of a consensus SCM definition(Stock & Boyer, 2009)

The Authors then summed up all the themes to come up with a comprehensive definition of supply chain management. According to them is;

“The management of a network of relationships within a firm and between interdependent organizations and business units consisting of material suppliers, purchasing, production facilities, logistics, marketing and related systems that facilitates the forward and reverse flow of materials, services, finances and information of the original producer to final customer with the benefits of adding value, maximizing profitability through efficiencies, and achieving customer satisfaction” (Stock & Boyer, 2009)

2.3.1 Objectives of Supply Chain Management.

Having defined Supply chain management and what it consists of, it is of relevance to identify its importance. Supply chain management can improve the performance of firms by integrating key

business processes from end to end through suppliers and vendors by providing products, services and information that that adds value to customers. (Jayaram et al., 2014).

Also, supply chain management creates value to customers. The ability of individual firms to create value (the competitive advantage of the individual supply chain) and the ability of firms to coordinate their value creation activities (the efficiency of the value stream) are enhanced through the alignment between firms in a supply chain. For firms to remain competitive in the market, creating value is fundamental from the very beginning of the supply chain. This is because satisfying end customers is necessary for the success of the company since they remain the main source of income for the supply chain (Fawcett et al., 2007).

Furthermore, supply chain management minimizes the risks that occurs from receiving inputs to delivering final products. Tang and Tomlin (2008) define risk as the likelihood of occurrence of an undesirable event or the negative implication of such an event. Tang & Tomlin, (2008) in same paper discussed Six (6) major supply chain risks which are related to supply, process, demand, intellectual property, actors' behaviour and socio-political situation. Lee and Wolfe (2003) in their paper identified two ways to reduce risk, and according to them, risk can be reduced by following risk avoidance mechanism, or by adopting total quality management (TQM) principles. The "Triple A" principle another way of reducing the negative implications of an event(Lee, 2004). This principle suggests that a supply chain needs to be adaptable (adjust design to accommodate market changes), agile (quickly respond to short term market changes) and aligned (develop common interest of all participating firms).

2.3.2. Supply chain management principles.

Having enumerated the objectives of supply chain management, some principles have emerged that can guide participants within a supply chain. These principles act as directives to supply chain participants in performing their functions. The principles are outlined below.

a) Know the Customer requirements

To construct a supply chain, a clear understanding of the requirements of the customer is needed. In a supply chain, the requirements of the customer can be identified by using various market

research techniques like collecting transaction records from market, conducting interviews, maintain the data in the records and analysing them. The customers' requirements can then be fulfilled by the delivery of products to the market through "logistics synchronization" which according to Simatupang and Sridharan (2002) is a coordinated arrangement that promotes the improvement initiatives in value creation during acquisition, consumption and disposition of products and services.

b) Prepare production plans taking market demand into consideration

The market size and the requirements of the customers determine the amount and kind of material to produce. Knowledge on the required quantity and type of good and services required by the market helps the actors to prepare demand based plan and this plan type ensures that the right product, and right product quantity is delivered at the right time(D. L. Anderson et al., 2007). For the effective and efficient implementation of this plan, actors pay attention to input viability, capital requirements, production requirements, labour charge, logistics arrangements and production infrastructure(Memedovic, et al., 2008).

c) Adopt agile or lean philosophies.

A supply chain is formed by the coming-together of different firms that perform strictly different functions in the supplying of Inputs to the delivery of the final product to the consumer. Involving different firms into one supply chain increases the chances for the chain to be long and complex. These long and complex supply chains often are slow to respond to the required changes that satisfy customer's wants, thus affecting the benefits of chain actors(Tang & Tomlin, 2008). It is therefore necessary to increase the performance of a supply chain by eliminating waste and this can be done by adopting the lean or agile philosophies. Agility is related to using the knowledge obtained from the market to quickly exploit profitable opportunities and is adopted where demand is volatile while, leanness is related to reducing all types of waste and is adopted where demand is stable (Bhasin & Burcher, 2006)

d) Developing a supply chain network

The functions of the supply chain such as order processing and tracking and tracing progress are facilitated by providing information timely to improve the production and delivery of products in

a supply chain. Information flow needs to be extended from supply chain actors to external service providers like warehouse operators and transport agencies in order to provide an efficient and effective chain(Lambert & Cooper, 2000). Real time information such as data, know how, design, technology, samples, specifications, customers profile, client list, order history and sales forecasts are facilitated by the information network and external agencies. The use of information and technology ensures fast exchange of data and seamless flow of information(Min & Zhou, 2002).

e) Integrate business processes.

Supply chain Business processes includes those activities within the supply chain that create value to the customers. The integration of these activities across the supply chain and within the firm allows for a successful supply chain management since it goes to improve responsiveness, efficiency and control and thus value adding by the to the customers.(Moura, 2002)

f) Develop and/or adopt appropriate technologies

Every supply chain requires constant and continuous improvement in their business process to satisfy customers. Sometimes, continuous improvement is not enough to address the requirements of customers. In such a case, rethinking and radical redesigning of the business process (Business process reengineering) is required (D. L. Anderson et al., 2007). With business process reengineering, an existing technology within the chain is completely replaced by a new technology in order achieve improvements in critical, and contemporary measures of performance such as quality, speed, cost, and service. According to Lancioni et al., (2003) the use of technology is becoming very essential for firms to stay competitive in the Market.

Having defined supply chain management from the viewpoint of different authors, supply chain objectives and supply chain management principles, it is relevant to throw more light on what constitutes a sustainable supply chain. The following section will focus on supply chain sustainability.

2.4. Supply Chain Sustainability.

There has been growing literature on sustainable supply chains over the last decades. Discussions on supply chain sustainability arise from the notion that supply chain performance should be

measured not just by profit, but also by its impact on the supply chain and ecological and social system (Pagell & Wu, 2009). According to him, for a supply chain to be considered sustainable, it should do no net harm to the natural and social system while still producing a profit over an extended period. He went further to say no such supply chain exist but rather, some supply chains are more sustainable than others and the more sustainable ones could continue in business far longer than its less sustainable counterparts.

According to Purvis et al., (2019) for a supply chain to be sustainable, all the three pillars of sustainability must be reconciled. These pillars are economic, social, and environmental pillars. Many actions taken in a supply chain can go a long way to improve performance in all three dimensions. The social factor addresses issues that are related to the company's workforce (health and safety, training and development), customer (accurate product information, labeling) and social issues (Human rights and local community issues, the environmental pillar addresses issues of the environment such as water, land, air, and the Ecosystem. Generally, firms can make the supply chain sustainable in three ways. By reducing emission, reducing resource consumption and by product innovation. And lastly the economic pillar ensures that companies use their resources in an efficient manner that they can continue production. It also ensures that companies make operational profit to enable them continue production. Without operational profit, businesses cannot stay in business. This model can be summarized by the figure below.

According to Vanclay (2004), the proposed triple bottom line concept has its detractors since there displays very little focus on Accounting (narrow accounting focus). Despite this, Purvis et al. (2019) mentioned that the triple bottom line is still wisely used as a tool for measuring organizations progress towards achieving a sustainable supply chain.

Sustainability does not only have a positive impact on the environment and the society but also on organizations. Sustainability practices can help organizations or companies reduce risks, the amount of waste generated and increase material and energy efficiency. When trying to improve the sustainability performance of a business, there are three major challenges that need to be addressed. Assessment of sustainability requires consideration of not just economic, but also environmental and social (Zhang et al, 2014).

Purvis et al. (2019) summed this up with triple bottom line diagram as presented below.



Figure 3: The Triple Bottom Line Venn diagram (Purvis et al., 2019)

B.Gail Smith (2008) in his research article “sustainable food supply chain” explains that developing sustainable supply chain depends upon the type of supply chain involved and the individual business attitude to extending responsibility for product quality into social and environmental performance within their own supply chains. He mentions the four types of food supply chains with their features as (+, low; ++, medium; +++, high):

Typical features of four types of food supply chains. (+, low; ++, medium; +++, high.)				
	Type of food supply chain			
	Local	Conserved	Manufactured	Commodity
overall complexity of supply chain	+	++	+++	+/+++
transportation distance (‘food miles’)	+	++	++/+++	+++
number of processing steps	+	++	+++	+
storability of finished product	+/++	+++	++/+++	+++
size of market for finished product	+	++	++	+++
seasonality of finished product on market	+++	+	+	++
volatility of market price	+/++	+	+	+++
demand for further processing by end user	++	+/++	+	++/+++

Table 2: Features of a Food Supply Chain. (Smith, 2008)

2.4.1 Indicators of Sustainable Farming:

According to (Yakovleva, 2007b) the food system is highly complex and highly industrialized oriented towards mass production and consumption. During the last century to meet the growing food need of the world population, many technological improvements for seed development has been done with widespread use of agricultural chemicals, modern farm machinery, advanced transportation system and agricultural production. This development has also led to globalization of the modern food system. However, the changes in technology, marketing, industrial structure, consumption patterns and evolution of consumer demands has caused many environmental and social concerns, which questions sustainability of food system. The globalized food system is a concern about sustainability because of increasing negative impact of its operations of society, economy, and environment. The main public concerns about impacts of operations of modern food system are:

Impacts on Natural Environment: soil erosion, loss of biodiversity, inefficient land use, water degradation, as well as escalating consumption of natural resources and pollution associated with food production and consumption including increasing energy use and greenhouse emissions

Impacts on human health and well-being: food safety, food security, food nutrition, food consumption patterns, and effects of food innovations on health and the environment.

Ethical Issues of Food Production: animal welfare and the rise of organic production.

Fair Trade: impacts of food trade on food suppliers in developing countries.

The food industry is constantly innovating different alternative strategies to decrease the negative impact of food supply chain on environment, society and economy through various production, marketing, labelling, accreditations schemes and initiatives (Weatherell et al., 2003). However, there is no formal modelling approach to benchmark sustainability of food supply chain (Yakovleva et al., 2012). Yakovleva & Flynn (2004) identifies sustainability indicators as sustainability assessment for benchmarking of supply chains which incorporates three dimensions of sustainability: economic, social, and environmental.

Supply Chain Stage	Environment	Social	Economic
Agriculture/	Energy Consumption	Employment	Labour productivity
Food Processing/	Water Consumption	Wages	Market connectivity
Food Wholesale/	Waste arising	Employment gender ratio	Import dependency
Food Retail/			
Food Catering/			

Table 3: Sustainability Indicators for Food Supply Chain.

Source: (Yakovleva & Flynn, 2004)

Indicator-based assessment of sustainability is widely used (Gaviglio, et al., 2017) but analysis still depends on methodology and concept issues including data availability, heterogeneity of agricultural system and complexity of concept of sustainability. Due to complexity of parameters describing farm sustainability, it is very expensive and complex to evaluate them all.

Agricultural Sustainability

Over the years, there is been growing literature on agricultural sustainability. According to Pretty (2008), concerns on agricultural sustainability is centered around the need to develop technologies and practices that;

- Do not have adverse effects on the environment
- Are accessible to and effective to Farmers
- Leads to improvement in Food productivity and has positive effects on environment, goods, and services.

According to the author, the concept of sustainability incorporates both the concept of persistence (the capacity of a system to continue over a long period), and resilience (the capacity of a system to buffer shocks and stresses). As a more sustainable agriculture seeks to make the best use of nature’s goods and services, technologies and practices must be locally adapted and fitted to place. Recent empirical evidence shows that successful agricultural sustainability initiatives and projects arise from shifts in the factors of agricultural production

2.4.2. Hydroponics Systems and Sustainability.

Many researchers have been concerned with this technology and have tried to compare the hydroponics system to the traditional soil-based means of crop cultivation with regards to self-sufficiency and sustainability. In hydroponics cultivation, the farmers using computerized systems have the ability to control the precise nutrition for the plants compared to the soil cultivation, which makes the farmers produce healthier products (Resh, 2016). According to this author, the quality of hydroponics output yields can be 50% higher in quality compared to soil-based cultivation which can greatly increase the profitability of farmers. Since the plant's growth is controlled in the right conditions with hydroponics, the fruit matures faster than in soil-based agriculture (Jones, 2014). Therefore, small scale farmers can produce at a faster rate and market their produce before soil-based agriculture products. Jones went further to say the initial investment in infrastructure and training of personnel is higher in hydroponics production compared to soil-based cultivation due to the technical specifications involved. Also, since the rate of maturity for hydroponics products is faster and of higher quality compared to soil based agricultural products, the profitability of small-scale farmers will be higher in the Long run.

Resh (2016) in his paper said soil-based cultivated products require pesticides to protect plants from disease attacks and insects which is harmful both to the environment, the consumer and the farmers, whereas, with hydroponics cultivation, there is reduced need for pesticides since crops are grown in a controlled environment. Also, according to him, soil based farming requires more fertilizer compared to the hydroponics system in order to nourish the soil with the appropriate nutrients required by plants for growth, whereas, hydroponics systems don't require a large amount of fertilizer since the nutrients required for plants growth is supplied through the nutrient solution. Fertilizer salts can contribute to pollution in waterways because salts can be carried by rain water into storm drains and surface waters (Traunfeld & Nibali, 2013). In hydroponics cultivation, 95% of water used in the system is recycled whereas, in soil agriculture water is inefficiently used and must be constantly re-supplied (Carruthers, 2005).

According to AUTHOR (2018) in a web publication, for soil-based crop cultivation, the forest is cut down to provide space for crop cultivation. The cultivation itself makes the soil loose thereby increasing the chances of erosion. These actions tend to harm the environment since trees are part of the earth's "lungs". On the other hand, with hydroponics systems, the amount of land needed

for crop cultivation is drastically reduced since crops are grown very close to each other and in nutrient solutions making it easier for crops to absorb compared to soil nutrients. Also, because hydroponics systems do not require soil for crop cultivation and are grown indoors, crops can be grown all year round which makes the system sustainable.

The Author also goes further to argue that for hydroponics systems, fossil fuel usage is reduced due to flexibility in growing location. With this technology, a farmer can choose to locate his greenhouse close to their market, which tends to reduce the average transportation distance for products, thus a reduction in fuel consumption, reduction in pollution and increases the profit of hydroponics growers. On the other hand, soil-based cultivation does not provide this flexibility. Thinking of this in the longer, hydroponics helps the environment by reducing emissions and environmental footprints associated with food production and market transportation.

2.5. The Network Theory:

Wellenbrock (2013) defines a network as the relationship between the companies of the same supply chain. This network emerged from a very simple relational alliance, of mostly two companies in the start but with the passage of time it has grown to many companies with different roles in the supply chain. According to author, the players in this network may include suppliers, distributors, focal company, retailers and even the customers. This theory started during 1970's and in 1980's, it was basically about the relationship between supply chain entities, but the network grew to multiple relationships with many counterparts throughout the supply chain. The network theory is mainly defined as the relationship in which supplier, manufacturer and the customer/buyers are engaged (Wellenbrock, 2013). Wellenbrock further mentioned that supply network theory defined by different authors which are as below:

In Harland (1996) defines network in his thesis as specific type of relation between persons, events or objects. Thorelli (1986) also defines network as long term relationship between two or more firms Chang, Chiang, and Pai (2012) in their paper mentioned that network supply theory is complex and depends upon the relationship between the parties involved in the network. Also, according to Håkansson (2012), supply network theory is important for companies that have made investments with the actions of other counterparts are involved in the company's supply chain.

According to Wellenbrock (2013), a network is studied in order to describe the relationship between companies that are in same supply chain. This concept emerged from the simple relationship of strategic alliance between just two companies to number of companies making complex network in the same supply chain are they suppliers, manufacturers, distributors, retailers and even the end customers.

Mari, Lee, et al.,(2015) in their paper discuss the increasing complexity of supply chain and a need for a robust and resilient supply chain in order to manage this complex network of supply chain. Through supply chain inefficiencies and inadequate infrastructure, supply chain risks are mainly characterized. Inorder to respond to complexities, unforeseen changes and unpredictable disruptions, which can be man-made or natural disasters like earthquake, flood or terrorist attacks (like tragic event of 9/11), its is needed to adapt new strategies to response quickly. Modern supply chain is getting very complex. It doesn't only includes suppliers, manufacturers, dsistributors and retailers but also supplier's of the supplier and customer's customer. Due to this increased complexity, supply chain is suggested by many authors to be described as network supply chain. Author also mentioned that there are huge number of interdependencies and interrelations among at different levels in this complex network of supply chain. It is no more linear and cann't be controlled by simple assumptions of linearised set of models. Therefore new approaches are required to deal with this complex network of supply chain. Old concept of linear structure has already been changed to complex system, making modern concept much more complex than old traditional one.

According to Hearnshaw and Wilson (2013), simple linear system of supply chain fails to describe interdependencies between modern large number of heterogenous firms in supply chain. In this paper he has applied complex network approach to the context of supply chain and argues that complex network approach is applicable in real world. After reviewing many previous models he came up to the conclusion that properties of efficient supply chain can be mirrored by scale-free network supply. Authors also mentioned that It is recoganzized that the scale-free network provides many insights and advantages to the supply chain that the simple linear system cannot

Food industry has become interconnected system with many complex relationships including horizontal and vertical integration, forward and backward cooperation(Hsiao, Van der Vorst, & Omta, 2006). In another study by Jarosz (2000), he argues that actor network theory and supply

chain management theory gives better understanding of regional food agricultural-food network theory. According to these theories trust and cooperation in this network depends upon strength of it. It is critical to further strengthen the cooperation and trust among the actors of the network like suppliers, producers, distributors, wholesalers and retailers. Resource sharing and training programs can be the key areas of cooperation within this network.

2.6. Relational contracting theory:

Relational contract is a contract that is built upon the relationship of trust. It was introduced by Macneil (1973), who were legal scholars in United States of America. Macneil renamed this theory as "Essential Contract Theory". According to him this theory can be characterized by a view of contracts as relations rather than as a discrete transactions (Macneil, 1973).

Mouzas and Blois (2008) in their study discuss the role of contracts in business relationship. Contracts exhibit the legally enforceable agreements. These are found in all sorts of business alliances and partnerships. Nature and forms of contracts have been studied by many different scholars, who have defined these in many different ways with different emphasis. The theoretical nature of contract is known as "relational Contract" and it takes into account all surrounding circumstances of relationships. In this study they mentioned two types of relational contract a) Norms based approach b) the organizational economists' study of incomplete contracts. Norms based approach evolved from relational contract theory, introduced by an American legal scholar "Ian Roderick Macneil". According to him contracts are mere transactions and norms are the basis for the manners to exhibit commercial exchange. They also believed that every transaction lie in the spectrum from discrete to relational. It is necessary for the companies to understand the importance of a need to sustain various repeated exchanges through contracts because most of it business activities are occurring through business partnerships or alliances that are regulated through contracts.

Relational contracts are essential part of global production processes which is sustained by the value of long term relationship (Kukharsky, 2016). Companies with their specialized suppliers have higher interest in long term collaboration. Especially when formal contracts can't be

enforced then such informal agreements can be established to enhance the efficiency in the collaboration (Defever et al., 2016).

Grafton and Mundy (2017) in their research define relational contract as informal self enforcing agreements while formal contracts are mainly used in ex post coordination. They argue that companies can reduce alliance risk through relational contracts. Informal agreements between the partners are sustained by the intention to work with each other in the future as well with possibility to gain a lot from this agreement and if not, then may face losses. Formal and relational governance structures has their own impact on the conduct and maintenance of the inter organizational relationships (Ambrozini & Martinelli, 2017).

Conflict resolution and renegotiation are studied under subjective evaluation in relational contracting (Zhao, 2012). Renegotiation has three effects in relational contracting A) incentives pay scheme is low powered with renegotiation making the contract less extreme. B) Renegotiation mostly makes contract termination impossible and enforce mutual cooperation. C) Renegotiation makes compels the parties to resolve their conflicts and select a contract that would maximize the lowest possible surplus for both of them.

2.7. End-to-end supply chains (E2E supply chains)

End to end (E2E) supply chain management refers to the entire supply chain operation being designed so that there is greater interoperability among the different pieces of the supply chain puzzle. The primary focus of an efficient supply chain is not only limited to ensuring the timely delivery of products in a supply chain but also to minimize costs by reducing waste (Sharma, 2018). It embraces a philosophy that eliminates as many middle layers or steps as possible to optimize performance and efficiency in any process. According to Kuhn and Joachim (2015), In an end to end eupply chain setting, the customer is determined with the end user of the product/service. This therefore means all efforts within this setting are geared towards customer satisfaction (base line) and delight (benchmark) causing a shift from traditional supply chains: companies are striving to minimize the logistical efforts between the suppliers and the companies themselves, whereas the end user is “only” reflected by a given milestone in the supply pipeline which marks the deadline for the product/service delivery. the value stream for potential time and cost saving processes (Kuhn, 2015).

With traditional supply chains, organizations tend to operate individually thereby resulting to inefficiencies in performance and a constrained supplier relation. An end-to-end supply chain view of a supply chain begins by designing a product, selecting and managing suppliers, scheduling, production, distribution and also after-sales customer service Mitchell (2019). When integrated, a supply chain acts as a tightened, more cohesive network, and as such may be studied as a system of well-interconnected parts: people, devices, and documents. Clearly, the notion of integrating a complete end-to-end supply chain is a formidable challenge, mainly due to its sheer scope. This also implies potentially increased complexity. (Engelseth et al., 2018).

An enterprise resource planning (ERP) system is required to build an effective end-to-end supply chain. The ERP system incorporates top-level business processes such as concept-to-launch, procure-to-pay and order-to-cash functions and also hire-to-retire and sustain-and-retain human capital asset management processes to present a holistic view of supply chain operations ,while improving organizational strategic planning & deployment, decision-making, workforce planning and overall business growth (Sharma (2018).

The final element for successful supply chain collaboration is to approach the work with a holistic, end-to-end perspective. Decisions in one part of a supply chain system impact results and processes in multiple other areas. According to Business (2018), to drive supply chain value through collaboration, supply chain leaders must understand and manage the system end-to-end. According to same article, to establish how collaboration initiatives are to be deployed, the unique nature of an end-to end supply chain must be clearly understood. In an end to end supply chain setting, supply chain leaders will agree value creation is a core element of effective collaboration and that unless there are clear returns, investing in collaboration is not a good use of resources. E2E integration is highly complex and requires high levels of collaboration.

Often, a lack of understanding of end-to-end Supply chains lies in the fact that people tend to view E2E supply chain from the perspective of the focal firm rather than as a series of processes of Source, make and deliver required to source the raw materials of the product up to the point of delivery of final product. Business (2018) went further to say attaining an E2E view of a supply chain entails crossing multiple enterprise boundaries. Major product supply and demand transformation occurs when companies can successfully integrate collaboration across procurement, logistics and operations in order to maximize total value creation.

Mostly, supply chains discussions are centered around reducing lead time and improving customer satisfaction by improving the service level for example and reducing the costs burden associated with logistical processes or other manifold target (Kuhn, 2015).

Christopher (2005) in his paper costs, order fulfilment, efficiency and reaching a certain service level are the terms in which traditional supply chains are controlled. Taking these perspectives into consideration, the time control had been a decision-making factor but the other predominant

2.8. Value and Utility

The concept of utility and value are very important relating to disruptive innovation and business models and thus the need for further elaboration. Value and utility have many different definitions.

Economist while trying to understand value has often used the theories of utility and marginal Utility. A basic assumption of this theory is that consumers use their income in a way that maximizes their utility. According to Bowman and Ambrosini (2000), Total utility refers to the satisfaction that comes from the possession of a good. Marginal utility can be as the satisfaction gained from the consumption of an additional unit of a product or service.

Economists often consider value subjective. Meaning a good or a service might be valued by one party and considered useless by another person (von Mises, 1963). Buyers generally are willing to pay different prices for products since they may have different objectives when they acquire the product. On same standpoint, Menger (1950) in his book developed the notions of exchange value and use value. The exchange value according to him is the price that he pays for the good or service while the use value is the value the consumer retrieves from the good or service. A consumer surplus occurs when the use value is greater than the exchange value.

There is much marketing literature on the distinction between value and price. Value sometimes to be a financial expression of what a customer obtains upon payment of a sum. J. C. Anderson and Narus (1998) argue that, the difference between value and price is what customers consider as an incentive to buy. This therefore means reducing the price of the product will not change the value obtained as per the definition; it rather only increases the customer's willingness to pay for the product.

Other scholars have gone further pointing at the subjective nature of value and argue that it can be defined as the perceived benefits in relation to perceived sacrifices (Dodds et al., 1991). Interestingly, this definition does not measure value in monetary terms, but rather, the definition suggests that value is subjective; meaning different actors make different sacrifices and obtain different benefits. These sacrifices could include costs related to maintenance, installation and even transactions (Walters & Lancaster, 1999).

In a certain context, value can be thought of as being created, thus the value of an offering depends on the surrounding environment Håkansson and Waluszewski (2001). It should be noted that value appropriation is not equal to value creation since a new creation of value can result undesired distribution of value. Consequently, actors are exposed to different tradeoffs between benefits and sacrifices hence different preferences (Björkdahl, 2007)

Norman and Ramirez (1994) refer to the relationship between the supplier and customer as offerings and these offerings are valuable if they create either enabling value or relieving value. Enabling value can be created by helping the purchaser do things differently or to do what was not possible before while relieving value is thought of as labor that is removed. According to them, offerings are not only limited to products but can also consist of risk distribution and access to information.

Conclusively, the concept of value as drawn from literature is subjective, since tradeoffs between benefits and sacrifices are both perceived and context dependent. Value can be created and distributed at several levels inside a firm and a network.

2.8.1 Hydroponics “A value to the food Supply chain”

Food security is a major concern to the world, especially in the next few decades because of the increasing population and increase in the economic wealth of rising economies. With the current agricultural production, we have already surpassed the carrying capacity of the earth. Controlling the rising pollution rate when there is a severe climate change, a shift towards bio-based economy from fuel based with increased competition for land, fresh water and labor, is becoming very complicated (Sundmaeker et al., 2016). Indoor farming can be a solution to this issue, a promise to contribute provision of regular food to societies and to tackle current and future environmental issues (Keleş, 2018).

Value is perceived differently both by consumer and producer. There is difference between supply chain and value chain. Value chain includes all the business activities that increases the value of the product for the buyer (O’Byrne, 2017). According to author, value is traced in opposite direction than supply chain. It flows from customer back through supply chain to production, creation, and extraction of the raw material. It also includes activities which are not included in supply chain such as value through marketing and product development etc. supply chain activities such as inbound logistics, outbound logistics and also manufacturing, ultimately add value to the final for the final customer that is why it is associated with value chain.

In an article by Neven (2020) sustainable food value chain (SFVC) is defined as:

“The full range of farms and firms and their successive coordinated value-adding activities that produce particular raw agricultural materials and transform them into particular food products that are sold to final consumers and disposed of after use, in a manner that is profitable throughout, has broad-based benefits for society, and does not permanently deplete natural resource”

The sustainability of the VC plays out simultaneously along three dimensions: economic, social, and environmental. On the economic dimension, an existing or proposed upgraded VC is considered sustainable if the required activities at the level of each actor or support provider are commercially viable (profitable for commercial services) or fiscally viable (for public services). On the social dimension, sustainability refers to socially and culturally acceptable outcomes in terms of the distribution of the benefits and costs associated with the increased value creation. On the environmental dimension, sustainability is determined largely by the ability of VC actors to show little or no negative impact on the natural environment from their value-adding activities; where possible, they should show a positive impact.

Engelseth (2016) argues that locally produced food supply chains are transparent and reciprocal interdependency is also abundant due to the fact that the activities of this kind of inter-organizational structures are so simple that it is sufficient for human perception to make understanding the operations. Though modern food production involves long series of low-priced, standardized consumer products are located at much distant places till it reaches final consumer. The local food supply has relatively short networked logistical processes and the number of actors involved in its supply chain are multiple. Despite the high prices, demand for local foods are rising and food consumers in developed countries are switching to local food for number of reasons,

mainly because locally produced foods are high quality. Engelseth (2016) went further to say the rise in the local food production is also associated with its effectiveness and efficiency. They are distributed through local food system and final products are marketed to the final consumers either directly or through some intermediary marketing channels. So, the locally produced food supply chains are short, transparent, effective, and efficient. Local supply chain has many economic, social and environmental benefits (Power & Gruner, 2014). The local food is desirable by food consumers because they evaluate the retail fresh outlets based on the food's quality, freshness, prices and consumer's own convenience. (Eastwood et al., 1986)

The chain of manufacturers, distributors, retailers and consumers in a particular place has made network of stakeholders more complex and has gradually replaced the traditional and direct producer-consumer relationship(Engelseth, 2015). According to him, in a local food supply chain, short supply chain and better logistical system performance can lead to be profitable for producers and through fresh vegetables it can be a source of satisfaction for consumers. Food produced locally has a positive impression on consumer for quality food supply and this in turn positively affects consumer's safety perception of food. Engelseth in same paper said local food system is perceived sustainable, involving small and permanent network who assure their community's health and boost local economy this way. Local manufacturers are not only customer-responsive but also bear the responsibility to take care of their community's health by producing fresh food. Consumers prefer buying locally produced food in globalized markets context because they can identify the nature and forms of these locally produced products. Due to increased personal ties, there is more manual exchange of information between the producer and consumer. According to this author, to increase the efficiency in local food supply chain, people and exchange skills are highly vitals. Interdependency is reciprocal in this form supply chain and solutions are negotiated in individual rather than planned.

Engelseth (2015) in same paper tries to differentiate global industrial agriculture with local foods. According to him, in global industrial agriculture, there is no direct interaction between consumer and producer. It has a complex web of interaction between producer, intermediaries, and the consumers. Market regulations are characterized by long distance between producers and consumers with complex and sophisticated packaging, transport, and interaction between intermediaries. While in local food system the supply network and interaction skills are mainly

based on knowing each other. In marketing channels, the nature and properties of supply network differ a lot from global industrial agriculture. The main characteristics of local marketing channels are short distance between producer and consumer with very few or even no intermediaries involved for packaging, transportation, and sales, also existence of primary marketing channel. Per further suggests that for the local food strategic development, manufacturing and logistical system should be designed in a way that sustains consumer positive attitude of consumers towards local food. One of such measures can be traceability system.

Local food system and direct sales have short supply chain system. To reduce hygiene risk and ensure food safety, the local food producers apply simplified working methods like temperature control, maintaining ph-value, diligent selection of raw materials, clean and disinfection devices, premises, and tools. For this purpose, for big plants where many people are involved in the food supply chain, it is necessary to implement Hazard Analysis Critical Control Point (HACCP) system. However, in short supply chains and direct sales there is a simplified approach for supplying safe food without hampering food safety (Agata et al., 2012).

There are many reasons to develop interest in local food which include economic, environmental, food safety, health and rural development benefits (Robert P. King, 2015). According to the Authors, the benefits of local food system is also associated in the mainstream of supply chain, where these products are provided to the supermarkets. This does not only include strengthening the regional and local economies and providing fresh and quality food but also preserving the local landscapes and family farms. According to this paper, consumers who seek to buy local food for quality and freshness even at higher price. Local food supply chain has given the local farmers to market their products on their own. Direct sales given them more control over distribution and allow them to earn higher market value as compare to selling mainstream intermediaries. Robert and King (2015) went further to say, this channel also allows consumers to seek fresh foods directly from the source. There are other mainstream supermarkets who understand this opportunity and increase customer loyalty by selling these local fresh and quality foods to their customers. There is also interest for federal state and municipalities to facilitate the development of the local food system in order to reduce food insecurity, support small farmers and rural economies, improve healthy eating habits, and foster closer connections between farmers and consumers.

Urban farming in local food supply chain is a practice to respond to challenges like shortening the food supply chain, reducing the greenhouse gases emission, microclimate improvement, improved health related issues, improved water management and stress reduction (Romeo et al, 2018). Urban farming is not a homogeneous practice. It can be small commercial farms, rooftop gardens or greenhouses, hydroponics and aquaponics farms, community gardens and agriculture, indoor agriculture etc.(Smit & Nasr, 1992). According to them, this type of agriculture can promote the development of circular economy as it closes the ecological loops through water waste and inputs of organic solid waste. With the use of renewable sources, hydroponics can be the best production system in each climatic area. Growing local food without occupying the land for agriculture is the value added by vertical hydroponics in order to fulfill the fresh food demand of urban population (Romeo et al., 2018).

According to Holt (2007), the local food supply chain system has a lot to do with the regional development. It specially effects the fuels, cost of transportation and socio economically. It helps promoting sound social trade including cultural knowledge, healthy diet, and opportunity for small local producers. It does not only support local system but also promote awareness of environmental and social impacts of existing international trade.

2.9. Food Chains

2.9.1. Short Food Supply Chains

The French ministry of agriculture defines SFSC as those systems with one or fewer intermediaries (R. Peters, 2012). Short food supply chains have the capacity to `re-spatialize` or `reserialize` food thus allowing consumers to make value judgements about food. The Food involved in this case are defined by specific farms where they are produced, or by localities. Marsden et al., (2000) went further to say in a short food supply chain, it is not the distance over which a product travels which is curtail but the fact that the product reaches the consumer with embedded information about the product. The embedded information for example could be information printed on the packaging or communicated in person at the sales point. According to them, the information enables the consumer to make connections and associations with the production point and production methods employed and also, products differentiated in this way allows the producer to charge a premium price if the information provided to the consumers of the product is considered valuable.

In a later publication, Renting et al., (2003) went further to identify three types of Short food Supply chains. Namely, face to face, spatial proximity and spatial extended. According to them, in a face-to-face short food supply chain (SFSC), the consumers purchase the products directly from the producer. The interaction between parties creates trust and authenticity. An example of a face-to-face SFSC is the pick-your-own farm shop, farmers markets, and roadside sales (Kneafsey et al., 2013).

For a spatial proximity SFSC, products are produced and retailed in a specific region of production and consumers are made aware of the "local" nature of the products at the point of sales. This category tends to include same retail space as face-to-face category even though the spatial proximity category could include some elements of the hospitality industry like (restaurants, hotels) and specialized retailers like (bakeries, grocers, and butchers). Proximate SFSCs often include intermediary actors in the agro food chain, whereby these take over the role of guaranteeing product authenticity. Examples are local shops and restaurants (for regional products), but also specialized retailers like 'wholefood' and dietetic shops which play an important role in the marketing of organic products (Michelsen et al., 2000). This category could also include public sector food provisions such as universities, hospitals, schools, prisons and care homes (Kneafsey et al., 2013).

As for spatially extended SFSC, all types of retail space are potentially appropriate and consumers outside the region and who may have no personal experience of that region are communicated information about the production process and place. This information is communicated through branding, product packaging and promotion and the use of legislation to protect named products with distinct geographical origin. In most cases products are exported from the region to national markets, but some extended SFSCs may span large distances covering the globe. Examples of these are well-known regional specialties like champagne wine or parmigiano (De Roest, 2000).

Reggiano cheese, the main examples of spatial extended SFSC's are PDO (Protection for designated origin) or PGI (protected geographical indication) (Barham, 2003). Products registered under such schemes tend to have a bigger market and must not only be retailed locally but can also be exported thereby benefiting the producers Kneafsey et al. (2013). According to Renting (2003), such extended SFSC's tend to incur transaction costs for certification and off course, distribution

costs making them occupied by larger businesses. Several products now use PDO's and PGI statuses and the geographical spread of the product registration is uneven.

Rucabado-Palomar and Cuéllar-Padilla (2018) in their paper sought to explore the initiatives carried out by local producers to date in implementing short food supply chain (SFSC) throughout the province and to examine, from the standpoint of the production sector, the constraints hindering its development and the strategies currently being adopted with a view to addressing them. Results obtained from the research show that although SFSCs are interesting for family farms, in terms of prices, economic profit and social recognition, the abilities and capacities these channels require to producers, jointly with technical, flexibility and time demands, make these channels to be not that successful and attractive. Small producers who are interested in SFSC must note that social linkages are very important and need to be take into consideration and create synergies and cooperation with other producers and stakeholders to facilitate the tasks associated.

2.9.2. Perishable Food Supply Chains

The value of a fresh product deteriorates over time and this is highly dependent on the level of humidity and temperature (Blackburn & Scudder, 2009). Also, for any supply chain to decide what supply stage strategy to adopt, a choice must be made between responsiveness and efficiency and that strictly depends on the level of change in value between production and delivery. In order to clarify this, Blackburn (2009) went further to define the marginal value of time (MVT) as a change in the value of a product at a given time, which measures the cost in of a unit time delay in the supply chain. According to him, the choice between responsiveness and efficiency is appropriate when the marginal value of time is relatively stable over time. However, this does not apply for agricultural products due to drastic changes in marginal value of time.

According to Blackburn (2009), Participants in volatile agricultural supply chain could only effectively manage and mitigate supply chain risk, if they can identify and describe the root cause. Taylor and Fearn (2006) in their paper seek to highlight the problems with demand management in retail food supply chains and propose a framework for improving it. In their paper, they found that the characteristics of demand within a number of retail food supply chains demonstrates a propensity for misalignment of demand and supply due to issues such as demand amplification,

inappropriate production policies and inconsistencies with information systems and data handling procedures. According to them, this could imply more information sharing, collaboration and joint planning beyond the manufacturer-retailer interface is crucial for retail food supply chains to function effectively. They thus, went ahead to propose a framework for improvement of retail food supply chains based on greater collaboration and joint planning from farm to fork. (D. H. Taylor & Fearnle, 2006)

Thron et al., (2007) on the other hand in his research investigated the impact of various supply chain advancements within the perishable food environment. He identified product issuing and replenishment as the most crucial in a perishable food chain since the product deteriorates in quality with age. According to the authors, a wide variety of investigation has also been carried out regarding the importance of collaboration and demand visibility on the supply chain and it has shown positive effects on the supply chain. Sabath and Fontanella (2002) in their own research went further to say despite the importance of collaboration, many companies still find it difficult to collaborate due to difficulty in implementation, fear of relinquishing control (Moberg et al., 2003), over-reliance on technology in trying to implement it (McCarthy & Golicic, 2002), and a lack of trust between trading partners (Ireland & Bruce, 2000). Thron (2006) suggest manufacturer and customers can substantially benefit from even a partial increase in demand visibility. This nevertheless can be costly since favoring some customers due to sharing a collaborative replenishment system, while others often seem to experience heavier delivery delays and declining service-level.

Ferguson and Ketzenberg (2005) in their paper identified information sharing between the producer and the retailer as the most important aspect in a perishable food chain. In this paper, they explored the value of information in the context of a retailer that provides a perishable product to consumers and receives replenishment from a single supplier. They assume a periodic review model with stochastic demand, lost sales, and order quantity restrictions. The product lifetime is fixed and deterministic once received by the retailer, although the age of replenished items provided by the supplier varies stochastically over time. Since the product is perishable, any unsold inventory remaining after the lifetime elapses must be discarded (outdated). In this paper, they ended up formulating a retailer's replenishment policy with and without knowing the age of the

product and measures the value of information in terms of the marginal improvement in profit of the retailer after information was shared.

2.9.3. Urban Farming

Urban farming can be defined as the production and cultivation of fruits and vegetables for the purpose of selling, precluding honey, eggs, and other agricultural activities at this time (Food, 1965). According to them, the operations may be both for-profit, non-profit, and/or social enterprise model.

Taylor and others (2012) in one of their papers on urban farming discuss the need for urban farming. According to them, transporting food from rural areas to urban areas where food is consumed by the people is becoming a challenge because of the rising fuel prices, poor infrastructure, and traffic congestion. It is also a challenge to fulfill the need of rising population in large global cities as according to United nations food and agriculture, 6600 tons of food needs to be exported to meet the food requirement in cities with population bigger than 10 million. Land degradation, large amount of freshwater use in agriculture and rising carbon foot prints, due to agricultural activities, are issues that has lead the need to adopt urban farming (R. Taylor et al., 2012). Half of the world's population, today, is living in cities and this percentage will rise to 60% by 2030. Though cities compromise only 3% of total earth's area by will produce three fourth of its total greenhouse gases. It will consume 95% of the total food production. In order to address these issues, sustainable urban farming need to be implemented by government in larger cities R. W. Taylor (2012).

2.9.4. Local Food Supply chains

A lot of research has been done on multi-national collaborations or large-scale supply chain of food businesses and industries, but very little work has been done in this regard on local food supply chain. Local food has great potential for a sustainable food supply chain environmentally. It is also said that local foods enhance health, food security and wellbeing of communities. The perception that local food has several social, economic, and environmental benefits, is driving a lot of consumers change their habits of food consumption to local food for a variety of reasons.

The increase demand for local food has led to emergence of local food system (Getachew & Peterson, 2011).

Food that is produced, marketed and consumed locally is termed local food and is not a new concept even though the term “local” is used in different ways, by different people and organizations (Hand & Martinez, 2010). Given the diverse interest of those using the term, it is more likely that local has come to mean different things to different people. While some definitions consider the political boundaries, others focus on how food is produced, marketed and distributed. C. J. Peters et al., (2009) went further to throw more light saying the term ‘local food’ evades easy definition. In part, it is a geographical concept referring to the distance between food producers and consumers. For example, in a recent survey of US consumers, most respondents defined ‘local’ as produced within 100 miles or within their home state. Also, Zepeda and Li (2006) found that while some African-American food shoppers defined “local” in terms of political boundaries, most food Shoppers defined in terms of driving time. According to them, since time rather than political boundaries define local foods, this brings up the argument against considering state labeled food as local. As per these definitions, local food can satisfy a set of consumer demands either they are related to quality and freshness, economic wellbeing or socio or environmental sustainability (Michael & Stephen, 2010).

Due to the difficulty in identifying the geographic definition of local, the US congress in the food, conservation and energy act of 2008 for the purpose of the certain federal rural loan programs defined locally produced food product as “any agricultural food product that is raised, produced, and distributed in the locality or region in which the final product is marketed, so that the total distance the product is transported is less than 400 miles from the origin of the product, or the state in which the product is produced.”(Hand & Martinez, 2010).

Even though there exist different definitions and examples of local food supply chains, the term “local” refers to food sourced from producers and farms nearby. The structure of local food supply chains can take several forms even though nearness between the producer and the supplier is an essential component of local food supply chains (Hand, 2010)

Hans (2010) in a sponsored research identified two local food: direct market food supply chain (producer-to-consumer) food supply chains and intermediated food supply chains (where one or

more intermediaries are involved in the handling locally produced product before it reaches the consumers). According to him, it is different from mainstream Food supply chains in that with food supply chains, the products are supplied through major grocery supply chains that do not attempt to make meaningful connections between the producers and the Consumers. The local foods marketing channel may be organized through local markets (e.g. Farmer's market), manufacturers' sales offices, community-based units, localized exhibition program and other mechanisms that manufacturers use to sell their products directly to consumers such as consumers coming to the farm or to fishermen (Engelseth, 2016).

In the concept of local foods, three key issues are addressed: How and where food is to be produced, how food is to be distributed and consumers preferences and options to (Darby, Batte, Ernst, & Roe, 2008). The demand for local foods can be associated to consumer behavior. Consumers attitude, behavior and socio cultural background determine their viewpoints regarding local foods(Zepeda & Li, 2006). The socio-cultural attachment refers to the consumers desire to support the local economy, the local people and also to improve the local environment (Zepeda & Leviten-Reid, 2004).

Wolf et al., (2005) in their article identified college students, women, and people with above average income in developed countries as the primary buyers of local foods. This aids distributors in segmenting their target market in their branding and promotions. The marketing efforts needs to be coupled with trustworthy logistics system and traceability to convince the customers that “quality food” are what they are promoted as. It is generally assumed that local food producers use less chemicals and more of natural ingredients which makes local foods more environmentally, secure and safe due to shorter food travel distances (C. M. Saunders et al., 2006). With regards to production method, it is generally assumed that local producers use macro or medium scale and use natural ingredients and market their market size is limited within a given geographical boundary. Factors ranging from; the nature of the business ownership, size of business, method of crop production and relationship to place are the different parameters that can be considered in the definition local foods (Kvam & Magnus, 2012).

Abate-Kassa and Peterson (2011) in their paper seek to examine the relationship between conventional supply chain actors i.e. retailers and wholesalers and local food producers in South East Michigan. In their study, they used the case study approach to examine the roles, experiences, and perceptions of supply chains actors. This was conducted through interviews with managers

and owners of wholesale shops of 11 Shops being their respondents. This study found differences in local food perceptions, buying experiences and perceived benefits and risks associated with local food sourcing activities. According to this paper, that implied that local producers in order to create better market access, they need to provide additional market services and develop trust based relationships with their customers.

2.10. Theoretical framework

We propose framework below for our case study holding and supporting the theories in chapter 2. The case is about a local vegetable growing company in Molde that grow locally and supply to local customers. Hydroponics growth chambers in controlled environment with LED lights, is used for growing green vegetables. The technology is part of urban agriculture. The analysis of this technology will be based on sustainability and value to customers. We will also study if the technology is a disruption to the traditional agriculture supply chain or not. Sustainability, value, and disruption, all will be assessed based on various theories proposed in chapter 2. The analysis will be carried out to judge these aspects in the following way:

- Value to the customers with respect to taste, organic nature, closeness to the customers and buyer-supplier relationship.
- And finally, disruption with respect to technology in food supply chain
- Sustainability with respect to environment, society, and economy.

The analysis will be summed up and conclusion will be made in chapter 5. Since the framework is particularly about Bygartner 1, it may not be used as benchmark for every case.

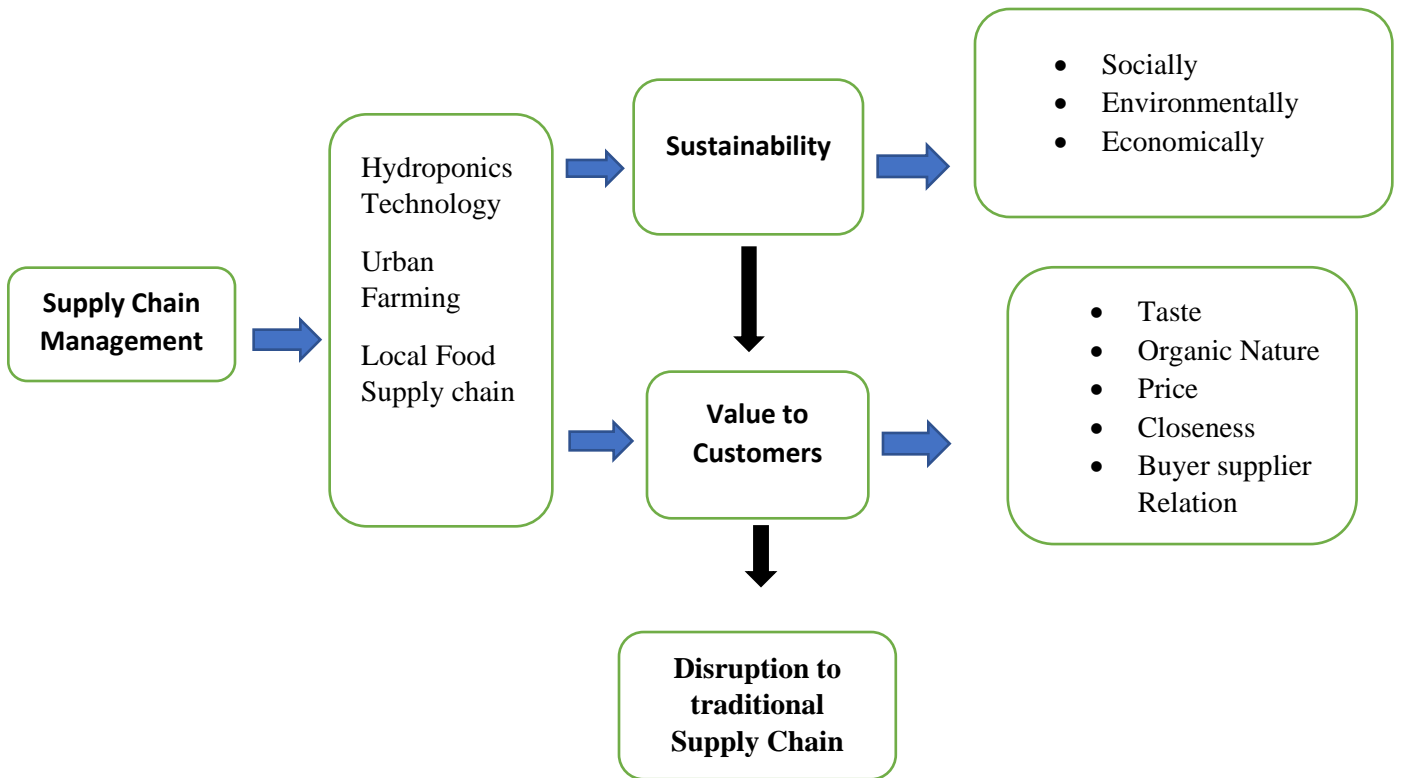


Figure 4: Framework for this thesis.

CHAPTER 3: METHODOLOGY

This chapter is all about research methodology of this study. It is the method of data collection and research design that will help in analysing overall data and information which will be essential solving the research problem through scientific method. According to Saunders, Lewis, & Thornhill (2003), research methodology is the “theory” of how research should be undertaken. They used the framework “research onion” to explain research methodology. According to this framework research methodology encompasses 5 layers which are:

- Naming and identifying the research philosophy
- Research approaches
- Strategy of conducting the research
- Establishing the horizon
- Methods used to collect the data.

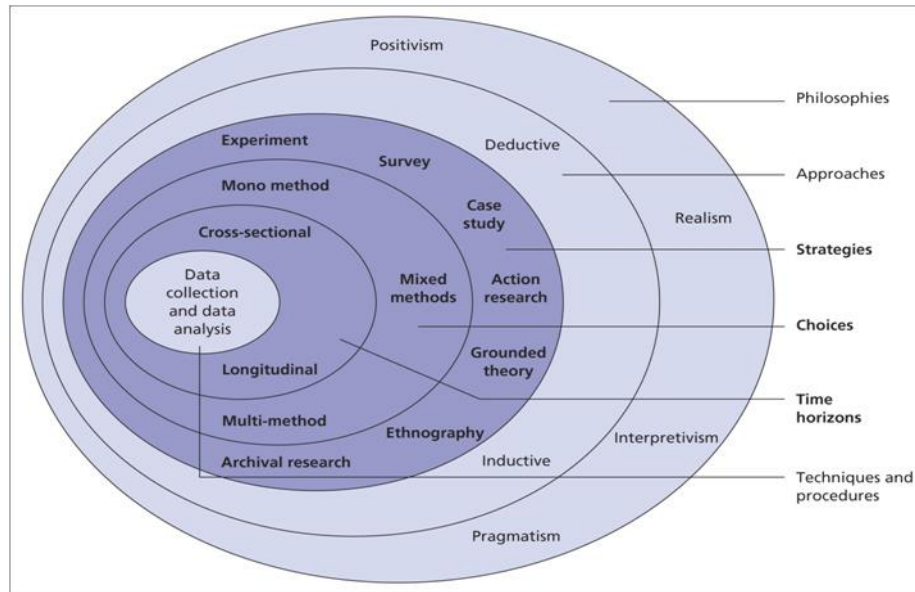


Figure 5 : The Research Onion (M. Saunders et al., 2003)

3.1 Types of research:

There are three types of research:

- Exploratory
- Descriptive
- Explanatory

Exploratory research (Team, 2014) is used to explore, discover the ideas and insights as opposed to collecting statistically accurate data. It is commonly used to further define company, potential growth areas, and alternative course of action. It has qualitative nature and mostly open-ended questions are asked from respondents during survey or interviews. Descriptive survey (mcCombes, 2019) accurately and systematically describes a populations, situation or phenomena. It answers to questions like what, when, where and how but not why. It can either use qualitative or quantitative method of research. Explanatory research also known as casual and predictive research is aimed to study the cause and effect relationship among variables. This type studies are quantitative in nature. This research answers how and why would one thing cause something else to occur.

This study is exploratory in nature. It is a case study about a company (Bygartner 1) in Molde, Norway. This company uses grow chamber hydroponics with artificial lights for producing fresh vegetables, as close to its customers as possible with least carbon emission. We will explore three research questions in this study which are:

- 1) How does the applied technology provide “value” to the customers?
- 2) How disruptive is the use of hydroponics in the supply chain?
- 3) How sustainable is the use of hydroponics?

3.2 Research Philosophy:

Research Philosophy (M. Saunders et al., 2003) adopted by researcher contains important assumptions the way researcher views the world. It is the basis of the research which involves choice of research strategy, problem formulation, data collection, processing, and analysis. Use of right philosophy has much significance in planning and carrying out the research. According to figure 3.1 research is like onion that needs to be peel away as we go through each phase. There are three philosophies of research onion:

- Philosophy of Ontology
- Philosophy of Epistemology
- Philosophy of Axiology

Ontology is the philosophy of nature of reality and structure of the world, directing to specify the form and nature of reality and question what the reality is (Wand & Weber, 1993). In other words, ontology clears the difference between reality and how one perceives it. It is classified under three philosophical positions:

- Objectivism portrays the position that social entities exist external to social actors concerned with their existence
- Constructivism it holds that social phenomena are created from the perceptions and consequent actions of those social actors concerned with their existence (M. Saunders et al., 2003)
- Pragmatism the meaning of this concepts is that ideologies should be found in their practical bearings, that the function of thought is to guide action, and that truth is

preeminently to be tested by the practical consequences of belief. If the ideology is unpractical it should be rejected (Webster, 2020).

Epistemology is the next onion philosophy. It tries to find the acceptable knowledge about the field of research and address the facts accordingly. It is based on the nature of human knowledge and understanding that can be acquired through different kinds of inquiry and alternative methods of investigation (Hirschheim et al., 1995). Epistemology (Jæger et al., 2019) can be divided into two concepts:

- Resources Researcher: it deals with the data from the perspective of natural scientist and involves developing positive philosophies.
- Feeling Researcher: it is concerned about the feelings and attitudes of the workers towards their managers and focus on interpretivist philosophy.

Epistemology is further divided into three philosophical positions:

- Positivism: this philosophy is based on observable social entity. According to this system whatever exist can be verified through experiments, observations, and logical proofs. Positivists believe in objective truth that whatever we experience as reality is out there in the world and deny the influence of things like theoretical and cultural biases that get in the way of science. In positivism all the statements are divided into three categories: True, False and meaningless (neither true nor false) (Terms, 2020). A positivist works with an observable social reality and end product of such research can be law-like generalizations similar to those produced by physical and natural scientists (Remenyi et al., 1998). The strategy of positivism is based on data collection and hypothesis development. These hypothesis are tested, confirmed, and used for further research. Positivists work on highly structured methodology in order to facilitate hypothesis (Jæger et al., 2019).
- Realism is another philosophical position. According to philosophy of realism what the senses show us as reality is the truth: that objects have an existence independent of the human mind. The philosophy of realism is that there is a reality quite independent of the mind. The two kind of realism is direct realism and critical realism. Direct realism portrays the world through personal human senses. Critical realism is the experiences and the images of things not the direct things (M. Saunders et al., 2003)

- Interpretivism is also known as constructivism (Jæger et al., 2019). It is the worldview by researcher that individuals seek to understand in which they live and work. The purpose of this type of research is to depend on participant's views and experiences. According to John Dudovskiy (2018), "interpretive researchers assume that access to reality (given or socially constructed) is only through social constructions such as language, consciousness, shared meanings, and instruments".

Axiology: This refers to ethical issues that needs to be considered while planning research proposal using philosophical approach for making right and valued decision. It considers the value that researchers attribute to different aspects of research, participants, data, and the audience to whom the result of research shall be reported. It simply addresses the question: What is the nature of ethics or ethical behaviour? (Kivunja & Kuyini, 2017).

3.3 Research Paradigm:

Research philosophy and research philosophy are the essential parts of research methodology. According to Guba & Lincoln research philosophy and research paradigm holds the utmost importance in research that guides the investigation (Guba & Lincoln, 1982). "A research paradigm inherently reflects the researcher's beliefs about the world that s/he lives in and wants to live in. It constitutes the abstract beliefs and principles that shape how a researcher sees the world, and how s/he interprets and acts within that world" (Lather, 1986).

3.4 Research Design:

Research Design is the overall strategy that researcher chooses to integrate different components of study in a logical manner so that the research problem could be addressed more effectively, and it constitutes blueprint of the collection, measurement and analysis of the data. Research design is mainly determined by the research problem to be used (California, 2020). Parahoo (2014) explains research design as a plan that describes how, when and where the data are to be collected and analysed. It is a plan and structure of investigation in order to get answer to a research problem (Kerlinger, 1986). Creswell (2016) describes as a systematic master plan for a scientific study that

has several approaches such as qualitative, quantitative or even both approaches can be used in the study.

(Library, 2020) Length and complexity of research designs vary but any well-developed research design will achieve the following:

- Identify the research problem and justify its selection
- Review previously published literatures in the same research problem area.
- Clearly specifies the hypothesis leading to the problem.
- Describes the method of analysis to be applied to prove hypothesis true or not.

According to Adi Bhat (2020), research design explains the type of research (experimental, semi-experimental, review, survey, correlational) and its sub-types like experimental design, research problem, descriptive case-study. Three main types of research design are:

- Data Collection
- Measurement
- Analysis

Four key characteristic of research design are as below:

- Neutrality (the result projected in research design should be free from biasedness and should be neutral)
- Reliability (Research design should lead to same and standard result each time experimented)
- Validity (Helping tools like questionnaire are only valid if it helps researcher in gauging a result according to research objective).
- Generalization (the outcome of the design should not be restricted to any specific sample but for any population with the same accuracy).

Research design can broadly be classified into quantitative and qualitative research designs. This study is based on qualitative research design.

3.4.1 Qualitative Research Design:

According to Van Weele, qualitative research is “an umbrella term covering an array of interpretive techniques which seeks to describe, decode, translate, and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world”. Main focus in qualitative research are process, understanding and meaning, primary instrument for data collection and analysis is the researcher, the product is inductive and the process is highly descriptive (Engelseth, Suarishvili, & Awaleh, 2017). They further describe that this type of research is an attempt to understand the uniqueness of the situation in a particular context and interactions there. It doesn't necessarily predict the future but an effort to understand the nature of that setting. Also the key concern is to understand the phenomena of interest from the perspective of participants and not the researcher's perspective.

According to Jæger et al., (2019), qualitative research is used for understanding and examining the problems of a particular group of people using questionnaires and interview. The method is inductive style with a flexible structure, inductively interpreting the data analysis and pay attention towards the complexity of the situation. Five strategies (Campbell, 2014) have been identified as qualitative research methods. They include;

- **Ethnographies:** “Ethnography is a qualitative strategy in which the researcher studies an intact cultural group in a natural setting over a prolonged period of time by collecting primarily observational and interview data” (Creswell, 2014)
- **Grounded Theory:** “Grounded theory is a design of inquiry from sociology in which the researcher derives a general, abstract theory of a process, action or interaction grounded in the views of participants” (Charmaz, 2006).
- **Case Studies:** It is systematic enquiry about an event or set of events and aims to explain the phenomena of interest. Unit of analysis differs from individual to organizations (Zucker, 2009). Voss et al., (2010) defines case study as “a history of past or current phenomenon, drawn from multiple sources of evidence. It can include data from direct observations and systematic interviewing as well as public and private archives. In fact, any fact relevant to the stream of events describing the phenomenon is potential datum in a case study”. “Case study as a research method is often indexed in most undergraduate research textbooks as neither qualitative or quantitative” (Zucker, 2009).

- **Phenomenological Research:** “Phenomenology is a form of qualitative research that focuses on the study of an individual’s lived experiences within the world. Although it is a powerful approach for inquiry, the nature of this methodology is often intimidating to health professions education (HPE) researchers” (Neubauer et al., 2019).
- **Narrative Research:** “As a distinct form of qualitative research, narrative typically focuses on studying a single person, gathering data through the collection of stories, reporting individual experiences, and presenting the meaning of those experiences for the individual” (“Handbook of Research Design & Social Measurement,” 2002)

3.4.2 Data Collection:

“Simply observing and interviewing do not ensure that the research is qualitative; the qualitative researcher must also interpret the beliefs and behaviors of participants” (Engelseth et al., 2017).

Data collection is the process (Integrity, 2020) of gathering information and measuring it on the basis of variables of interest in an established systematic fashion so that it enables to answer the research question, test hypothesis and evaluate the outcomes. Data collection in research is a common component in all fields of study. The methods vary with respect to discipline but ensuring honest and accurate collection is same in all researches to maintain the integrity of the research. Improper data collection can lead to inability to answer research question also inability to repeat and validate the study. There are two types of data collection;

1. **Primary Data:** Primary data is the data collected by the investigator himself for research purpose. It is the raw data collected at source. This type of data (BBAMANTRA, 2020) is directly obtained from first-hand source through different means like observations, experiments and surveys and not subjected to any manipulation or processing. In this study primary data was collected from Bygartner 1’s 3 customers which include Rema 1000 (a grocery shop) and 2 restaurants (Medly foods and Den Gode Smak).
2. **Secondary Data:** The data source in this is someone other than the user. These are gained from journal articles, webpages, books and press releases. In this study main source of secondary data collection are several research articles regarding short food supply chain and Hydroponics. Webpages, books and Bygartner 1’s main website were also used to for

data collection. Data regarding 2 major competitors (ASKO and BAMA) of Bygartner 1 have been collected from respective companies' websites and yearly reports.

According to Gaurav Jha (2017), there are four methods for data collection;

- **Observation:** Making direct observation can be a good way for collecting simple data about manual and orderly tasks.
- **Questionnaires:** It is instrument of data collection that is administered to the sample subject either through mail, phone or online.
- **Focus Group Discussions:** This method is frequently used in qualitative research in order to get an indepth knowledge and understanding of any social issue. The discussion is between purposely selected group of individuals (Mukherjee, 2018).
- **Interviews:** interviews in research is a conversation between the interviewer and the respondents in which questions are asked by researcher to elicit information from respondents. It is a valuable method for primary data collection. Face to face interview is one the most accurate and compassing method of data collection with factor of trust between interviewer and the respondent to access confidential informationa and for further inquiry and explanation (Engelseth et al., 2017). Interviews are appropriate when an in-depth information is to be collected on people's opinions, thoughts or experiences. Interviews can be conducted face-to-face, on telephone or online. Face-to-face interviews are better when the respondent can communicate better face-to-face than they could by writing, online or on telephone.

Before conducting the interview, we articulated some problem and needs that had to be addressed for this process:

- we took ensured the place of interview be where our respondents feel comfortable. All of them agreed at their work place.
- While booking the appointment for interview, we explained the purpose of interview to all of our respondents so that they make their mind more ready for the interview.
- We also took into account confidentiality of some data (during site visits) that had not to be shared in our research.
- At the time of booking the appointment we explained the format of interviews to our respondents and asked for their willingness to answer the interview questions.

- Timing, date and length of the interviews were all decided while taking the appointment.
- At the end of these interviews we asked each of our respondents for their telephone number or email address and the permission to contact in case of any confusion or need for further data.
- All of these interviews are recorded in mobile voice recorder app with the permission of our respondents.

In this study both primary and secondary sources of data have been used. The process for data collection was planned with care and insight that it may become helpful to answer the three research questions in this study. Respondents for this purpose were contacted few days earlier than the interview. Despite their busy schedules, we were lucky enough to get appointments for the interviews. We interviewed Tugushan Alp (CEO of Bygartner 1) two times, Alejandro Alvarez the manager and owner of Medly Restaurant, Kristian Farstad manager of Rema 1000 and Nana Kristine Jensen of Den Gode Smak in Molde Torget. The nature of qualitative data (Labs, 2018) makes it difficult for the researcher to separate himself from the data but we tried to avoid biasness and achieve objectivity by:

- using multiple references to code the data and show consistency in our interpretation
- asking our supervisor and Bygartner 1's owner for the review of this study's conclusion.
- using as many data sources to justify our interpretation as we could.
- trying to establish the results of this study from the perspectives of our respondents because participants are the only ones who can legitimately judge the credibility of the results.

Primary data is mainly collected through several semi-structured interviews from the owner of Bygartner 1 and structured interviews from few customers within Molde. Respondents were decided with care. Customers include restaurants and grocery shop to whom Bygartner 1 supply fresh vegetables. Interview was conducted face-to-face and responses were recorded through mobile voice recorder app. Customers included 2 Restaurants Medly foods, Den Gode Smak and Rema 1000 (grocery shop) in Molde. Appointments were booked for the interview, interviews went very well. Interview from customers were to collect regarding research question 1. During the interview with Tugushan Alp, we also visited production site and got the pictures. We also

visited Rema 1000 in order to observe how products from Bygartner 1 have been positioned in the shelves of Rema 1000.

There were two different interview guides for customers (different for Rema 1000 because that is a grocery shops while other two are restaurants) and a semi-structured interview guide for the owner of the company, which were carefully created in collaboration with supervisor (present in Appendix). All of the respondents were interviewd according to their respective interview guides in order to be able to compare the result and eventually analyze them. Main goal of the interviews were to get response from the respondents which could help to answer our research questions. The length of the interviews varied from 30 minutes to 1.30 hours depending upon the respondent.

Secondary data in this study has been widely used firstly using journal articles in the literature review. These are used in order to understand and get an insight of existing research regarding hydroponics and finally being helpful to guide us to answer our three research questions. These articles were also valuable to give a understanding of how research findings are presented and discussed in hydroponics supply chain. Through these research articles we came to know that how hydroponics in local food supply chain is percieved by research community and that is how we tried to find the gap through our research. We used these research articles as our source of argument in chapter 2. We also used different reliable websites, books and company reports for collecting secondary data in this study. Taking reliability into consideration, we have also cited these websites in our reference list in the end.

CHAPTER 4: BACKGROUND OF COMPANY

This is a case study of the small firm, Bygartner 1 located in Molde. The entrepreneur is originally from Turkey and is proficient in both Norwegian and English. This firm started production of horticulture in a closed environment applying hydroponics on November 2017 (Bygartner1 2019). Hydroponics is a subset of hydroculture, which is a method of growing plants without soil by instead using mineral nutrient solutions in a water solvent. Terrestrial plants may thus be grown with only their roots exposed to the nutritious liquid, or the roots may be physically supported by an inert medium such as perlite or gravel. Bygartner 1 has the first commercialized growth chamber in all nordic countries. The chambers are pilot base. Plant growth chambers provide controlled environment (Porter et al., 2015) to analyze the effect of environmental parameters such as light, temperature, atmospheric gas compositions, moisture etc. Bygartner 1 was established mainly with aim to meet the food crisis in growing population when due to agricultural activities lands are demolished and environmental pollution is increasing. Cities are getting bigger; world's population has reached more than 7.5 billion. Growing food to meet the increased demand through traditional agriculture has affected both earth and atmosphere. Intuitively, hydroponics should allow economic food production close to the market regardless of climate outdoors. In Norway, this may mean that such production is an alternative to producing e.g. herbs and salads from large-scale farming including imports. Bygartner 1 uses efficient production system with minimum use of power to minimize pollution. Horticulture produces the least pollution compared to other agricultural innovations and almost half of the pollution that smart greenhouses produce. Company is aimed to further reduce the usage of electricity as less as possible (Bygartner1 2019).

4.1 Mission of Bygartner 1

According to (Tugushan, 2020) the CEO of Bygartner 1, his company has as its mission to

“To produce lettuce, micro greens and some selected plants in controlled areas as much as they can, limiting pollution, and bringing products as closer to the customers as possible”.

(Tugushan, 2020)

4.2 Vision of Bygartner 1

The CEO of Bygartner 1 went further and shared future vision of the company, he said:

“We are working with expanding first of all for the møre og romsdal here, we are working to open a gartneri 10 sizes this one to produce further in Romsdal Høgre. it is going to be in Molde. It is first and after this BAMA is going to advise us but it’s mostly north not south”.

The CEO also said that:

“We give you the best taste and care for the environment at the same time”.

4.3 Products of Bygartner 1

4.3.1 Fresh Vegetables:

Bygartner 1 is the sole supplier of 100% fresh, nutritious, and environmentally friendly food such as different types of lettuce, basil and parsley micro greens and herbs in Molde. Company for now is mainly producing lettuce.

According to the CEO of Bygartner 1 (2019):

“95% of our products are tastier than traditionally grown vegetables except lettuce rockets which tastes much strong when grown this way”.

(Tugushan, 2020)

Bygartner 1 produces following products:

1. **Micro-Greens:** These are small and edible green plants that are produced by herbs or other plants. Including stems and leaves, they vary in size from 2.5 cm to 5 cm long. Micro-greens have single central stem that are cut just above supra line during harvesting. They have fully developed seed leaves called cotyledon leaves, usually one small pair (partially developed true leaves. The typical style and leaf configuration for microwaves is approx. 2 cm. to 5 cm. in height and 1 cm to 2.5 cm. in width across the top.



Figure 6: Micro-Greens (Bygartner1, 2020)

Micro-greens despite their small size have quite intense taste. They are used for fresh flavour in restaurants in different dishes and salads. These restaurants also use micro-greens for creative presentation and tastier dishes. The micro, delicate, fresh look provides beauty and dimension combined with a variety of flavour elements.

2. Lettuce: it is among widely consumed vegetables all around the world and it is annual leaf vegetable of the aster family (Asteraceae). There are different types of lettuce which are (Fritz, 2013):

- Romaine lettuce (also called Greek salad. It is sweet and crunchy).
- Iceberg lettuce (also called crisp head and has crisp texture and mild taste).
- Butter lettuce (also called Boston and Bibb lettuce. They are large green leaves are soft and sweet in taste).
- Devils lettuce
- Red and green leaf (has delicate taste)

Lettuce is a rich source of vitamin A and K, but nutritional value also depends on the variety of it.



Figure 7: Lettuce (Bygartner1, 2020)

Following are some health benefits of lettuce:

- The calories in lettuce are very low with no fat.
 - They are rich source of fibre and cellulose.
 - Vitamin C and beta-carotene in lettuce prevents build of plaque, those healthy for heart.
 - They have high ratio of omega-3 fatty acids
 - Romaine lettuce has 20% of its calories as proteins (Fritz, 2013).
3. **Parsley:** it is another widely used vegetable that is indigenous to mediterranean but now is cultivated throughout the world (Drugs.com, 2007). Its scientific name is *petroselinum crispum*. They are up to 80 cm long with yellowish green colour. Entire plant is used in different salads and dishes which include leaves, fruits, and roots. Fruits are sub globose or ovoid that is very aromatic with five equal ribs (plants, 2020).



Figure 8: Parsley (Britannica, 2020)

Parsley is used as a rich source of vitamins and minerals. Different uses of parsley over time are (Drugs.com, 2007):

- Parsley seeds were once used traditionally as carminative to decrease flatulence and colic pain.
- The root was used as diuretic.
- Parsley juice was used to treat kidney ailments.
- Parsley oil has been used to regulate menstrual flow in different treatments.
- It has also been used to treat anaemia, arthritis, and cancers, as an expectorant, antimicrobial, aphrodisiac, hypotensive, diuretic, and laxative.
- Vitamin K in parsley also helps prevention of bone fracture by improving calcium absorption and reduce calcium excretion in urine.

4. **Basils:** is a common cooking herb (Pontz, 2015) that is commonly used in Italian cousin. It is a tender plant with strong, pungent, and sweet smell. The plant sizes differ depending on the variety ranging from 30 cm to 150 cm. basils are richly green and whole plant is edible. There are different types of basils, but sweet basils are commonly used for its sweet taste worldwide.



Figure 9: Basils (Pontz, 2015)

Due to its medical importance it is cultivated from past 5000 years. Main benefits of basil are:

- Basils are strong antioxidants.
- A rich source of magnesium, promoting blood flow.
- Being a good source of Vitamin A, it can improve eyesight.

- Basils are also good source of vitamin C, iron, manganese, calcium, omega-3 fatty acids.

4.3.2. Lead lights and hydroponics systems:

Coupled with the cultivation of lettuce, basil, parsley and other micro greens, the company also distributes LED lights and hydroponics systems built according to customer's specifications. For now, most of their distributions are in Molde since the company is still quite small. They intend to extend their products and services to other parts of Norway in the future.

4.4. Suppliers of Bygartner 1:

According to the CEO, about 85% of everything in the growth chamber is imported from Turkey. While seeds are bought from Norway. Norgro and the farmers shop all based in Norway are the 2 shops that supply these seeds. The products are supplied either through POST or through other third-party logistics companies depending on the type of the seed to be supplied. Seeds sent through truck are basically those that needs special care and must be transported in the presence of nitric acid. According to the CEO, hydroponics systems requires many components which at times cannot be found in Norway. In that case, some of the components are often ordered from other countries like Sweden, Denmark, and others. Company signs contracts with all his customers and suppliers for any sale and purchase.

4.5. A typical Hydroponics system with artificial lights.

Bygartner 1 uses the hydroponics system with artificial lights. This system is quite different from the normal hydroponics system which uses natural lights. A typical hydroponics system with artificial lights constitutes the following components.

- **Growth Chamber:** To grow anything, space is needed. A growth chamber is a designated and enclosed area used for the cultivation of crops in a hydroponics system with artificial lights.
- **Growing racks:** This is the shelves on which the crops are grown. The racks at Bygartner 1 are made up of several shelves. These shelves maximize available space by increasing growing capacity and avoiding new construction.

- **Lead light:** Just like crops grown outside need natural light to grow, to grow vegetables and Micro greens hydroponically in dark enclosures, the grower needs Lead lights. Bygartner 1 has Lead lights as one of the requirements for his hydroponics system.
- **Water Pumps:** Plants in a hydroponics system requires water (nutrient solution) to grow. This water is supplied in the system by a water pump.
- **Rockwool:** A Rockwool, also known as stone wool or mineral wool, is the most widely used substrate for the commercial production of hydroponics. Rockwool's need constant monitoring and irrigation to hold a high level of aeration and moisture at the same time.
- **Growth tray and Dome:** A grow tray is a container designed to hold one or more plants in a hydroponic growing system. The rock wool is placed in a growth tray before the seeds in a hydroponics system can be nursed. When placed on a Rockwool, the tray is covered with a dome to enable seeds sprawl effectively.
- **Hydroponics Nutrient Solution:** A hydroponics nutrient solution is a liquid which contains all nutrients necessary for plants growth. Compared to soil, hydroponic system makes it easier to measure and fill the exact amounts of nutrients in the water solutions.
- **Climate control Equipment:** Just as many plants require a certain temperature to grow well, so too do plants in grown hydroponically. The temperature in the growth chamber needs to be monitored and controlled for plants to grow effectively. This is done with the aid of a climate control equipment
- **Carbon dioxide (CO2) generator:** A CO2 generator is a machine used to enhance carbon dioxide levels in a greenhouse or enclosed areas to promote plants growth.
- **Control device for Nutrition and PH:** Every plant requires different quantities of different nutrients substances to grow. In a hydroponics system, to provide plants with the appropriate quantity and type of nutrients, a control device is used.
- **Timer for Lights:** Just like plants grown outside require varying periods of daylight and night, so too do plants grow hydroponically. The lights used in the enclosed growth chamber need to be controlled. This job is done by a timer.

4.6. The Production Processes

Lettuce, basils, parsley, and other green plants are produced in Bygartner 1. According to Tugushan Alp, the total surface area of production is 60m² and there are several processes taking place here. The main processes include:

4.6.1 Seedling process

Every hydroponics growing begins with the seeding stage. At this stage, the rock wool is used as a substrate for the seeds and is placed on a tray, hand watered and covered with a dome. Afterwards, the seeds can sprawl, and this takes approximately 2-3 days depending on the season/period of the year.

4.6.2 The Growth process

After the seeds sprawl, they are then moved to the growth system where it stays till it is mature and ready for consumption. On the growth system, the control device for nutrition constantly supplies the plant with the nutrients in their right PH necessary for plants growth while the Led light provides the plants with artificial light needed for growth. Also, CO2 generator helps the plants to generate CO2 required for growth. According to the CEO, the plants take approximately 4 weeks to be matured and ready for consumption.



Figure 10: Lettuce in Growth Chamber with LED Lights in Bygartner 1



Figure 11: Parsley in Growth Chambers with LED Light in Bygartner 1

The harvesting process: After the growth comes the harvesting process. The plants are carefully harvested and ready for packaging and delivery to customers (Bygartner1 2019).

4.6.3 Packaging.

Bygartner 1 is a small company with 2 people managing the whole activities. Once the harvesting is done, the team manages to pack all the products in the company. Although the plastic used for packaging is not recyclable, but company has plans to use such plastics in future that could be recycled. For this purpose, company is doing a lot of research and negotiation with authorities that can be helpful to make this cause possible (Bygartner1 2019). Awareness of the people for separating the recyclable plastics and non-recyclable plastics is quite challenging. But with the current changing climate, there is a need for us to adopt measure that minimize the earth pollution as much as possible.

4.6.4. Storage and Distribution.

Company is mainly producing different types of lettuce. Its harvesting period is from 2-6 weeks depending upon the type of the lettuce being harvested. Once the vegetables are harvested, they are packed and delivered to Bare, a distribution company, who distributes Bygartner 1's products to 46 shops out of Molde. In Molde, Bygartner 1 is responsible for its product's distribution and the products are distributed to the various customers immediately after harvest (no storage) (Bygartner1 2019). The vegetables remain fresh for more than 5 days once harvested.

4.6.5. Market

Main market of Bygartner 1 is Molde. Bygartner 1 distributes its products in Molde while to the rest 46 shops, products are distributed by another distribution company called Bare (which is a joint venture of Rema 1000 and Bama Gruppen). Products are received by a truck at 8pm every evening and supplied to the shops for the next day sale.

4.7. Customers of Bygartner 1

Bygartner 1 make contracts with all its customers for vegetable supplies. The number of productions also depends upon these contracts. it supplies its products to Rema 1000, Bama Gruppen, and any major restaurants in Molde such as Medly Food, Linjebygg AS canteen etc. Customers prefer its vegetables because they are tastier and healthier. The CEO of Bygartner 1 says:

“My products are not cheap. Its 5 kroner expensive than another one but I am selling more than another one. It’s because of the taste, because of the freshness. And of course because there is no herbicides or pesticides on them”

The following section will analyse Bygartner 1’s customers and the range of products they order from Bygartner 1:

4.7.1 REMA 1000.

REMA 1000 AS is a business owned by Reitangruppen and operates both in Denmark and Norway and is one of Norway’s strongest brand. This Business has offered low priced and good quality goods to customers all over both countries since 1979. In Norway, REMA 1000 has 6 distribution offices, 12 regional offices and has it headquarter located in Oslo. The head office performs tasks related to finance, procurement, IT, and joint marketing while the regional offices offer services to stores in the region, regional marketing, and establishment of news stores in the area.

REMA 1000 is the main customer to Bygartner 1 in molde and this business has 2 main locations in Molde (REMA 1000 Fuglset and REMA 1000 Reknes). This company became a customer since January 2019 and according to (Farstad, 2020) they used to order 5 products from Bygartner 1 but today, they only order crispy Salad due to the new Norwegian regulation

which restricts small farmers to produce. Manager of REMA 1000 (Reknes Molde), Kristian Farstad says:

“We have crypsy salad from Bare but the main reason for choosing Bygartner because bygartner because it is selling more and more so we decreased our order from Bare and increase that of Bygartner”.



Figure 12: Displayed crispy salad at REMA 1000

4.7.2 Den Gode Smak.

This is a gourmet shop and café. It is situated in Molde torget (shopping mall) and was started by Ellen Espeland since 2005 replacing Peppes Pizza (Silseth, 2017). The cafe offers (Tennøy., 2020) large variety of coffee and tea, high quality olive oil and many other exciting products from Italy, France and New Zealand. They also offer food products from Trondheim and Geiranger like cheese, salmon, jam, mustard, and confectionary. It serves baked cakes, yeast baking, ice cream and various coffee types at this restaurant. It orders fresh vegetables from BAMA, ASKO and Bygarter 1 herbs and crispy salad from Bygartner. Den Gode Smak get these supplies from Bygartner 1 once a week but in the season of high peek it plans to order the amount of salad.



Figure 13: DEN GODE SMAK (Silseth, 2017)

The cafe is now serving in a larger room. It has 9 total employees now. It is no more just selling smoothies and coffee, but also serving hot lunch. For this purpose, they are seeking one chef in a full-time position, two weekly cleaning assistants and one extra assistant. In an interview with Rbnett, Managing Director Nanna Kristine Jensen said that:

“It will be exciting to develop our concept further. We will focus more on the smoothie and focus on the coffee shop concept. We also serve food for everyone, so that those with allergies and intolerances can also come and eat with us”

Bygartner 1 is a major supplier of fresh salad to Den Gode Smak. They supply herbs (Basilica) and crispy salad (lettuce) to them. They also used to supply micro-greens but due to some governmental regulations, they had to stop its production. Nana Kristine Jensen, manager of Den Gode smak in an answer to a question that are they willing to buy more from Bygartner 1 if Bygartner 1 increases its production capacity, she replied:

“We actually don’t know yet. If he grows different things, I will order from him instead of Bama, but the amount I am not sure since we have to adjust to the number customers”

She further said that:

“We support Bygartner 1 because he is a local producer and that is very important to us and also to support the local community which is important”

4.7.3 Medly Food.

Medly is a small local restaurant started as Molde's first food truck for spring 2107. The restaurant is owned by Alejandro Alvarez. Due to formidable response from customers, he took over the premises at ferry quay where Skippy's served fast food for years. Medly offers specialty burgers, grilled on real charcoal grill. Apart from burger the restaurant also offers exciting variety with the salad of the week and the taco of the week, made in a real Mexican way, BBQ spareribs, fish, and chips and much more.



Figure 14: Medly Food (Rbnett, 2020)

Medly food uses different vegetables in their salad and dishes including onions, carrots, chillies, herbs from rosemary, green onions, chives, tomatoes. They order these vegetables from BAMA. Medly food also order Bygartner 1 lettuce (mostly), micro-green and basils. As per Alejandro Alvarez, they order salad from Bygartner 1 because:

“Yeah, the fact its local company that is growing a salad a 150m from us. I think that’s is very positive because we are using very little gasoline to move salad from there here. I think it a luxury that I can afford to buy a salad that is made so close from where we are serving it. And also it help those small companies to help each other. Kind of to promote the economy between small companies and yeah that’s positive”.

We asked Alejandro Alvarez if he feels any difference between the salad from Bygartner 1 and other companies, he replied:

“The salad from Bygartner 1 is super fresh. He is cutting them the day before delivering to me. And he is packing them himself and it’s the salad that can stay in fridge for the whole week with

no problem. If I order salads from BAMA, these are salads that have been travelling already for days and it might be the case that I get the box of salad and there is already a couple of salad that are starting to look bad or suffocated. They have been closed in the bag for long time. Totally, I mean the quality of product that I get cannot be better. There is no company in Norway that is gonna bring a better salad than what he is bringing me”.

The demand for these salads varies depending on the season and number of customers. Medly food get the supplies of these vegetables twice a week and the owner of the restaurant is willing to order more if there is an increase in demand coupled with increase in production of these vegetables by Bygartner 1.

4.8. Competitors of Bygartner 1

According to (Tugushan, 2020), due to the cold climate, most fruits and vegetables consumed in Norway is mostly imported and this is done by two large importers (BAMA and ASKO) controlling two different food supply chains. There are a few local producers of Vegetables in Norway, but they mostly produce in summer due to the cold weather. In this study, we consider BAMA and ASKO competitors since they import fresh vegetable products like (Lettuce and Microgreens) from other countries which can as well be produced locally. The rest of this section will focus on the competitors.

4.8.1. ASKO:

ASKO is a Norwegian company with 3300 employees. It is Norway’s largest grocery wholesaler and is part of NorgesGruppen. NorgesGruppen is a grocery wholesaling group with various retail outlets covering all parts of Norway and had a market share of 43.2% in 2018. NorgesGruppen has 1200 suppliers throughout the country for its different product range (N. A. Report, 2018). It runs its own private labels which include First Price, Eldorado, Folkets and 6 more. ASKO serves 25 thousand products to 14 thousand clients all over the country(ASKO, 2020).

- Transport: (address closeness) ASKO ensures effective distribution of products to the grocery, retail convenience goods and institutional catering sectors. Throughout the country ASKO has 13 regional warehouses, 8 storcash stores (B2B), 2 central warehouses, one consolidation terminal in Vestby, Akershus. In 2018, ASKO implemented a new transport

management system to make better use of the transport equipment through good planning, stable deliveries, and good deviation alerts. The system is one of the most advanced of its type in Europe (N. A. Report, 2018). ASKO continues to roll out solar panels on their warehouse roofs and assess other measures to cover the remaining energy requirement when electrical and hydrogen-fuelled distribution vehicles become a reality. The ASKO companies have established their own biofuel tank facility. This fuel is used in the distribution of goods out to customers and is offered to haulage contractors hired to deliver goods from suppliers. In 2017 60% renewable fuel has been used for the overall distribution of products by NorgesGruppen (Report, 2017)

- Quality: ASKO claims to be in the forefront when it comes to environment and quality. ASKO's focus is on good quality, resource efficiency, low emission, food safety and sustainable development.
- Positioning: An effective distribution network is a prerequisite to ensure that the consumers get products to the lowest price and best quality possible. Retailers throughout Norway get competitive prices and a wide range of products being customers to ASKO. ASKO has 4 chains throughout Norway which are KIWI, MENY, SAPR and Joker.
- Customers: apart from selling its products in its chains, ASKO also supply groceries to Horeca (which includes hotels, restaurants, caterer, and hospitals). The external customers include:
 - Catering ASKO has 14,000 customers in the catering market.
 - Groceries In addition to its own stores, ASKO also delivers to external grocery store operators (N. A. Report, 2018).
- Value creation is through purchase of Norwegian agriculture which are produced locally. According to NorgesGruppen (N. A. Report, 2016) "The most important contribution to value creation in the districts and living local communities is the purchase of Norwegian agricultural produce and locally produced food, as well as store operation in the districts". NorgesGruppen has introduced online shopping since 2017 for a quick and easier shopping for their customers. They observed that online customers are keen to take advantage of special offers, shop more healthily, and plan more (Report, 2017).

➤ Warehouses: The items in the warehouse are rolled over within an average of four to five days, and some within just a few hours. ASKO is localised with regional warehouses from Tromsø in the north to Lillesand in the south, with a central warehouse at Vestby in Akershus (N. A. Report, 2016). Their efficient distribution network, with an automated central warehouse and several regional warehouses, ensures consumers products of high quality, at the lowest possible price, and makes retailers' lives easier (N. A. Report, 2018). NorgesGruppen aims to be a leader within environmentally friendly transport, store, and warehouse operations. This includes measures to achieve greener fuel, reduce food waste and use of plastic, improve energy efficiency, and increase production of renewable energy. In 2018, For the first time, ASKO's production of renewable energy almost cover its total electricity consumption.

4.8.2 Bama and Bare

BAMA is one of Norway's oldest privately owned retail company and has been in operation for 133 years (B. A. Report, 2018). BAMA HoReCa is a market leader in the marketing and distribution of fruit and vegetables. In recent years other product groups such as fresh meat, chicken and above all seafood and game have contributed a rising share of sales. The HoReCa market covers hotels, restaurants, catering, the public sector and the business market (B. A. Report, 2016). BAMA was started in 1886 by a sailboat skipper businessman by name Christian Emil Matthiessen at the age of 36. Bama was the first Norwegian company to start importing Bananas in 1905 and has since then proved adaptable through two wars and tough competition.(BAMA, 2020)

Today, Bama is not only Norway's leading fruit and vegetable supplier but also has a very strong position in fresh processed products. According to BAMA (2020) this company is the Norwegian company with the highest number of suppliers worldwide with over 1400 (on all continents) and their company alone supplies over 17,000 Norwegians with over 500,000 tonnes of products ordered worldwide. These products are handled through their terminals and Some of the products are short lived hence, Bama has developed an advanced logistics system that allows fresh and high-quality products to be delivered to customers(BAMA, 2020). In 2018 (B. A. Report, 2018), 506,000 tonnes of fresh products has been supplied by BAMA out of which 34% were from

Norwegian producers. They were taken at 300 different loading points from 1,163 suppliers while 66% were international producers and these products are loaded at 220 different loading points from total of 234 suppliers.

Fruit and vegetables are live products whose quality must be maintained, regardless of distance, and well-thought-out logistics solutions play a crucial role in ensuring that fresh and pristine products reach our customers and the consumer as quickly as possible. Reducing the distance from field to fork is an ever-present aim in this context, and the products are refrigerated during their entire transport, regardless of origin (B. A. Report, 2018)

Bama takes upon itself not only to offer fresh products but also takes the health of their clients, the nutritional value of their products and the environment into consideration. Bama in order to ensure that they offer high quality products, they engage into all aspects of production and distribution from farm to fork. Bama controls and monitors their crop producers to ensure awareness on Hygiene, plant protection, and cooling chain amongst others.(BAMA, 2020)

This company being a food company owning several production units all over Norway is subject to some regulations pertaining to food safety. This regulation is to ensure that food produced, packaged, stored and transported in these units adhere to the regulations.

Furthermore, with research being an important tool for value creation, works closely with work closely with Gartnerhallen, Nibio (formerly Bioforsk), Nofima and other national and international research institutions as needed to increase production and value creation of Norwegian fruit and vegetables and also to increase their understanding of virus and bacteria activity and growth conditions. (BAMA, 2020)

BAMA (B. A. Report, 2018) also aims to reduce CO2 emission and to achieve this goal they require to choose appropriate transport means. As a cost-efficient and environmentally friendly option, Shortsea is a good choice. BAMA aims to use more direct transport and make less use of central warehouses. Shortsea solutions are competitive and satisfy their requirements for both emissions and quality. Several harbours in Norway could potentially be of interest in this context. They are working to replace fossil resources with renewable resources. For while BAMA's actual products are renewable, they still use fossil resources in packing, packaging, transport and processing. they are striving to reduce emissions by making more stringent requirements for

transport service procurements, increasing the share of sea and rail freight and optimising packaging that increases utilisation rates for each transport.

Bama is the main distributor of the products of Bygartner. BAMA has been a distributor of Bygartners products since 2019 and distributes to over 46 other shops out of Molde. According to the CEO of Bygartner 1, BAMA became a distributor of their products in 2019 and since then, sales has been increasing gradually.

4.9 Future goals.

According to the CEO of Bygartner 1 (2019), they have plans to increase the production, but this mainly depends on the number of contracts it receives from its customers. All the work has already been done in this regard and they are waiting to receive the contracts from their customers. In an interview with the CEO of the company, he said:

“The vision of this company is of course this is pilot we are talking about, similar of this one but much bigger size and at different places in Norway, where they need, where they have no production because climate doesn’t allow them to produce”.

The company is expected to increase its production to 25000-30000 lettuce each month depending on contract. For now since the production is not much on a bigger scale that is why the CEO himself has the responsibility to distribute the products in Molde but once they increase the production on a larger scale, they will handover this responsibility to the third party company and solely focus on production of these vegetables. The company is expected to expand in other parts of Norway as well. In this regard CEO of Bygartner 1 says that:

“We are working with expanding first for the møre og romsdal here, we are working to open a gartneri 10 sizes this one to produce further in Høgre Romsdal, it’s going to be in Molde. It is first and after this BAMA is going to advise us but it’s mostly north not south”

In an answer to a question regarding his views about future of hydroponics system with artificial lights in controlled growth chambers, he said:

“It will come to those countries which doesn’t have the climate to grow those things. I don’t say everywhere. It will come to Nordic countries, it will come to Arabic countries, Africa will use it but not with artificial light because they do not need it. It will come to places where there is extremely much population like in the middle of Shanghai an industrial area, New York, London has already started it in their tunnels. All those countries will do it. Will it come to Mediterranean? Yeah, after verse when we have even less water because we don’t have water”.

Considering the current issues faced due to sudden climate change, Bygartner 1’s future goal is to use plastic that could be recycled contributing for a cleaner environment as much as possible. It also has plans to use a system that would minimize use of power as much as possible because that would be more environmentally friendly. Bygartner 1 is already working as an agent for the distribution of LED lights and Hydroponics system in Norway and is also ready to provide training and mentor those who wants to establish hydroponics system so, that they have great start.

CHAPTER 5: ANALYSIS AND DISCUSSION.

Based on the presented cases and knowledge gained while reviewing literature in chapter 2, this chapter will now analyse the secondary data obtained in the field to answer our research questions. This analysis will be done with some reservations as it has been very hard getting complete data from the competitors due to the COVID-19 outbreak.

To effectively achieve the purpose of this thesis, which is to answer our research questions, the analysis has been divided into three (3) sections each targeting a specific research, question. Section A targets the question “How does the applied technology provide value to the customers?”, section B targets the question “How disruptive is the use of hydroponics in the supply chain?”, while section C, addresses the third research question “How Sustainable is the use of hydroponics?”

Section A: How does the applied hydroponics technology provide value to the customers?

Looking at Bygartner 1, which is a Small and Local company, based in Molde with a very small customer base, value can be provided at any stage of the Supply chain i.e. from procurement of seeds and equipment’s to production, right up to consumption.

5.1. Supply Chain management and value creation.

Supply chain management remains an integral part of every successful business. The success of every business relies on management of certain key business processes ranging from procurement, production, inventory management, transportation until when the final products are delivered, and cash realized.

Every supply chain if efficiently managed translates to low cost of final products, which goes to benefit both the company in terms of profit and the final consumer in terms of lower costs. Supply chain management is a continuous process and always needs improvements in the process of growth. Nowadays, many companies face instability in their supply chains due to the absence or lack of two parameters that feed Supply chain stability: “timely exchange of information” and “process integration”.

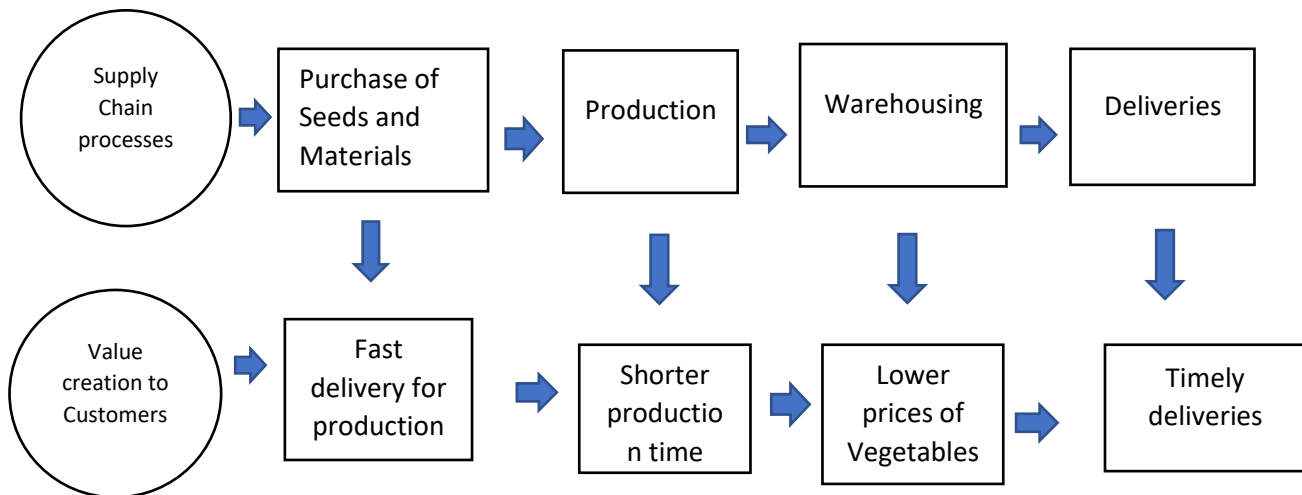


Figure 15: Supply chain processes and Value creation of Bygartner 1

5.1.1. Value creation to customers by Bygartner 1.

As concerns the the supply chain in question, Bygartner 1 has a relatively short supply chain since most of his activities from procurement of seeds; right up to consumption of final product is done mostly within Norway whereas, for the competitors, fruits and vegetables are imported from

abroad. For Bygartner 1, this means the entire supply chain is shortened and intermediaries are reduced. The value provided by Bygartner 1 to his customers can be summarised below.

	Organic Nature	Taste	Durability (Freshness)	Price	Closeness	Buyer Supplier Relationship
Madly	✓	✓	✓	✗	✓	✓
Den Gode Smak	✓	✓	✓	✗	✓	✓
Rema 1000	✓	✓	✓	✗	✓	✓

Table 4: Value provided to Customers by Bygartner

With respect to procurement, Bygartner buys seeds, nutrient solutions, and other required equipment's for production from companies all based in Norway. This alone makes it possible for the ordered products to arrive the company on time (relatively faster deliveries), enable the company produce vegetables on time, and meet the deadlines of its customers. Thereby making Bygartner 1 also reliable in terms of supplies to its customers.

Another major process in a Hydroponics system is the **production** process. In a Hydroponics system, the time taken for vegetables to grow mature and ready for consumption is relatively shorter compared to the production of vegetables in a traditional farming system. This makes the tie taken from “farm to fork” shorter. Also, the vegetables produced hydroponically are Pesticide free. This makes it both environmentally friendly, safe, and healthy for human consumption. While interviewing some of the customers (restaurants), they confirmed that they ordered the products due because they are organic. Meaning they do not only care about feeding but also about eating healthy. Meaning this adds value to the customers.

Furthermore, warehousing which is one of the supply chain processes is not required in a hydroponics system of Bygartner 1 since, crops produced hydroponically are not stored before delivery but rather, are delivered directly to the consumer immediately after harvest. This benefits the producer in that no cost is incurred on warehousing which goes a long way to reduce the expenses of the producer (Bygartner 1), and to some extent to reduce the final price of the product. In addition, the absence of warehousing makes it possible for the vegetables to be delivered early enough after harvest and for products to arrive the customers in total freshness, compared to those imported by competitors as mentioned earlier in chapter 5 of our study.

With regards to transportation within Bygartner 1, transportation within molde is carried out by the CEO himself since the distance between the company and customers is relatively short. This makes the products arrive the customers in total freshness. In addition, emergency deliveries to customers are easily met due to short distance between Bygartner 1 and his customers. For customers out of Molde, Bama carries out transportation. The main value added to customers here is that the products take a short time to arrive customers.

Looking at the supply chain of Bygartner 1, we notice that he has very few intermediaries and processes. This makes it easier for him to integrate the processes effectively. Furthermore, Bygartner 1 has direct contact with his customer's which makes it possible for the customers to channel their worries regarding the products directly to Bygartner.

Hydroponics technology being a Local food, helps the entire community

5.1.2. Value creation to customers by ASKO and BAMA

ASKO is Norway's largest grocery wholesaler and is part of NorgesGruppen, while BAMA is one of Norway's oldest privately owned retail company and has been in operation for 133 years. These both companies, beside supplying other various grocery products throughout Norway, also supply fresh vegetables in their retail shops, through online sales and directly to different HORECA customers like hospitals, restaurants, catering, the public sector, and the business market. These companies started decades ago as compared to Bygartner 1 that is why they have major market share in Norway. These companies buy their supplies from different parts of the world and sell

their products all over Norway that is why their supply chains are much more complicated than Bygartner 1 which produce locally and sell to local customers only.

Unlike Bygartner 1, they have much longer supply chain that involves a lot of suppliers, distribution channels, advanced transport system to supply their products throughout Norway and number of retail shops to sell these products to final customers. For such a huge supply chain, with so many players in it, it takes a lot of time for the whole process, getting the supplies from suppliers to selling them to final customers.

ASKO is controlled by the parent company NorgesGruppen that has 1200 suppliers for their overall products throughout Norway. All the food suppliers for ASKO are local producers throughout Norway. BAMA has 1400 suppliers from 80 different countries in all the continents in the world. More than 60% of these suppliers are outside of Norway. Managing these huge number of suppliers with respect to timely delivery and quality product, is quite complicated. These suppliers also produce these vegetables traditionally in soil and this traditional form of farming requires use of different pesticides and other chemicals for killing pests and for proper growth of these vegetables. Beside drawbacks like soil erosion, too much water-use and more land for less production, this method of producing is also not very healthy and very time consuming. It is also impossible to grow vegetables this way in areas with harsh weather, especially in winter, that is why these companies may need a lot of suppliers to overcome the supply shortage. This form of growing vegetables makes them less preferable for end users as compared to vegetables produced in hydroponics growth chamber with LED lights in controlled environment.

Both ASKO and BAMA manage transport of vegetables to their respective retail shops and Horeca customers in different parts of Norway themselves. Throughout country ASKO has 13 regional warehouses, 8 “storcash” stores (B2B), 2 central warehouses, one consolidation terminal in Vestby, Akershus, while BAMA has central warehouses from where these fresh products are distributed to their respective retail shops and Horeca customers. Managing transport of fresh products at such long distances is a difficult task. Lead times are longer and there are additional costs during transportation like landed costs, customs duties, and freight forwarder charges. These companies use special transportation with refrigerators in them to keep vegetables fresh till they are brought to their customers. Quality of these vegetables are pretty much compromised due to

days of travelling after they are being harvested, making them less durable as compared to vegetables produced by Bygartner 1 through hydroponics growth chambers with LED light in controlled environment. The transportation also causes tons of carbon dioxide emission in the environment. As compared to this kind long food supply chain, short food supply chain of bygartner 1 is environmentally friendly, safe, and healthy for human consumption.

Section B: How disruptive is the use of Hydroponics in the Supply Chain?

To be able to answer this question, it relevant come up with some more research questions that will facilitate the answering of this question. In this section, we will also be drawing literature from chapter 2 while discussing alongside data collected on the field to enable us to answer this research question.

- How is the Norwegian food supply chain structured?
- What innovation or additional value does this technology bring to the existing food supply Chain?

5.2. Situation of the Norwegian Food Supply Chain.

As mentioned in chapter five of this work, the Norwegian food supply chain is controlled by two main companies BAMA and ASKO. Every food and vegetable item imported or produced locally and sold within Norway must pass through these two major companies. This therefore means that, there is very little competition in the food industry in Norway. With the case of Bygartner 1 a local hydroponics producer with artificial lights, even though his products are preferred by the local customers, he only produces following guidelines laid down by BAMA. For instance, in an interview with the CEO, he said he no longer produced microgreens since he did not meet the minimum requirements placed by the Norwegian government.

Even though there exist some few farmers who produce fruits and vegetables within Norway, this is mostly done in summer (approximately 2 months duration), when the temperature is favourable for plants growth. Even local farmers within Norway are controlled by the ASKO and BAMA. Since, they must be registered in their system to have access to the market as mentioned above.

With the current food Supply chain in Norway, fruits and vegetables ordered by BAMA, ASKO from other countries take some days or weeks to arrive their warehousing facilities in Norway before being distributed to the various regional stores. This therefore means the fruits and vegetables do not arrive Norway very fresh compared to those harvested and sold in Norway.

5.3. Innovation to the Food Supply chain in Molde.

Judging from data collected on the field, it is evident that this technology is best suited for the cultivation of some selected vegetables such as lettuce, parsley and other microgreens which take a shorter time to mature. This is because, growing hydroponics with artificial lights consumes more energy in the growth process making it not suitable for the cultivation of other crop types that require more time to grow. Whereas, with the traditional method of farming using soil, all other crop types are grown using natural light which makes this method of farming relatively cheaper when compared with those crops that take time to mature.

Furthermore, from the data collected on the field, it can be noticed that, all the customers of Bygartner 1 tend to choose his products mostly because his products are fresh, taste good and are local. Most of his customers chose his product for the sole purpose of convenience, since they could get products delivered fast enough than that of his competitors who mostly import from abroad. The prices of Bygartner 1`s products in the market are higher than those of competitors, which implies Bygartner 1 has the potential to compete with the high-end customers of the competitors provided she has the capacity.

From the research, it can be drawn that the hydroponics systems require smaller unit area for its cultivation compared to the land area needed for the traditional farming technique. This makes it a preferred technology for farming lettuce and other micro greens in the cities due to limited land.

5.4. How disruptive is the technology in the Food Supply Chain of Molde?

For a disruption to take place according to C. Christensen and Raynor (2003), there needs to be a disrupter (in this case Bygartner 1) and the Incumbent firms (ASKO and BAMA). Also, according to them, a disruption occurs because of innovation and innovation comes in various types, each taking a different approach. In our case, hydroponics with artificial lights has made several

innovations in the food supply chain of Molde (as enumerated above). The authors also mentioned that disruption originates in two main markets: low end and new market footholds. And at the low end, literature suggests that disruption occurs due the fact that incumbent firms pay more attention in terms of improved products and services to the most profitable and demanding customer segment while paying less attention to the less-demanding/less profitable customers. This situation opens the doors for disruptors who come in to provide the low-end customers with good enough products. Literature on new market holdings suggests that the new coming firms (disrupters) create a new market for their products by simply turning non-consumers into consumers. Bygartner 1 happens not to fall in any of the categories. Before bygartner came into operation, the incumbent food chain provided satisfied all their customers within Norway. Bygartner 1 has simply added value in the production of Vegetables and micro greens.

Christensen and Raynor (2003), Schmidt and Druehl, (2005), who suggests that diffusion and substitution of the new product for the old may in some cases be primarily due to improvements over time in the new product's attributes and costs. In that same reasoning, Bygartner 1 is still at an infant stage in the industry and this technology is still new and still requires a lot of research. The CEO of Bygartner 1 himself in an interview mentioned that the crops during growth require a lot of expertise to handle. According to him, in his absence, the crops might end up death since not many people know about this technology in Norway.

This technology is best suited for the cultivation of lettuce and other micro greens that need a shorter time to grow and mature. For this technology to be a disruptive innovation in the food supply chain of Norway and other areas, it will take some more time to research and adapt the technology to the cultivation of other crop types like potatoe, tomatoes and many others which as of now is uneconomical according to our research. Unless stricter environmental laws are put in place, the traditional way of Farming using soil even though not good for the environment remains the ideal method of cultivating crops that take time to mature.

Section C: How Sustainable is the use of Hydroponics?

As mentioned in the literature review, sustainable food supply chain dependent on the type of supply chain involved and how responsible the individual business is towards society, economy, and environment within its supply chain. Bygartner 1 is a local business with a short supply

chain. This is also a company that is practicing sustainability in its entire supply chain and making decisions accordingly. The sustainability of its supply chain is analysed based on the value along three dimensions, which are:

1. Economic
2. Social
3. Environmental

5.5. Economic impact:

Price volatility:

Though Bygartner 1 is comparatively more expensive than vegetables by other companies but it is less volatile than them because unlike its competitor companies, his products final price does not include most of the transport, storage, and logistical costs.

Support to small local businesses (as per customers of bygartner 1):

Larger companies are administered from one part of the world to other parts. The economic benefit is mostly availed by the company and does not benefit much to local economy. While local companies' like Bygartner 1 provides employment to locals thus boosting local economy. For many customers of Bygartner 1 like Medly and Den Gode Smak, one of the reasons for buying vegetables from Bygartner 1 is because it is like local companies supporting each other. Instead of supporting larger supermarkets, these companies help each other thus keep their money in their community.

5.6. Societal Impact:

No further processing of products:

To preserve vegetables for more days and for transporting them to far away areas, vegetables produced traditionally needs to be processed more after being harvested. Most of these vegetables are frozen, dried, pickled, and canned to preserve them for more days. Vegetables produced by Bygartner 1 are transported to customers a day after being harvested and packed without any

further process. It does not even take an hour for transporting these vegetables to customers in Molde because of the short distance from the place of production.

Totally organic vegetables with no use of chemicals has so many health benefits for the customers:

Normally for growing vegetables, different pesticides and other chemicals are used to protect these vegetables from various kind of pests. These chemicals are also responsible for damaging nutritious value in these vegetables. While vegetables produced by Bygartner 1 is a lot tastier and healthier as during the whole process no chemical is used. Due to indoor farming with no soil base, vegetables have no chance to be damaged by pests. They are more durable and remains fresh inside the fresh for more than 5 days after being harvested while other vegetables reaching more take days during transportation. Healthier, tastier, freshest, and more durable salad by Bygartner 1 is the best option that compels all its customers to prefer over others.

Fresh vegetables available throughout the year:

Bygartner 1 produces fresh vegetables through hydroponics growth chamber in controlled environment with LED lights in the period of 2-6 weeks. Unlike traditional form of farming through soil, this method of growing vegetables can be used to produce fresh vegetables throughout the air. These vegetables are also tastier, healthier, and chemical free compare to vegetables through soil. Bygartner 1 uses pilot base growth chambers with LED lights to produce fresh vegetables like lettuce, parsley, microgreens and many more, for its customers in Molde. This is not possible through other forms of farming, even though greenhouse due to the harsh weather of Norway during winter specially. This can be one of the reasons for loyalty to Bygartner 1 by its customers.

5.7. Environmental Impact:

Carbon Dioxide Emission:

Most of the fresh vegetables in Molde are imported from cities out of Molde. Huge amount of carbon dioxide is emitted in air for each truck transport of these vegetables. This is also expensive because of the fuel and these vegetables need special care like refrigerator etc. during transportation. Bygartner 1 was established to provide people in Molde tastier and healthier fresh vegetables by taking care of the environment at the same time. Bygartner 1 is responsible for growing fresh vegetables in Molde for locals of Molde. Only transportation is needed for seeds and solutions to grow those seeds. While growing and harvesting these vegetables, there is no such process involved that would cause carbon dioxide emission but instead company buys carbon dioxide that is consumed by vegetables during their growth process. All of Bygartner 1's customers are in Molde that are not more than 4 km away from place where these vegetables are produced. Short distance between Bygartner 1 and all its customers result in much less amount of carbon emission.

Soil Erosion:

Bygartner 1 was established mainly with aim to meet the food crisis in growing population when due to agricultural activities lands are demolished and environmental pollution is increasing. Cities are getting bigger; world's population has reached more than 7.5 billion. Growing food to meet the increased demand through traditional agriculture has affected both earth and atmosphere. Soil erosion is an agricultural production challenge. The topsoil is deteriorated as soil particles are removed during the season of heavy rain and through tractors tires that makes deep grooves while making ways for water. Since the production system by Bygartner 1 involves no soil and less area for producing more vegetable than what could be produced through traditional farming that is why it is more sustainable form of farming.

Overall complexity of supply chain: larger companies' performance is mainly impacted by their global supply chain network. Increasing the global reach for them is a complex and difficult task. Bygartner 1 is a local company with a very few numbers of people running it, the CEO of the company and 1 employee. As compared to its competitors, there are few actors involved in it's over all supply chain. In a world where complex supply chains are becoming threat to economy

and particularly to logistical processes, simple and explicit supply chain like Bygartner 1's is a remedy.



Figure 16: Bygartner 1's Supply Chain Process

The procurement for seeds and other solutions needed for growing vegetables is only from Norwegian companies. Selection of the suppliers are part of accomplishing company's vision "best taste and care for the environment at the same time". All these supplies are transported to Bygartner 1 either through post or through trucks (those that need special care). The seeds are grown inside hydroponics growth chambers in controlled environment. LED light used help them grow. LED light is also used to because it is more sustainable and use less power. These vegetables are harvested, packed, and transported by CEO of the company to its customers with no third party involved in between. This short and simple supply chain is the reason why Bygartner 1 has good relations with its suppliers and customers. Bygartner 1 has immense trust with its customers mainly because this direct interaction has led it to have a better understanding with all its customers and opportunity to know about their likeness regarding these vegetables.

CHAPTER 6: CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

6.1. Conclusion

According to FAO statistics, the world's population is to exceed 9.4 billion by 2050 and in order to meetup with the future food demands, the world needs to step up food production by 70% in the next 40 years (M. Yu & Nagurney, 2013). This growth in food production is parallel with the growth in Urbanization which has led to the emergence of new crop cultivation methods in cities with hydroponics being one of them. A hydroponics system is a system of growing plants in an aqueous solution including troughs for conducting a predetermined level of nutrient solution. This

solution is supplied to each trough by a branch pipe extending the length of the trough and including a plurality of outlets spaced at uniform intervals.

The purpose of this thesis was to investigate how disruptive the hydroponics system is to the food supply chain of Molde and to investigate how Bygartner 1 (the company under study) provides value to his customers. Also, due to the increasing concern placed on the environment worldwide, some companies and countries now have increased their focus on sustainable practices sustainability. This thesis thus investigates how sustainable this technology is to the food supply chain. To effectively carryout this research, three research questions were generated.

- 1) How does the applied technology provide “value” to the customers?
- 2) How disruptive is the use of hydroponics in the supply chain of Molde?
- 3) How sustainable is the use of hydroponics?

With respect to relevance, according to Baatargtokh (2015), disruptive innovation despite its widespread use, its essential validity and generalization has seldom been tested in academic literature. The Christensen theory states which states that *“traditional companies cannot be disruptive since they are busy keeping their customers and fighting the competition; hence, they will ultimately fail when disruptors take over”* Vossen, Schönthaler, and Dillon (2017) Also, Yakovleva, (2007) despite the growing public concerns on sustainability due to the operations and impact of modern food systems on the environment such as (soil erosion, biodiversity loss, escalating consumption of natural resources, inefficient land use and water degradation) , very little has been done on the sustainability of the hydroponics technology.

To achieve the purpose of this thesis, the researchers conducted in depth interviews with the CEO of Bygartner 1 and to his customers. The researchers then analyzed the data obtained from the interview to come up with our results.

From the results obtained from our research, with respect to value provision by Bygartner 1 to his customers, this technology provides the customers with fresher, tastier, and healthy food. Also, hydroponics farming being a local form of agriculture makes it easier for the customers to access the products. From our research, we also found that hydroponics technology unlike the traditional method of farming using soil, is more sustainable. This method of farming satisfied the three pillars of sustainability being (environmental, social, and economic) pillars.

Furthermore, with respect to disruption, from the results, we can judge that this technology is quite new (especially in Norway), and much research is still being carried out on the field. This technology also at moment is best suited for the cultivation of some selected vegetables and micro greens that take very little time to mature. That said, this technology may be disruptive in the future it is fully adapted to the cultivation of other food types or if it is fully adopted as a means of cultivation lettuce and other micro greens in Norway. It must be noted that the Norwegian government highly regulates the agricultural sector a lot which tends to limit some potential farmers in one way or the other. For this technology to be disruptive, the government needs to relax the laws governing the agricultural sector in Norway.

The remaining section will address the limitations and recommendations of the Study.

6.2 Limitations:

There are some limitations while conducting any research which can be unavailability of accurate data, access to data, lack of time etc. These limitations impact the research study. We also faced limitations while conducting this study.

we mostly relied on secondary data for competitors who were supposed to be interviewed too. Due to spread of COVID-19, unfortunately we could not get the response and we had to rely only on their respective company websites. Hydroponics is an emerging concept in Norway. We had not much available accurate data about hydroponics food supply chain and sustainability in Norway that is why we had to mainly depend on literature. Time constraint and lockdown due to COVID-19 was also the reason why we had to rely a lot on literatures. Another constraint is that our respondents (few customers of Bygartner 1) were not much aware about hydroponics. Though we tried to let them know about this technology in the beginning of the interview but still the validity and reliability of the study should be checked before future study. This study is particularly about Bygartner 1, the future use of this study on any other case, needs to be checked though we have tried our best to validate our study through research articles and other sources of secondary data.

6.3. Further Study:

It is not possible to cover (analyze and explore) all the aspects of anything in one master thesis. There are issue and contents which can be explored in future studies. Here are few recommendations that can be explored in future studies

- Future study can be on cost effectiveness of Hydroponics in food supply chain.
- Hydroponics technology and local food supply chain can help CO₂ emission in the environment. Future study can be CO₂ percentage reduction due to less transport needed
- Study can also be conducted the supply chain barriers of the local food which we could not due to time constraint.
- Efficiency in hydroponics local food supply chain with the use of different IT softwares can be studied in future

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APPENDICES

INTERVIEW GUIDE.

Addressing the question on Value.

The target population: Customers of Bygartner 1. (Shops and Restaurants)

Rhema 1000.

1. Do you know about Hydroponics?
2. What do you think of the technology?
3. Which companies' do you order your fresh vegetables from?
4. What fresh vegetable products do you order?
5. Amongst these products which do you order from Bygartner 1?
6. What made you chose Bygartner 1 products
Ranking (Closeness, Price, Quality, Organic nature, Taste, sustainability)
- 6) Do you ever run out of Stock for Bygartner 1s products?
- 7) How do your customers respond to the products of Bygartner 1
- 8) How long do the products last (durability) compared to the other products?
- 9) Do you differentiate the products when displaying? If yes, How?
- 10) Do you price the same products differently? If yes, what criteria do you use?
- 11) If yes, what criteria do you use to differentiate prices?
Freshness, Organic natures, durability,
- 12) Comparatively, is there an increase in the Volume of sales of the products of Bygatner 1?
- 13) Do you think the products of the other companies can substitute Bygartner 1s product?
Why?
- 14) Do you have the capacity to buy more if Bygartner 1 increases production?
- 15) What is the sales volume of Bygartner 1s product compared to substitutes?
- 16) How satisfied are you with Bygartner 1s Product?
- 17) Are there areas you think need improvement? If yes which?

Restaurants

1. Do you know about Hydroponics? What do you know about?
2. Which companies' do you order your fresh vegetables from?
3. What fresh vegetable products do you order?
4. Amongst these products which do you order from Bygartner 1?
5. What made you chose Bygartner 1 products
Ranking (Closeness, Price, Quality, Organic nature, Taste, sustainability)
6. Do you see any difference between the products of Bygartner 1 and other products?
If yes, what difference (s).....?
7. How often do you order?
8. How satisfied are you with the Products of Bygartner 1 (Scale)
- 11 Do you have the capacity to buy more if Bygartner 1 increases production in the future?
- 12 Are they areas you think need improvement? If yes which?

Addressing question on disruption.

Target Population: Competitors of Bygartner 1.

1. Name or Organization.....
2. Do you know about Hydroponics?
 - i) If yes, do you consider it a threat or future threat to the traditional way of Farming?
3. Have you ever checked/compared their products in terms of Quality in the Market?
4. Are your sales affected with the advancement of this technology and how?
5. With regards to the prices of other products, how do you consider your product?
(cheaper, same, relatively expensive, Very expensive)
6. Do you experience changes in your sales volume ever since the Hydroponics technology was introduced?
7. How long do your Products last in the fridge?
8. Do you grow vegetables all year round?

Questions to the CEO of Bygartner 1

Current Supply Chain of fresh vegetables in Molde.

1. What are company mission and Vision?
2. Who your Supplier of Seeds and Chemicals.
3. Any Contract within your Supply Chain (Customers, distributors or Suppliers)?
4. Who are/is your distributor(s)?
5. All restaurant Names whom Bygartner 1 supplies
6. Ask about storage (does it store or directly distribute after packaging)
7. What are some of the Logistical challenges you face?
8. What is your yearly revenue?
9. Future Goals
- 10) Have you ever witnessed Shortages/excesses in Demand for your products?