FARMING FOR THE FUTURE

A CASE STUDY OF VERTICAL FARMING IN DENMARK

Master Thesis
Copenhagen Business School
M.Sc. International Marketing and Management

Authors
Anna Husted Lægaard (103004)
Katrine Reinholdt Rasmussen (110870)

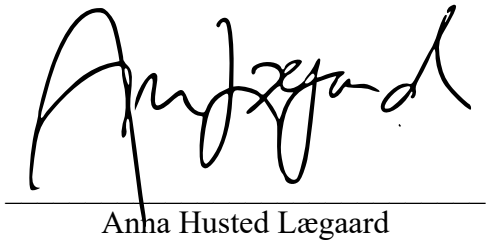
Number of Pages/Characters
119,4/271.724

Date of Submission
May 17th 2021

Supervisor
Maximilian Schellmann

Acknowledgements

The process of writing a master thesis is everything but a solo run. We would therefore like to thank our helpful supervisor Maximilian Schellmann for stepping in in March and supporting us on our journey, by taking our thesis to "new heights" and showing genuine interest in our research. Moreover, we would like to thank Søren Henning Jensen for helping us kick-start our process, and Dr Dickson for seeding our initial interest in vertical farming. We would also like to express our gratitude to our interviewees for their participation and insightful perspectives on this new industry, and a special thanks to Nordic Harvest for letting us experience the fantastic production facilities. Last but not least, we are grateful to our families for their unconditional support and willingness to lend their apartments, houses and summerhouses - this has played a vital role in facilitating great discussions and collaboration between the two of us when writing a thesis under pandemic circumstances.



Anna Husted Lægaard

Katrine Reinholdt Rasmussen

Abstract

Vertical farming is an agricultural technique that involves growth of vertically stacked crops in fully controlled indoor environments, entailing optimal balances of light, nutrients and temperatures. The technique has emerged as a response to the global food and environmental crises, representing a potential solution to deliver sustainably produced food to the world's increasing population. Vertical farming has recently entered the agricultural nation of Denmark as an innovative industry, and a few established players are starting to rise. Within this context, the purpose of this thesis is to examine how vertical farming may obtain the potential to gain ground and possibly contribute to sustainable development.

This is researched as a case study of the two companies Nordic Harvest and Infarm that operate with different business models in Denmark. The research approach includes a theoretical framework structured around innovation strategy theory, supported by industry expert interviews and extensive secondary data. These methodological steps pave the way for an in-depth analysis of the case companies, including how they create value, are able to capture value and are allocating resources. The analysis leads to the understanding that Nordic Harvest and Infarm are capable of gaining ground in Denmark. This finding is based on the conclusion that both companies generate economic, social and sustainable value across different stakeholder groups. Moreover, both utilize strategies to capture a share of the value and allocate sufficient resources in terms of facilitating this value creation and capturing.

Ultimately, the findings of the analysis serve as input for a critical discussion. Here, it is concluded that vertical farming is able to contribute to specific areas of sustainable development and may even emphasize the role of technology in sustainable food production. In this context, it is reasoned that vertical farming is likely to adopt a supplementing position to traditional farming but holds the potential to substitute a share of today's import, greenhouse production and export its technologies. A realization of this role combined with overcoming identified roadblocks, is argued to enhance the potential to contribute to sustainable development in Denmark.

Table of Content

List of Figures

List of Tables

List of Pictures

1. Introduction

"Creating the perfect day, every single day"
Freight Farms (2021)

This saying may sound utopian in the context of farming but is however the physical plant conditions that are possible to create within the agricultural technique of vertical farming. The technique involves indoor growth of crops in fully controlled environments stacked in vertical layers, ensuring the optimal balance of light, nutrients and temperatures. This results in high and reliable yields, at all times (Birkby, 2016). Vertical farming has risen to counter the challenge of an increasing global population causing a lack of arable land and future scarcity of essential resources such as food and water (Despommier, 2020; Oda, 2019). The global population is projected to reach 9.8 billion people in 2050 with 68% living in urban areas. This entails a need for increasing the global food production significantly, while at the same time using less land and resources (ibid.).

These demographic shifts call for new solutions in order to realize the vision of the Food and Agricultural Organization of the United Nations, namely creating "a world free of hunger and malnutrition, where food and agriculture contribute to improving the living standards of all, especially the poorest, in an economically, socially and environmentally sustainable manner" (Food and Agriculture Organization of the United Nations, 2017: 3). On account of the major environmental impact caused by agriculture and food production, sustainable productivity within the agricultural industry is considered a vital issue (Dutta et al., 2017). Innovation is regarded a key element in terms of coming up with new solutions to meet the rising demand in a sustainable way (ibid.). This emphasizes the importance of developing new food production methods and investing in technological innovations that will improve today's practices. Vertical farming is a part of a new generation of rapidly advancing agricultural innovations that present potential solutions to overcome both the food and climate crises (ibid.). The increasing number of vertical farms globally, taking various shapes and formats, indicates an upward trend within agriculture (Despommier, 2020; Rozinga, 2017). Thus, vertical farming might not just create the perfect day, every single day, but may furthermore hold the potential of contributing to a sustainable food production in the future. However, we argue that the global impact of vertical farming partly depends on its success in local markets. Therefore, the aim of the following section is to delineate the broad notion of vertical farming to a Danish context and argue for the relevance of this research scope.

1.1 Research Scope and Relevance

While vertical farming has risen as a response to the global food and environmental crises, we intend to study the phenomenon in a Danish context. We argue that vertical farming is of high relevance in Denmark due to a comprehensive focus on a broad sustainable agenda, including the topic of transitioning to sustainable food production methods. The urgency of this issue is emphasized by the prime minister stating that "we must start transitioning Danish agriculture to even more climate-friendly production. As the world reopens, the demand for green solutions will increase. It is time for us to combine Danish businesses, research and ambitious climate goals. The green transition must succeed" (Statsministeret, 2021). Thus, there is an apparent need to consider alternative solutions that are viable for sustainable farming and food production in Denmark.

This is echoed by the Vækstfonden stating that we grow world-class food in Denmark, but need to continuously develop and innovate in order to stay on top and secure sustainable production methods in the future (Vækstfonden, 2020). In addition, the above-mentioned challenges regarding increasing population and scarce agricultural land impact Denmark as well, as the Danish population is expected to increase with 46% by 2050, while agricultural land will decrease with 25%. Thus, implying that we will be more people for less land (Landbrug & Fødevarer, 2018). The research scope of this thesis will therefore be to examine vertical farming as a potential solution to more efficient agricultural practices and food production methods in Denmark. The relevance hereof is emphasized by the fact that Denmark is a long-standing agricultural nation (Appendix 7), implying an extensive environmental footprint. The magnitude of this is exemplified by the fact that almost two thirds of Denmark's geographical area is agricultural land (Samson, 2019), which further stresses the relevance of reevaluating current practices. Overall, vertical farming is interpreted as a new industry that has entered the Danish market.

1.2 Research Question

Based on the above research scope and relevance, we set out to examine the potential of vertical farming in Denmark, as well as whether it might contribute to sustainable development. This has led to the formulation of the following research question:

How can the innovation of vertical farming obtain the potential to gain ground in the Danish market and contribute to sustainable development?

The purpose of the thesis is therefore to answer this research question, which we intend to do by researching the emerging industry of vertical farming in Denmark as a case study of two companies, namely Infarm and Nordic Harvest. The motivation for choosing the Danish market will be elaborated on in section 3.3, followed by the choice of the specific case companies in section 3.4. However, we find it important to first ensure a common understanding of what the research question entails. This includes two distinct elements that we consider critical to clarify the meaning of, which are how we interpret vertical farming as an innovation, and what it means for this innovation to gain ground in the Danish market.

An innovation may be referred to as the commercialization of an invention, either through a new good or service or through a new production method, whereas an invention entails the development of new products or processes (Grant, 2016). The hydroponic, aeroponic and aquaponic growing systems used in vertical farming are not per se new inventions (section 2.2.3). However, combining these with the vertically stacked structures indicate that the production methods of vertical farming are understood as an invention. Nordic Harvest and Infarm use these inventions in commercial scales and are among the first to do so in Denmark, which motivates why we consider vertical farming and the operations of the two case companies as innovations. In more detail, we comprehend vertical farming as a green innovation, which we define as innovations consisting of "new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability" (Calza et al., 2017: 3). Similarly, it may also be defined as "hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management" (Chen et al., 2006: 332). It can thus be derived that green innovations positively impact environmental sustainability and concern either products or processes

related to delivering this, which corresponds with several of the main potentials of vertical farming (section 2.3). Thus, we study vertical farming as a green innovation, which will be exemplified through the case companies of Nordic Harvest and Infarm.

The understanding of vertical farming as an innovation in the Danish market therefore entails that we will use innovation theory to analyze the cases. Accordingly, we define a solid innovation strategy as an enabler of the potential to gain ground, based on the theory of Pisano (2015). Moreover, we consider vertical farming to have gained ground in Denmark once it has become widely known, prevalently accepted and broadly distributed. This definition implies that the industry of vertical farming is to create traction and achieve a certain size that allows for impact in the existing market. Moreover, the definition is motivated by the newness of both the industry and the case companies, which implies that it will be difficult to measure gaining ground on quantified benchmarks such as sales numbers or market share. Thus, the fact that the industry is new in Denmark involves that there are no existing points of references that we find it meaningful to directly measure vertical farming against. When deemed relevant, we however intend to compare vertical farming with both conventional and organic agriculture as well as greenhouse production, which we will collectively refer to as traditional farming or traditional agriculture. We consider this distinction valid since the products of vertical farming are likely to compete with the crops of traditional farming, and moreover since Denmark is an agricultural nation (Appendix 7), which is the context that vertical farming enters into. Lastly, we intend to explore the concepts of sustainability, sustainable development and vertical farming in much more detail, which is the objective of chapter 2. The steps that we will take to answer our research question will now be presented in the following section.

1.3 Structure of the Thesis

The structure of the thesis is illustrated in Figure 1, with the aim of clarifying how the different parts are connected, and thus create a better understanding of the research. This provides a clear structure with logical coherence throughout the thesis, ensuring that the overall learning objectives are met. The thesis takes its point of departure in the research scope, leading to the establishment of our research question. To set the scene of the research, the concepts of sustainability, sustainable development and vertical farming are explored, followed by an introduction of our case companies. Subsequently, we present our methodological reflections including both our research philosophical stance, research approach and data collection methods. Based on selected academic literature, we

construct our theoretical framework consisting of three theoretical levels. These three levels likewise constitute the structure of our analysis, which in combination with our discussion ensures a profound answering of our research question. Lastly, we propose three directions for further research and conclude on our research findings.

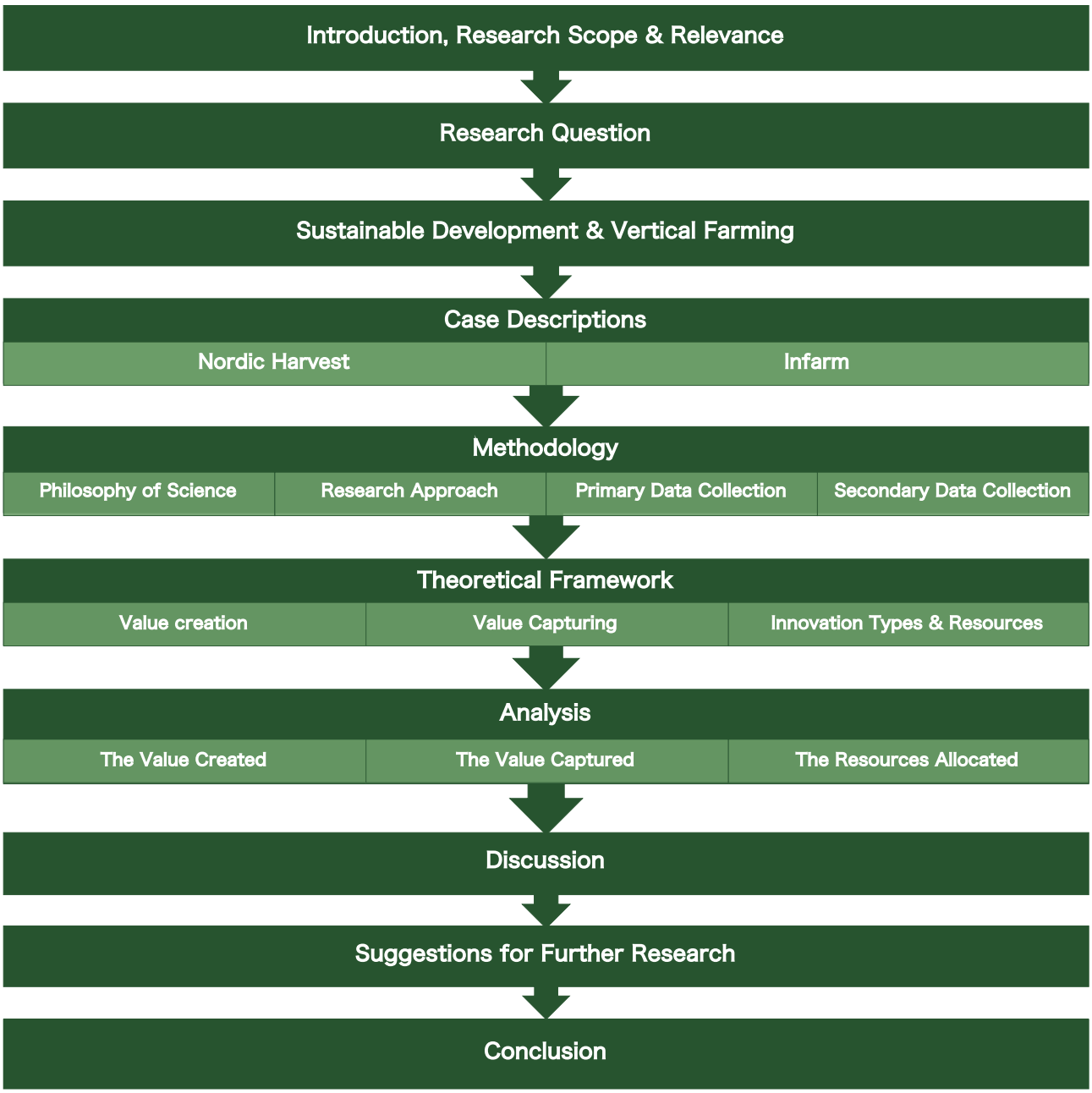


Figure 1 Thesis Structure. Own representation

2. Sustainable Development and Vertical Farming

The purpose of the following chapter is to present the concept of vertical farming, as well as the potentials and challenges hereof. Furthermore, the notions of sustainability and sustainable development are explored, in order to allow for a meaningful examination of vertical farming in relation to sustainable development. Due to the constant evolvement of these concepts, we consider it meaningful to present how we intend to use them for the purpose of this master thesis. Thus, this chapter contributes with an in-depth understanding of the key concepts of the thesis, which lays the foundation for the subsequent sections.

2.1 Sustainability and Sustainable Development

In order to be able to answer our research question, it is deemed necessary to first establish a mutual understanding of sustainability and sustainable development. Only then are we able to ultimately assess whether vertical farming holds the potential to contribute to the sustainable development in Denmark. While many definitions of sustainability exist, a common denominator is that they often revolve around the dimensions of economic development, environmental quality and social equity (Rogers et al., 2012). These three are also known as profit, planet and people, which are referred to as the triple bottom line (ibid.), illustrated in Figure 2. The economic dimension can be expressed as maximization of income while maintaining a constant or increasing stock of capital, the environmental dimension as maintenance of the resilience and robustness of biological systems, and the social dimension as maintenance of the stability of social and cultural systems. The main idea behind the triple bottom line is for organizations to balance these three dimensions equally to achieve sustainable results (Rogers et al., 2012). The concept of the triple bottom line will form the basis of how we understand sustainability throughout this thesis.

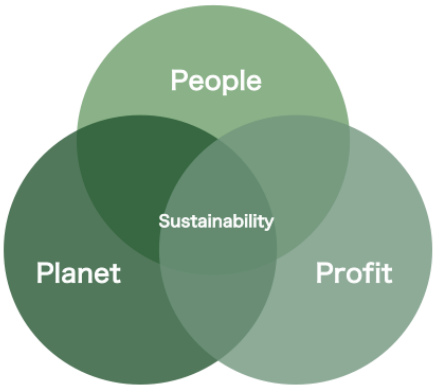


Figure 2 Triple Bottom Line. Own representation, adapted from (Rogers et al., 2012)

In terms of sustainable development, the most widely used definition dates back to a report from the World Commission on Environment and Development from 1987, named Our Common Future. Here, sustainable development was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Elliott, 2013: 1). This definition puts emphasis on conserving our resources in a way that secures future generations. Within the same line of reasoning, Rogers et al. (2012) state that sustainable development is a "dynamic process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are made consistent with future as well as present needs" (Rogers et al., 2012: 42). Based on this, the understanding of sustainable development deployed throughout the thesis will concern the overall development as well as specific activities aimed at balancing the economic, environmental and social needs of today and tomorrow (Danish 92 Group & Global Focus, 2020).

Sustainable development has been institutionalized by the United Nations (UN) with 17 Sustainable Development Goals (SDGs) (United Nations, n.d.). According to the UN, the SDGs recognize that "ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests" (United Nations, n.d.). The 17 SDGs are illustrated in Figure 3, which all 193 UN member states contribute to in order to achieve sustainable development in a global perspective. Each SDG consists of several sub-goals, specifically aimed at achieving each of the goals (ibid.). As of now, these sub-goals will not be elaborated further. Whether vertical farming has the potential to contribute to any of the SDGs will be discussed and assessed in chapter 7. According to the Sustainable Development Report, Denmark is ranked as number 2 out of all 193 nations in terms of total progress towards achieving all of the SDGs. It is assessed that the goals of No Poverty (1) and Reduced Inequalities (10) have already been achieved in Denmark, whereas major challenges remain in Responsible Consumption and Production (12), Climate Action (13) and Life Below Water (14). Moreover, it is assessed that challenges or significant challenges remain within the other 12 SDGs in Denmark (Sustainable Development Report, 2020).

Figure 3 Sustainable Development Goals (United Nations, n.d.)

2.2 Defining Vertical Farming

As outlined in the introduction, vertical farming is an agricultural technique which can be defined as "growing crops in controlled indoor environments, with precise light, nutrients, and temperatures" (Birkby, 2016: 1). This includes optimizing plant growth and use of soil-less methods, which will be explained in more detail in section 2.3.3. Moreover, vertical farming involves growing crops stacked in multiple layers (ibid.), allowing for 90-99% less use of land compared to traditional farming methods (Oda, 2019). The term vertical farming was first coined in 2000 by Dr Dickson Despommier, professor of microbiology and public health in environmental health sciences at Columbia University (Despommier, 2020). Vertical farms are now rising for commercial use in cities around the world, and is a growing trend of what could be the future of food production (Despommier, 2020; Rozinga, 2017). Vertical farming is at times used interchangeably with urban agriculture, although they are not the same. We therefore consider it of high relevance to clearly define how these differ. Essentially, urban agriculture involves growing or producing food in an urban environment. This includes a broad array of concepts that aim at bringing farming closer to urban areas, and thereby moving food production as close as possible to consumption (Greensgrow, n.d.). This process may involve vertical farming but could also include more traditional growing practices, implying that while vertical farming can be urban, it does not have to be. Vertical farming includes many different concepts, which can range from small-scale hobby farms to large automated buildings and can possess different characteristics and potentials (Jürkenbeck et al., 2019). These conceptualizations will be elaborated on in the following section.

2.2.1 Categorization of Vertical Farms

There are four predominant categories of vertical farming, which are skyscraper farms, wall and roof top farms, vertical greenhouses and plant factories (Cognition, 2018). The purpose of this section is to gain an understanding of what they entail and how they differ, in order to ultimately define the main category of interest in the thesis.

Firstly, skyscraper farms are city skyscrapers filled with production of fruits and vegetables, and possibly even animals. Skyscrapers typically represent expensive real estate, which can be a challenge for activities regarding fruit trees and rearing of animals, as they may be associated with relatively low value density. This can even be the case for dense premium crops, such as herbs. In addition, these costs increase exponentially with height, as transportation of water vertically requires substantial energy (Cognition, 2018). Secondly, wall and roof top farms are aimed at utilizing unused spaces for food production. The costs of starting these are often rather small and many are established by hobbyists. They may contribute with green oases in urban areas, but the amount of surfaces that can be used are however rather limited (Cognition, 2018). According to Despommier, if all of the roof tops in New York are fully utilized by farming, it can still supply just two percent of the city's population in 2050. The ability of wall and roof top farms to solve large scale issues is therefore questionable (Despommier, 2020). Thirdly, vertical greenhouses are large transparent structures that utilize multiple growing levels (Cognition, 2018). One of the challenges associated with vertical greenhouses is providing enough light for the crops, as the glass buildings absorb some of the sunlight. This may be accommodated by adding artificial lights, which leads to more effective yields but also a higher energy consumption than traditional greenhouses. Furthermore, the glass buildings of vertical greenhouses imply explosion to local climate conditions and light levels, which adds an element of instability and makes vertical greenhouses difficult to run in some geographic areas (ibid.).

Lastly, plant factories represent the most technologically advanced version of vertical farming. Crops are produced in enclosed environments where light, water usage, nutrients and temperatures are completely controlled, thus creating a mini ecosystem. This means that the production areas are sealed and thermally insulated with no windows, and thereby no natural lighting (Cognition, 2018). Light-emitting diode (LED) technologies are therefore utilized in order to create photosynthesis within these ecosystems, which will be further explained in section 2.2.3. Thus, plant factories offer the greatest savings in terms of land and water, and imply that any type of plant or crop can be grown in any

region of the world, at any time (Cognition, 2018). Due to the potentials that the fully controlled and technologically advanced systems of plant factories provide, these will be the main area of interest in this research and will from now on be referred to as vertical farms. This involves that the sole focus of the thesis is on vertical farms in a commercial context, meaning that all non-profit or hobby-driven vertical farms are not considered relevant. This distinction has also motivated our choice of case companies, which is outlined in section 3.4.

2.2.2 Types of Vertical Farms

Since the focus of the thesis is on plant factories, the aim of the following section is to elaborate on the different types of vertical farms that are classified as plant factories. Our research has revealed three predominant types, which are container farms, in-store farms and large-scale farms. Container farms are old shipping containers refurbished as vertical farms (Picture 1).The containers enclose stacked shelves for growing different types of greens and are typically self-reliant with computerized systems that can be controlled remotely (Birkby, 2016). The 30 square meter size of the containers allow them to be located in central urban areas close to consumers and even just outside of restaurants, schools, grocery stores etc., allowing for hyper-local and fresh produce all year around (Birkby, 2016; Freight Farms, 2021). In-store vertical farms are highly similar to container farms as they as well grow hyper-local produce in city centers with computer automated systems (Picture 2). These farms are located inside grocery stores, canteens or restaurants, and are typically in the form modular cabinet-like structures with glass doors. Once fully grown, the crops are harvested and sold directly to consumers (Manson, 2020).

Lastly, large-scale vertical farms are larger building-based farms (Picture 3). These are typically located inside abandoned warehouses or buildings in urban areas, or in some cases in newly constructed buildings. Large-scale farms hold the potential to produce at very high capacities and sell its' produce to various types of customers, such as grocery retail and food services (Cognition, 2018). As such, vertical farming exists in several different formats, scales and structures, which are illustrated in Figure 7. The growing systems used in these different types can however differ, which present an additional way of further classifying vertical farms.

Picture 1 Container farm (Alesca Life, 2019)

Picture 2 In-store farm (Infarm, 2019a)

Picture 3 Large-scale farm (Financial Times, 2019)

Picture 4 LED Lights (Leahy, 2021)

2.2.3 Growing Systems and Technologies

There are three prevalent growing systems in place, hydroponics, aeroponics and aquaponics, which are all soil-free techniques aimed at supplying plants with the right mix of nutrients in a closed loop environment (Birkby, 2016). These three systems are explained in the coming sections.

Hydroponics

Hydroponics is the most widely used growing system in vertical farming. Here, the plants are placed in individual holes in growing trays, with the roots sticking through the holes. The roots are then submerged in perfectly balanced nutrient-rich water below the tray, which consists of essential nutrients such as calcium, nitrate and potassium sulphate, adapted to the specific needs of the plants. The solution is monitored regularly and is circulated in order to maintain a correct mix of chemicals (Birkby, 2016). Figure 4 illustrates how the nutrient solution is circulated through overflow from the grow tray into a water reservoir below the tray, where a pump then re-fills the grow tray using a pump

and a timer. This process typically happens a few times a day, but the specific timings are set according to factors like plant sizes, growth cycles, air temperatures and specific nutrient requirements (Gupta & Ganapuram, 2019). This approach allows the crops to uptake the needed nutrients and fertilizers without much effort, as opposed to the plants having to find and extract nutrients in the soil. This implies that the plants save more energy for vegetative growth, which in part explains the high efficiency of vertically farmed crops (Simply Hydroponics, n.d.). Moreover, using hydroponic growing systems reduce water usage with up to 95% compared to traditional soil-based farming (Infarm, 2021; Nordic Harvest, n.d.-e).

Aeroponics

Aeroponics is a technology developed by NASA in the 1990s with the aim of efficiently growing crops in space. The use of water is extremely limited in this system, as plants are grown in an air/mist environment (Birkby, 2016). The plants are placed in trays that are similar to those in hydroponic systems, but the roots are hovering in air as opposed to being submerged in water. As Figure 5 illustrates, the hovering roots are misted with a nutrient solution using a fine spray nozzle, which additionally ensures sufficient oxygen to the roots (Gupta & Ganapuram, 2019). Aeroponics is the most advanced and efficient growing system in terms of water use, as it uses up to 90% less water than hydronics. Moreover, this system facilitates even faster plant growth, further increases crop yields and reduces use of fertilizers. The plants have even demonstrated an intake of higher nutrition concentrations, meaning that the produce may be healthier and more nutritious (ibid.). Thus, while there are many advantages of adapting aeroponics, it is also a much more complex and less cost-effective system. As an example, the mist flows cause more fluctuating water levels, which result in a system that requires even more continuous censoring. Aeroponics therefore require higher skills in terms of studying, operating and maintaining the system, which explains why only few commercial farms have adopted this technology (Brio Hydroponics, 2020).

Aquaponics

Lastly, aquaponics essentially uses the same growing systems as hydroponics, but includes fish in the growing system, thus combining aquaculture and hydroponics (Gupta & Ganapuram, 2019). Here, the water reservoir is replaced with a fish tank that produces wastewater rich in ammonia (Figure 6).Lastly, aquaponics essentially uses the same growing systems as hydroponics, but includes fish in the growing system, thus combining aquaculture and hydroponics (Gupta & Ganapuram, 2019). Here, the water reservoir is replaced with a fish tank that produces wastewater rich in ammonia (Figure 6).

This is utilized as nutrients for the crops by being pumped into the grow tray, where the ammonia is turned into nitrite. The plants then uptake the nutrients as well as purify and filter the water, which is then recycled back to the fish tank, thus creating a circular growing system (ibid.). As of today, this kind of growing system is primarily used in vertical farms of smaller scales, as larger commercial farms usually focus on the production of fewer crops with fast turnovers (Birkby, 2016). However, notable advantages of aquaponics include that careful monitoring is only necessary in the initial phases of setting up the system, but after about a month, just the ammonia levels and pH balance have to be monitored on a weekly basis (Gupta & Ganapuram, 2019).

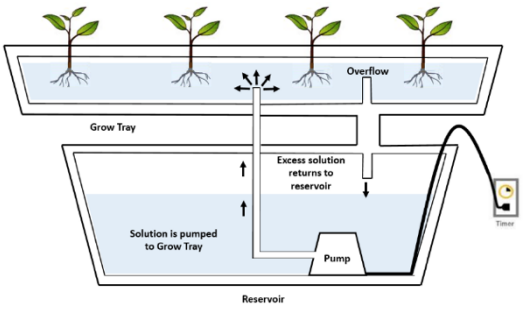


Figure 4 Hydroponic Growing System (Gupta & Ganapuram, 2019)

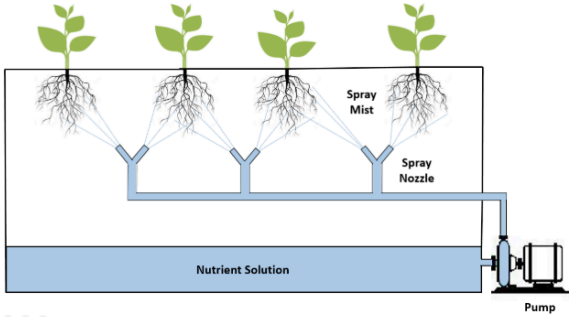


Figure 5 Aeroponic Growing System (Gupta & Ganapuram, 2019)

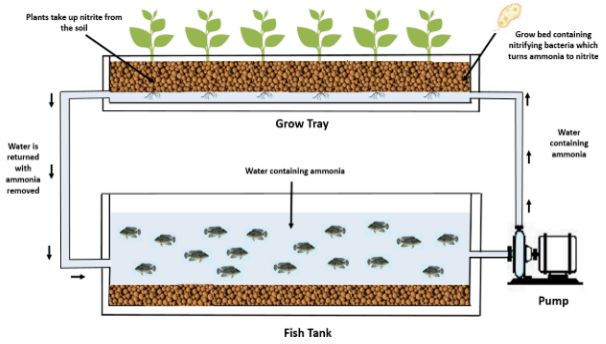


Figure 6 Aquaponic Growing System (Gupta & Ganapuram, 2019)

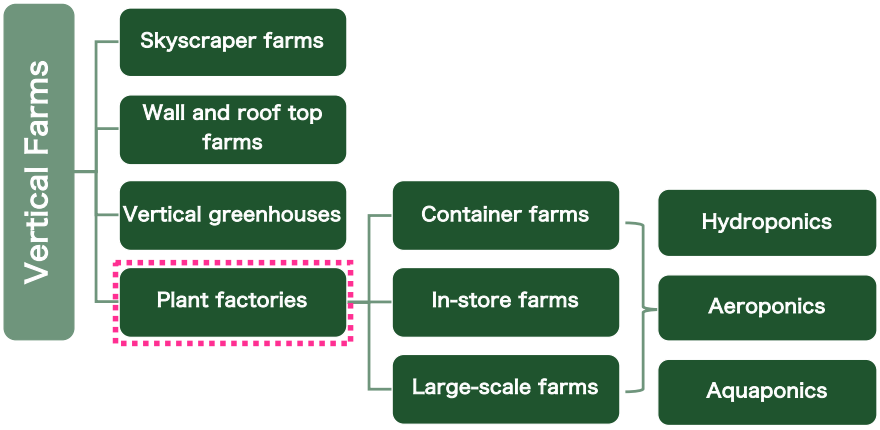


Figure 7 Conceptualizations, Types and Growing Systems. Own representation

LED Technologies

As briefly mentioned in section 2.2.1, LED technologies are an essential part of creating photosynthesis in vertical farming, which is the case across all types of growing systems. The increasing interest in vertical farming may be partly due to recent developments within LEDs, which for years have been a very costly technology to work with (Crumpacker, 2018). According to the US Department of Energy, the prices of LEDs have decreased by 90% just from 2010 to 2014. Meanwhile, the lifespan and efficiency, meaning the light produced per energy unit, have almost doubled in the same time period (Yamada & Stober, 2020). Consequently, it has allowed for vertical farmers to produce crops in a more profitable manner in the recent years.

In addition to efficiency and increasing affordability, there are more reasons as to why LEDs are utilized in vertical farming. Firstly, lights should be distributed evenly across the crops in order to achieve efficient growth. Due to the multiple layers of vertical farms, growing lights are needed in each level to avoid shadows being casted onto the plants. LEDs release very little heat compared to other types of artificial lights, which allow them to be located closely with crops in each level, without creating harm (Crumpacker, 2018). Secondly, the pink LED lights used for vertical farming are of this specific color due to efficiency reasons. Light consists of different wavelengths with a broad color spectrum, where natural sunlight consists of colors such as red, orange, blue, yellow and green. However, plants do not need all these wavelengths to grow, as they mostly respond to red and blue lights. Using LEDs involve the ability to target the wavelengths by just emitting red and blue color specters, which results in the characteristic pink lights (Picture 4). Consequently, it means that the plants only receive the exact lights needed, whilst the vertical farms prevent wasting energy from producing unnecessary wavelengths (ibid.). Thus, using pink LED lights are beneficial due to the high efficiency and suitability in vertical farming.

2.3 The Potential of Vertical Farming

Despite vertical farming being a relatively new technology, various opportunities have been discussed by different scholars. In the following section, opportunities of vertical farming are explored. For each opportunity, we will contextualize how it relates to a Danish context in order to ensure that the section supports an answering of the overall research question regarding vertical farming in Denmark. When deemed relevant, the identified opportunities are related to appropriate macro societal challenges, which vertical farming is argued to address. This provides a broader understanding of the relevance of introducing a new type of farming. This section is followed by an exploration of the

challenges that may limit vertical farming and thus influence the degree to which it contributes to solving these macro societal challenges.

2.3.1 Opportunities of Vertical Farming

The ten primary opportunities include 1) Improved productivity, 2) Year-round crop production, 3) No weather-related crop failures, 4) No use of pesticides and reduced use of fertilizers, 5) No agricultural runoff, 6) Ecosystem restoration, 7) Reduced water usage, 8) Reduced transportation, 9) Food safety and security, and 10) Meeting demand for better food. The outlined opportunities are derived from Despommier (2020) in combination with additional research on the topic. These are considered the most well-known, and thus the most researched ones. However, due to the area of vertical farming being new and constantly evolving, additional opportunities may prove more vital in the future. The assessment of the ten opportunities will therefore be followed by an exploration of two additional opportunities that we consider of increasing importance with the emergence of vertical farming. In the end of this section, Table 1 provides a summary of the ten primary opportunities.

1) Improved Productivity

The controlled environment implicates that plants grow substantially faster in a vertical farm compared to an outdoor field (Nielsen, 2021), implying that harvesting can be done more frequently in vertical farming (Nordic Harvest, n.d.-d). The frequent harvest, in combination with the reduced need for land, results in an overall increased productivity. Thus, vertical farming may be a solution to encounter the challenge of feeding the world's growing population (Despommier, 2020). With the expectation of an increase in the global population to approximately 10 billion people in 2050 (United Nations, 2019), the challenge of providing enough food for everyone is rising drastically. Moreover, around 54% of the global population currently lives in urban areas, which is expected to increase to more than 65% by 2050 (Food and Agriculture Organization of the United Nations, 2017). Therefore, the idea of placing vertical farms close to urban areas is a possible way to move the food production closer to the growing urban population. Overall, the population growth and increased urbanization are putting pressure on traditional agriculture and are changing food consumption patterns as well as employment patterns significantly (ibid.). Thus, feeding the global population in a sustainable way is pivotal in the future, why this opportunity plays an important role both in a global and Danish context.

2) Year-round Crop Production

The changing climate is disrupting seasonal patterns, which causes difficulties for the farming industry. As opposed to traditional agriculture, vertical farming is not dependent on seasons. This implies that crop production can take place all year around and is not determined by weather or soil types (Despommier, 2020). Furthermore, the use of vertical farming expands the possibilities of growing crops in new regions that otherwise have been limited by either very extreme or lack of seasons. Therefore, vertical farming may represent a strategy for reliable food production (ibid.). Traditional farming in Denmark is likewise heavily impacted by the seasons and is very challenged by the large variability from year to year. The changing seasons in Denmark makes it difficult to determine the optimal time for harvesting, which causes negative consequences for especially the most vulnerable crop types (Hansen, 2014).

3) No Weather-related Crop Failures

Vertical farming is not challenged by extreme weather phenomena such as hailstorms and cyclones, which often destroy farmland. In addition, extreme drought may cause failed crop productions in some regions. Overall, traditional agriculture is thus heavily impacted by climate changes, which cause increased variability in weather phenomena. However, the indoor environment of vertical farms is said to eliminate weather-related crop failures (Food and Agriculture Organization of the United Nations, 2017). Despite the weather not being very extreme in Denmark compared to other parts of the world, research indicate that the Danish weather patterns will change significantly in the future due to climate changes. Heavy rain, drought during summer and a larger variability from year to year are weather phenomena that are expected to challenge the Danish agriculture industry in the future (Koszyczarek, 2020).

4) No Use of Pesticides and Reduced Use of Fertilizers

Pesticides and fertilizers are considered crucial in traditional agriculture to maximize production output. However, the controlled environment in vertical farms implies that no pesticides are needed for crop production. Moreover, the use of fertilizers can be controlled in order to ensure that the essential nutrients are covered for all types of plants (Macovei, 2020), which leads to a use of 90-99% less fertilizer compared to traditional farming methods (Oda, 2019). Thus, consumers do not have to worry about pesticide residue in consumed greens. Studies show that a high level of pesticide residue can be harmful to humans, as pesticides are designed to kill living organisms (Roberts, 2020). Despite limited knowledge on the exact effects, various studies indicate that people with high

exposure to pesticides are more prone to health issues such as productional problems, cardiovascular diseases and cancer (ibid.). Danish farmers are large contributors to this issue, as more than 50% of the total area of Denmark is sprayed with pesticides. Agriculture accounts for 99% of the pesticides used in Denmark, while about 1% is used in private gardens (Danielsen, 2018). Usage of both fertilizers and pesticides have however been steadily declining in recent years, which is due to the increased awareness of the environmental and health related side effects, as well as a greater political focus (ibid.).

5) No Agricultural Runoff

The consequences of agricultural runoff include negative effects such as permanent alteration of landscapes and water degradation. Agricultural runoff represents a major cause of pollution but is unavoidable due to the current irrigation practices used in traditional farming (U.S. Environmental Protection Agency, 2020). In order to maximize yield production, traditional farming uses a high amount of fertilizers and pesticides. The high concentration of nitrogen in fertilizers have a destroying effect on fresh- and saltwater organisms, as it ultimately ends up in rivers and lakes. The closed system approach used in vertical farming prevents damage caused by runoff (Despommier, 2020). Agricultural runoff is a significant issue in Danish agriculture as well, since it negatively impacts the ecological conditions of the groundwater, streams, lakes and coastal waters in Denmark. In 2016, residues of pesticides were found in 25% of conducted groundwater test (Danmarks Naturfredningsforening, 2019). Much work has been put into this in recent years, which has led to reduced runoff, but the conditions of Danish waters are still below the thresholds set by the European Union (EU) (Knudsen, 2017).

6) Ecosystem Restoration

If vertical farming increases in size, it can potentially replace the need for some of the fields that are used for traditional farming today. Converting agricultural fields into forests would thus enhance the chance of wild nature reestablishment (Despommier, 2020). Using trees to remove carbon dioxide from the atmosphere is one of the main advantages of forest restoration. The amount of carbon that can be removed by trees seem to depend on the tree type and tree characteristics (ibid.), but research however indicates that forest restoration is a way to positively impact climate changes (Pearce, 2017). Today, 14,6% of Denmark is covered by forest, which has gradually increased over the past 200 years (Nord-Larsen et al., 2020). The political ambition is that 20-25% of Denmark should be covered by forest by 2100, with the purpose of less underground water pollution, improved living conditions for

plants and animals and increased carbon dioxide storage in the Danish forests (Miljøminisetriet & Skov- og Naturstyrelsen, 2002). Thus, if vertical farming allows for ecosystem restoration it may contribute to reaching this ambition in Denmark.

This implies that vertical farming might address the issue of deforestation. Today, agriculture is estimated to be the main driver of 80% of the world's deforestation (Food and Agriculture Organization of the United Nations, 2017). The increased food demands of the growing global population lead to future shortcomings of agricultural land, which drives deforestation and emphasizes the need for resource efficiency within agriculture and food production (Despommier, 2020; Food and Agriculture Organization of the United Nations, 2017). The vertical format and high productivity of vertical farming is therefore argued to positively impact land use, prevent deforestation and provide the possibilities to convert agricultural land into areas with wild nature.

7) Reduced Water Usage

The use of water is significantly reduced in vertical farming, due to the perfectly balanced nutrient-rich water. Currently, 70% of all available freshwater on earth is used by the traditional agriculture industry, which causes negative side effects such as pollution and agricultural runoff (Despommier, 2020). The technologies used in vertical farms do not only ensure reduced water consumption, but the closed loop approach also allows vertical farms to recycle water from the growing process (Despommier, 2020; The B1M, 2019). As previously described, the water consumption in vertical farming is dependent on the chosen growing system, with aeroponics being the most effective system (Gupta & Ganapuram, 2019). In Denmark, about one third of the total water consumption is used for field irrigation in agriculture, which increases to almost half in dry years (Vandetsvej.dk, n.d.).

8) Reduced Transportation

Moving food production closer to the cities significantly reduces the need for transportation, and thus reduces the food miles. Placing vertical farms close to where people live create a local and sustainable source of produce, which increase the freshness of products, as they do not have to be refrigerated or frozen prior to consumption. Moreover, this does not only positively affect the quality of the products, but also lead to reduced carbon dioxide emissions (Despommier, 2020). In Denmark, the import of greens has increased significantly the last 20 years. This is the case for types of vegetables and fruits that are and are not produced in Denmark, and takes place during both high and low seasons of Danish production (Landbrug & Fødevarer, 2012). These imports thus happen at the expense of Danish

produce and represent heavy food miles for the greens consumed in Denmark. In addition to the reduced transportation of crops, vertical farming also eliminates the use of large engine-driven machines used in traditional agriculture such as combine harvesters, tractors etc. (Birkby, 2016).

9) Food Safety and Security

In terms of food safety, Despommier suggests that vertical farms should be designed and constructed as clean rooms in order to ensure pest- and pathogen-free operations (Despommier, 2020). Plant diseases and pests from insects can easily destroy the production and negatively affect both the operation and profitability of the vertical farms (ibid.). The clean and safe indoor environment for crop production can be ensured by filtered air suppliers, secure locks and employee hygiene such as change of clothing before entering the farm and screening for parasitic infections (ibid.). Since vertical farming prevents the spreading of these risks, it entails high control of food safety and security. Moreover, the controlled environment does not only eliminate wildlife, weather and cross-contamination, but also eases the process of traceability. Ultimately, it means that vertical farming can ensure a stable flow and amount of food with high levels of safety (PowerHouse Hydroponics, 2018), which is assumed to be the same in a Danish context as well.

Increasing food security through stability and safety is considered a way to address challenges regarding supply chain shortcomings. Vertical farming provides a way to shorten the supply chain and increases the resilience in terms of the high supply reliability due to its' aforementioned independence of weather and seasonality, as well as its' higher productivity, quality and food safety. Moreover, the technological advanced farms are highly suitable for automated labor, which further decreases vulnerability (Ebrahimnejad, 2020b). The Covid-19 pandemic is an example of a crisis that has heavily impacted the food industry and affected a large number of supply chains globally. According to the UN World Food Program, over 250 million people globally is estimated to suffer from hunger by the end of 2020 due to coronavirus. During 2020, huge amounts of fresh food have been destroyed due to many producers, suppliers and supply chains not being equipped and prepared to overcome the pandemic consequences (ibid.).

10) Meeting Demand for Better Food

In Europe there is an increasing consumer demand for high quality food with high nutritional value and great flavor (Ebrahimnejad, 2020a). More consumers are paying attention to the impact of their food choices, which includes an increased consumer awareness both on a societal and a personal

level. This involves an increased desire to limit the environmental impact of food consumption and awareness on how eating habits affect personal health (Deloitte Consulting, 2019). The high control of nutritional value, obtained through the use of vertical farming, may be a way to accede the consumer demand of high-quality food. Moreover, the techniques used in vertical farming and reduced need for transportation of food may be appealing to environmental-orientated consumers. This increased demand for better food is argued to be of key importance in Denmark as well, which will be outlined in more detail in section 2.6.

Opportunity	Key points
Improved productivity	More frequent harvest Feeding the world's growing population
Year-round crop production	Season independent plant growth Growing crops in new regions
No weather-related crop failure	Less vulnerable to extreme weather phenomena
No use of pesticides and reduced use of fertilizers	Elimination of pesticides 90-99% less fertilizers
No agricultural runoff	Less water pollution Less wildlife harm
Ecosystem restoration	Allows for forest restoration Prevents deforestation
Reduced water usage	Natural resource savings
Reduced transportation	Less carbon dioxide emissions Local and fresh produce
Food safety and security	Reduced health risks Supply chain resilience
Meeting demand for better food	High-quality and nutritional food

Table 1 Summary of Opportunities. Own representation

Additional Opportunities with Industry Emergence

As mentioned above, the continuous evolvement of the vertical farming industry implies that additional opportunities become increasingly relevant. Selected opportunities include new employment opportunities and utilization of postharvest plant material. Firstly, as large-scale vertical farms depend on a large variety of different sets of skills and knowledge within areas such as technology, farming, sustainability etc., the establishment of vertical farms has the potential of attracting various types of employees. The rise of vertical farming may therefore lead to the creation of new jobs both within the vertical farming industry and associated industries, which is considered

plausible in a Danish context as well (Despommier, 2020). A second additional opportunity is the fact that leftovers from plants have the potential of being used for other purposes such as animal feed (ibid.), depending on the crops that are being produced. This is considered highly relevant in a Danish context as 80% of the agricultural area in Denmark currently is used for animal feed production (Danmarks Naturfredningsforening, 2020).

2.4 The Challenges of Vertical Farming

While there are many opportunities associated with vertical farming, the technology also presents several roadblocks. Through our research, two overarching challenges have proven to be predominant, which are concerned with the high energy consumption and the economic viability of vertical farming. In addition, we have identified a challenge regarding the current range of viable crop types for vertical farms. These challenges are elaborated on in the following.

2.4.1 Economic Viability

The first challenge regarding the economic viability can be further divided into three main themes, which are the costs of electricity, the costs of real estate and the high investment costs. These three themes represent significant and distinct challenges, why they will be individually presented in more detail.

Electricity Costs

The technological nature of vertical farming leads to an increased usage of electricity compared to traditional farming methods, which results in costly electrical bills. The research of this thesis has shown that electrical bills can represent the largest expenditure of vertical farms (Appendix 4). Electricity costs alone make up approximately 30% of the total production costs in large-scale vertical farms, which is equivalent to 91% of total variable costs. The electricity costs can be further grouped into three primary posts, which stand for different shares of the total costs. Lights represent the heaviest post with a 50-55% share of total costs, whereas climate control make up for 30-35% and production facilities for 10-15%. The electricity used for climate control is specifically dependent on the efficiency of the lamps and how much heat they emit (Orsini, 2020), emphasizing the importance of high efficiency LEDs. As previously mentioned, much research and development are currently taking place in terms of LEDs, which will affect both costs and consumption of energy. Research has shown that implementing movable LEDs can reduce the cost of lamps per unit of growing surface by

50% (Orsini, 2020), which could be a potential solution to electricity savings. Specifically, movable LEDs entail that instead of having lights installed above all growing trays, they are merely above half of them. This means that the lights are moving laterally back and forth between two rows of growing trays, as the plants just need lights for about 12 hours a day (ibid.). Nevertheless, even with improvements and alterations of the LEDs, vertical farming is still heavily reliant on technology, why the costs of electricity are expected to remain a heavy expenditure and thereby a significant challenge.

Real Estate Costs

Moreover, a key notion of vertical farming is the ability to move production closer to consumption, which inherently implies more urban locations. Real estate and properties in urban areas can be very expensive, especially when compared to the rural fields utilized in traditional farming (Birkby, 2016). This challenge may be solved by locating vertical farms in existing unwanted spaces. According to Despommier, less desirable and underutilized places in urban areas such as abandoned buildings, empty lots, warehouses or old plants all represent viable potential locations for vertical farms (Despommier, 2009). As an example, Despommier performed a study surveying the five boroughs of New York City and discovered 120 vacated sites that were suitable for building vertical farms. With this in mind, it is assumed that the same would be the case in other cities around the world (ibid.). However, the prices of these idle sites are not confirmed to being less costly than rural fields, and the prices of refurbishing these unwanted places into technologically advanced vertical farms will probably require heavy investments.

Investment Costs

Lastly, the high upfront cost of setting up a vertical farm is considered a significant challenge. Investing in technology, equipment, labor, education and so on requires a large start-up capital, which is deemed as a disadvantage of vertical farming. A high scalability of the production could however be the key to offset these costs and sell at profit, although achieving this may be considered a significant challenge in itself (Gupta & Ganapuram, 2019). Moreover, maintenance and labor costs are estimated to be considerably higher in vertical farming.

All of the costs mentioned in these sections collectively lead to higher product costs for the end-consumers, which may also represent a challenge. However, in order to gain a full picture of the economic challenges of vertical farming, it is also considered important to take some cost benefits into account. Based on the potentials of vertical farming (section 2.3), we argue that decreased

transportation needs as well as reduced usage of water, fertilizers and pesticides combined with increased productivity and automated labor will most likely compensate for some of the abovementioned costs. In time, the technology is expected to be even more efficient in terms of electricity and productivity, such as the development of LED lights (section 2.2.3), which is expected to reduce costs as well.

2.4.2 Energy Consumption

The second overall challenge of vertical farming is regarding the aforementioned high energy consumption. This is considered a significant disadvantage of vertical farms and directly overlaps with the previous challenge of high electricity related expenses. However, the issues of this section are concerned with environmental sustainability related matters, whereas the previous section dealt with the economics.

Research has shown that the production of lettuce grown in a hydroponic vertical farm requires 15.000 kJ of energy per kilogram, whereas production of lettuce grown in traditional outdoor farms require 1.100 kJ of energy per kilogram (MarketLine, 2020). This substantial usage of energy escalates the need for fossil fuels, which creates a large carbon footprint and thus may offset some of the significant benefits of vertical farming. In order to accommodate this problem, the key is renewable energy sources combined with utilizing the location of the vertical farms, according to Despommier (2009). This is meant in terms of taking advantage of the natural environment surrounding your farm. Sun filled places such as the Middle East and Asia can maximize natural sunlight through solar panels, while regions with steady winds are ought to utilize this in their energy consumption (Despommier, 2009). However, in order to exploit these renewable energy sources, the technology and resources behind need to be available in the specific location of the vertical farm. Moreover, plant waste such as roots from the harvested produce could be exploited to create electricity or biofuel, which may compensate a share of the energy consumption (ibid.). This showcase how alternative resources could represent opportunities to avoid waste and reduce some of the costs occurred by vertical farming.

2.4.3 Viable Crop Types

In addition to the two overarching drawbacks, there is an additional challenge in terms of crop types. As of today, the production methods of vertical farming are most suitable for lettuces, herbs and micro

greens, since they can be produced in large scales, have quick turnovers and high margins. Staple crops and slower growing vegetables such as corn and wheat have lower margins and are not yet cost-effective alternatives and are thereby not profitable in the context of commercial vertical farms (Birkby, 2016; Gupta & Ganapuram, 2019). This constraint is a considerable challenge since staple crops are the source of a large majority of the world population's energy intake (National Geographic, 2014). Therefore, limited types of viable crops may affect the ability for vertical farming to address the issue of providing food for the increasing population. Moreover, it is rather challenging to grow different types of crops in the same vertical farm, since all crops have distinctive environmental requirements. In addition to this, there is a constraint in terms of changing the layout and design of vertical farms, making it difficult and very costly to accommodate the needs of different kinds of produce (Gupta & Ganapuram, 2019).

The challenges outlined in this section are based on general tendencies in literature on vertical farming. Through our research we have identified an additional challenge, which is considered as overarching and highly relevant to put emphasis on. This challenge is in terms of the temporality of the industry. While the techniques of the different growing systems are somewhat longstanding, using these systems for commercial use in vertical controlled environments is a novel invention. There are several challenges associated with the newness of vertical farming, since the industry has yet to be fully established in terms of technologies, political support, competitors, awareness etc. This challenge even relates to all of the previously mentioned challenges regarding costs, energy and crops, as several facets correlate with the newness of the market as well. The early stages of the industry will be further emphasized and examined in the analysis of the thesis regarding value capturing (section 6.2.2). Moreover, the following section is aimed at elaborating on some of the relevant dynamics in the market, as well as presenting examples of existing players, in order to provide an understanding of the market conditions for vertical farming.

2.5 The Market of Vertical Farming

The objective of this section is to provide background information on market dynamics for vertical farming in an international setting, which will be contextualized to the Danish setting in the subsequent section. The focus will be to offer insights on a few trends and drivers combined with a presentation of selected companies from the existing entrepreneurial landscape. This section is motivated by establishing an understanding of the broader context of vertical farming before

narrowing it to the Danish market. This is further incentivized by the fact that vertical farming is an international phenomenon with a more longstanding and advanced industry in other regions, which has entered the Danish market rather recently.

Recent research has projected the global market for vertical farming to grow at a CAGR of at least 8,9% from 2020 to 2025. North America and Europe are expected to be the fastest growing markets, whereas North America and Asia Pacific are contributing with the largest growth rates as of today (Fortune Business Insights, 2020; Mordor Intelligence LLP, 2020). Moreover, the global vertical farming market is estimated to be valued at USD 12.039 million by 2026 (Fortune Business Insights, 2020). The rapid growth of the market is promoted by two main drivers. These are defined as an increasing need for independent agricultural techniques to tackle climate conditions and a growing demand for organic products combined with enhanced living standards and higher disposable incomes (ibid.).

In terms of the different types of farms, large-scale and in-store make up around 55% of the total market share in North America and container farms around 45%. The market share of building-based farms is expected to grow at a faster growth rate than container farms in the coming years. In terms of growing systems, hydroponics holds the largest market share today, whereas aquaponics holds the smallest. This trend is expected to maintain the same towards 2026 (Fortune Business Insights, 2020). In Europe, the number and sizes of vertical farms are still quite limited. The industry is however experiencing an increasing interest from investors and an extensive rise of start-up companies. In addition, the financial crisis of 2007-08 resulted in huge amounts of office buildings being vacated, which fostered new locations for vertical farms (Butturini & Marcelis, 2019).

An overview of the international entrepreneurial landscape of vertical farming is outlined below in order to provide a broader understanding of the market. The aim of this is not to present all companies within the industry, but rather to showcase the broad variety of actors that operate in the international setting. Our research has shown that the common denominators across the companies are that they are technologically advanced, manage very similar assortments of crops and operate with an extensive and inherent focus on sustainability. However, they often vary in terms of their operations within geographical regions, types of farms, types of growing systems, and combinations hereof. In order to provide an overview of this landscape, we have chosen a range of companies based on these three conditions and sorted them after types of vertical farms (Table 2).

With the exception of Infarm, none of the vertical farms in Table 2 currently operate in Denmark and are therefore not considered direct competitors to our case companies. This is based on the assumption that crops produced in large-scale vertical farms in other countries are not transported to Denmark as this would be in contradiction with one of the key premises of vertical farming, namely reducing transportation. However, due to the mobility of in-store and container farms, it is assumed to be easier to export their production to the Danish market in the future, but for the sake of this research we only consider companies with current local operations as direct competitors.

Company name	Region	Growing system	Comments	Websites
Large-scale farms				
AeroFarms	New Jersey, US	Aeroponics	Certified B Corporation	www.aerofarms.com
Bowery Farming	New York, US	Hydroponics	Specialty limited edition products in assortment	www.boweryfarming.com
Growing Underground	United Kingdom	Hydroponics	Located underground	www.growing-underground.com
GrowUp Farms	United Kingdom	Hydroponics	Operated with aquaponics initially	www.growupfarms.co.uk
NextOn	South Korea	Hydroponics	Located in a tunnel	www.inexton.com/index.php
Plenty	California, US	Hydroponics	Combines large-scale with wall farms	www.plenty.ag
Spread	Japan	Hydroponics	Offers educational programs	www.spread.co.jp
Upward Farms	New York, US	Aquaponics	Freshwater fish as part of product range	www.eatupwardfarms.com
YesHealth Group	Taiwan	Hydroponics	Partnering with Nordic Harvest	www.yeshealthgroup.com
In-store farms				
Good Bank	Germany	Hydroponics	Located in restaurant + sells food boxes	www.shop.good-bank.de/
Infarm	Germany	Hydroponics	Operates in 10 countries	www.infarm.com
Swegreen	Sweden	Hydroponics	Operates as service company	www.swegreen.com
The Green House	Netherlands	Hydroponics	Located in a restaurant	www.thegreenhouserestaurant.nl
Container farms				

Agricool	France	Hydroponics	20 km as max. product transport	www.agricool.co
Freight Farms	Massachusetts, US	Hydroponics	Operate in 45 US states and 28 countries	www.freightfarms.com
Growcer	Canada	Hydroponics	Focus on Arctic environments	https://www.thegrowcer.ca
IKEA	Sweden	Hydroponics	Supplying in-store restaurant with produce	www.ikea.com
LettUs Grow	United Kingdom	Aeroponics	One of few aeroponic containers	https://www.lettusgrow.com

Table 2 Entrepreneurial Landscape. Own representation

2.6 The Danish Context

Based on above outline of the international market, the aim of the following is to contextualize selected dynamics of the vertical farming industry to the Danish setting, mainly focused on a consumer perspective and the entrepreneurial landscape. In the Danish food industry, sustainable consumption and purchase of organic products are considered two important aspects. More than 65% of Danish consumers consider sustainability to some degree when purchasing food or drinks, whereas only 11% consider it to a large extend (Vesterbæk et al., 2020). Specifically for greens, sustainability is considered highly important for 16% of the consumers. Similarly, an organic certification is an important aspect to a large number of consumers, and 26% of Danes always buy organic when purchasing greens (Appendix 12). However, the most crucial aspects for Danish consumers are the quality and that the products look fresh and delicious. Furthermore, the main concern for the Danish consumers in relation to the purchase of greens is the usage of pesticides and more than 70% of all consumers are either partially concerned or very concerned with this aspect (ibid.).

The vertical farming industry in Denmark is rather new, resulting in a low degree of knowledge about vertical farming among Danes. According to a study from 2020, only 20% of Danes know about the industry. However, 71% of the consumers who have heard about the industry are willing to buy products from a vertical farm (Appendix 12). Generally, knowledge about the industry is most common among the well-educated part of the younger generation with high income. When explained about vertical farming, 24% of consumers believe that it seems interesting and are willing to try products, while 32% are not concerned with the farming technique, as long as the quality is good.

This implies that 56% of the Danes can be considered potential customers as long as the products have a high quality (Appendix 12).

The industry only has a few established players implying a low product accessibility for the Danish consumers. The top players in a Danish context are Nordic Harvest, Infarm, Kaya Herbs, Grow Up Farm, Nabofarm and Nextfood. All players are growing crops directly to consumers, whereas Nextfood additionally provides retailers, food service companies and vertical farms with automatic farming systems and maintenance (Nextfood, n.d.). Infarm and Nordic Harvest can be considered the two largest players in the Danish market and will together comprise the case material for this thesis. The purpose of the following sections is therefore to present the two companies and motivate the choice hereof.

3. Case Descriptions

The purpose of the following is to introduce the two companies that have been chosen to form the case and which are studied with the aim of answering the research question regarding vertical farming in a Danish context.

3.1 Case Introduction: Nordic Harvest

Nordic Harvest is a Danish vertical farming company established by CEO Anders Riemann, located in Taastrup outside of Copenhagen (Nordic Harvest, 2020). In 2020, Nordic Harvest finished building the first phase of a large-scale vertical farm with 14 layers of crops and a current production capacity of 250 tons produce a year, that is 100% driven by wind energy (ibid.). The construction is expected to reach full capacity by the end of 2021 (Appendix 2), which involves a production facility of over 7.000 square meters that will deliver 1.000 tons of produce through 15 harvests each year. This makes Nordic Harvest the first large-scale vertical farm in Denmark (Nordic Harvest, 2020). In terms of financials, Nordic Harvest has raised around 62 million DKK in start-up capital from a broad range of different investors, including Vækstfonden, Danmarks Grønne Investeringsfond (The Danish Green Investment Fund) and independent estate managers (Iværksætter Historier, 2021).

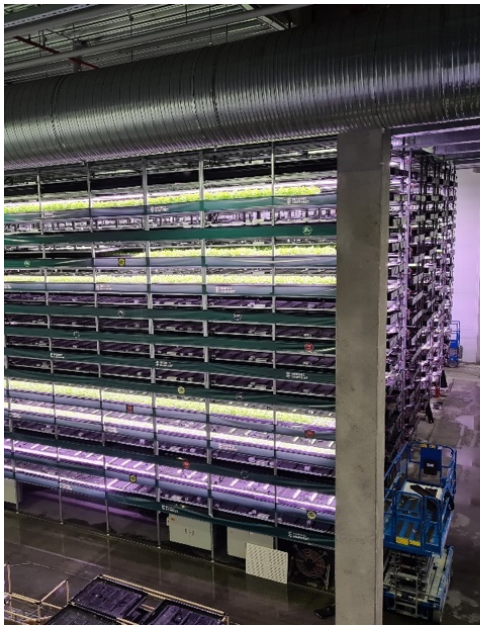
The vision of Nordic Harvest is to prove that growing fresh produce can be done in the cities (Riemann, 2020). Moreover, the company believes that consumers can base their buying decisions on taste, quality and store-prices, but that the transparency of how nature is affected by our food choices is limited. Therefore, Nordic Harvest seeks to make sustainable food the obvious choice (Nordic Harvest, n.d.-b). This includes ambitions of consistently supplying high-quality produce year around, optimizing use of space and giving agricultural land back to nature (ibid.). According to Riemann, Nordic Harvest can only succeed with this vision if it is profitable, which explains why Nordic Harvest is starting with the most profitable crops, lettuces and herbs (ibid.). However, the plan is to eventually expand to other crop types, such as stevia, blueberries and strawberries (Appendix 2). According to the Chief Commercial Officer (CCO), Flemming Dyring, Nordic Harvest will only produce crops where the entire crop can be either used or re-used, meaning that there should be no waste. As an example, this implies an intention to re-use the future blueberry bushes for multiple production cycles (ibid). Moreover, it involves that the roots of the crops are being used to produce

bio-fertilizer (Nordic Harvest, n.d.-e), and will be sold to research and as protein in vegan meals (Appendix 2).

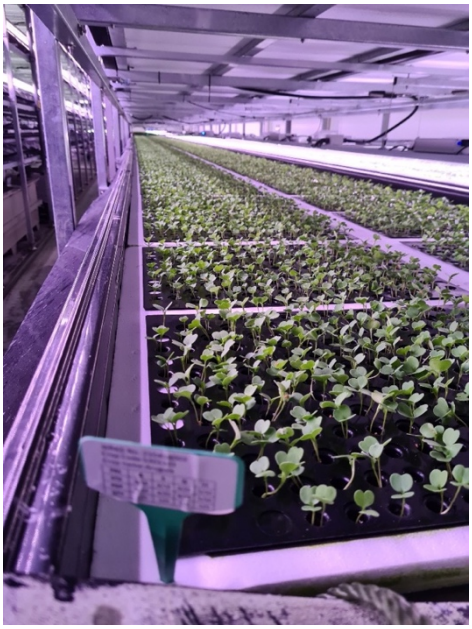
The business model of Nordic Harvest therefore involves production of crops in a large-scale vertical farm with a hydroponic growing system. The large-scale farm is illustrated in Picture 5 and crops in growth in Picture 6, see Appendix 10 for more pictures of Nordic Harvest. In terms of setting up the system and gaining knowledge, Nordic Harvest partners with YesHealth Group, a Taiwanese vertical farming technology company. YesHealth Group has developed the state-of-the-art technology that Nordic Harvest utilizes, as well as its' own LED lights. A group of employees from YesHealth Group has spent several months in Copenhagen, setting up the entire system, running tests and educating in the methods and technologies (Appendix 2). In addition, Nordic Harvest has its own lab located in the vertical farm, in which fertilizer is being produced. This means that Nordic Harvest has complete control and transparency in all ingredients and methods behind the fertilizers and nutrients that go into the produce (ibid.). Moreover, Nordic Harvest is actively working towards achieving an ISO 2200 certification (ibid.), which is a high-profile standard regarding food safety management (ISO, 2018).

A majority of first year's produce has been pre-sold to hotels and canteens, and the remaining produce is planned to be sold to retail (Nordic Harvest, 2020). The ambition is to be present in Danish grocery stores in April 2021[1], and eventually to sell its products to Michelin restaurants as well, with the purpose of being branded as quality products. After having established itself in Denmark, the ambition of Nordic Harvest is to expand its production and distribution to Helsinki and Oslo (Appendix 2). In addition to establishing large-scale vertical farms, Nordic Harvest has a vision about bringing back wild nature and forests in Denmark (Nordic Harvest, n.d.-b). Once Nordic Harvest is running on full capacity, the aim is to reinvest the earnings into a reforestation project (Granyon, n.d.). Through the fund Nordic Reforestation, Riemann has an ambition about acquiring agricultural land and convert it into wild nature (Kristensen, 2020).

[1] On April 26th 2021, Nordic Harvest launched its first products nationwide in Bilka and Føtex stores (Salling Group, 2021) This launch occurred after the data collection process of this thesis, why it has not been accounted for in the research



Picture 5 Nordic Harvest's large-scale farm



Picture 6 Nordic Harvest's products

3.2 Case Introduction: Infarm

Infarm was established in Berlin in 2013 by Osnat Michaeli, Erez Galonska and Guy Galonska with the vision of distributing the farms instead of the produce (Jørgensen, 2020). This is done in order to build a new and transparent food system, where tasty food could be grown locally, while at the same time positively impact the planet (Jørgensen, 2020). Infarm's business model involves installing in-store vertical farms using hydroponic technology at the location of its customers, including locations such as supermarkets, restaurants and canteens. Additionally, the business model involves 'farming as a service', as Infarm is responsible for harvesting and maintenance of the farms (Jørgensen, 2020). An example of an in-store farm is illustrated in Picture 7 and products in Picture 8, see Appendix 10 for more pictures of Infarm. Furthermore, Infarm builds Infarm Hubs in the cities it operates in, which are facilities where the plants start the growth process before they are moved into the in-store vertical farms and where growth of additional greens take place (Infarm, n.d.-a). These Hubs provide Infarm with a possibility to supplement the in-store production and thus avoid situations, where demand exceeds in-store production capacity (Appendix 1, 3). The in-store farms are data-driven and are controlled remotely from the headquarter in Berlin through a cloud-based system, which is based on artificial intelligence, ensuring continuously improvements and adjustments of the growing recipes (Jørgensen, 2020).

Infarm currently has more than 1000 vertical farms installed globally (Jørgensen, 2020), and operates in Canada, France, Germany, Japan, Luxemburg, UK, USA, Switzerland, Netherlands and Denmark (Coop, 2020). However, the ambition of the company is to further expand globally, which Infarm considers feasible as the business model allows for scaling due to the mobility of the in-store format (Jørgensen, 2020). Infarm has operated in the Danish market since 2019, through a collaboration with Coop's high-end supermarket chain Irma. This implies that Infarm's products can be purchased in all 69 Irma stores located across Copenhagen and the Zealand region (Coop, 2020). However, only 40 of these stores are equipped with an in-store farm (Appendix 6) and the rest are supplied by the Infarm Hub located in Taastrup, as they are too small for accommodating an in-store farm (ibid.). Moreover, the Hub provides all Irma stores with lettuce because only herbs are grown in the in-store farms due to different production cycles for herbs and lettuce. Infarm visits all Irma stores approximately 2-3 times a week to deliver fresh produce and harvest the in-store products using electric cars (Appendix 5).

Picture 7 Infarm's in-store farm

Picture 8 Infarm's products

3.3 Choice of Market

Prior to explaining the rationales behind the choice of case companies, we consider it necessary to motivate our choice of market. In the thesis we focus on vertical farming in a Danish context, which is mainly motivated by three different reasons 1) Possibility to experience vertical farms at firsthand, 2) Denmark as an agricultural nation, 3) Sustainability as of high importance for Danish consumers.

In order to better grasp the complexities of vertical farming, we visited the vertical farm of Nordic Harvest and conducted small-scale field trips to Irma stores as a part of our research process. These field trips provided us with an enhanced understanding of both large-scale and in-store vertical farms, which were enabled by the Copenhagen adjacent locations of Irma stores and the production site of Nordic Harvest. The experiences and insights gained from these trips are argued to have established a market specific foundation of knowledge, which is argued to improve the outcome of the thesis. Another reason for choosing the Danish context is Denmark's status as an agricultural nation (Appendix 7). In 2017, 62% of Denmark was made up by agricultural land, which makes Denmark the most cultivated country in Europe (Samson, 2019). With this in mind, we consider it interesting to examine the tension field between traditional agricultural and the new technology-based farming practices, which vertical farming represents. The last reason for choosing the Danish context is motivated by the aforementioned interest of Danish consumers in organic and sustainably produced food (section 2.6). This sustainability awareness among Danish consumers could potentially influence both vertical farming and the sustainable development in Denmark positively, which corresponds well with the scope of our research question.

3.4 Choice of Case Companies

Nordic Harvest and Infarm are used to form the case study of the thesis. The choice of selecting and combining these two companies is based upon three main reasons: 1) Operations in the Danish market, 2) Difference in business models, 3) Commercial productions. The motivations for these three choices are explained in the following section.

Despite Infarm being a German company (Appendix 6), both Infarm and Nordic Harvest currently operate vertical farms in Denmark. Both companies are therefore deemed relevant in terms of researching how vertical farming may obtain the potential to gain ground in the Danish market. Moreover, both companies are among the few established players in Denmark but operate with two very different business models, as described in the above case descriptions. While Infarm uses a combination of in-store farms located in Irma stores and the Infarm Hub, Nordic Harvest produces all crops in the large-scale vertical farm. Furthermore, Infarm offers farming-as-service to its customers, which is facilitated through an exclusive partnership (Appendix 3, 6). Despite not having launched its products yet, Nordic Harvest is interpreted to operate with a traditional supplier-buyer model, by selling its products to grocery retail, hotels and canteens (Appendix 2).

Including the aspects of the different business models in the research of this thesis is considered meaningful due to the newness of the vertical farming industry in Denmark. This means that all of the established players in the Danish market are fairly new, why it is not clear whether some business model elements or dynamics are more effective in terms of enabling vertical farming to gain ground in Denmark. Thus, we consider it meaningful to include two companies with differentiated business model. Furthermore, this choice is motivated by ensuring a multifaceted perspective on vertical farming, as the two companies are considered to complement each other in the analysis and thereby ensure a nuanced analysis of vertical farming in Denmark.

Since the research of this thesis is focused on how vertical farming may gain ground and contribute to sustainable development, we find it of high relevance to include case companies that we consider having the potential of reaching large commercial sizes. Both Infarm and Nordic Harvest operate with high capacities allowing production of considerable amounts of crops, which enable them to be able to reach a large number of Danish consumers. Therefore, we argue that both companies may be capable of influencing consumers and other various stakeholders to a larger extent than some of the more small-scale players in Denmark. The choice of two commercially focused companies is thereby driven by the research question. Overall, we have thus chosen to research Infarm and Nordic Harvest as a combined case study due to their local operations, complementing business models and commercial focus.

4. Methodology

As our ability to study vertical farming as phenomena relies on the research philosophy, the purpose of the following section is to present the research philosophy used in the thesis. Subsequently, the methodical considerations including the research approach, the collection of primary data, the collection of secondary data as well as the evaluation and limitations of the chosen research approach are presented. Overall, the methodology chapter will illustrate and reflect on the course of action that we have adopted in order to attempt at holistically answering the research question.

4.1 Philosophy of Science

We consider it crucial to reflect upon the research philosophical stance of the thesis since we acknowledge that our choice of research philosophy shapes our world view and how we generate knowledge throughout the thesis. The purpose of the following section is therefore to present the research philosophy of the thesis, including our ontological and epistemological perceptions.

4.1.1 Ontology and Epistemology

According to Saunders (2019), ontology refers to the nature of reality and the perception of objects. Thus, our ontological assumptions shape how we study and understand our research object. In this case, it includes objects such as vertical farming, sustainability, the case companies and the opinions of the interviewees. The ontological stance of this research leans towards the research philosophy of interpretivism, where the nature of reality is perceived as socially constructed and where objective reality is impossible for human beings to grasp (Chen et al., 2011; Saunders, 2019). We thus accept that the conclusions of our research will be context-dependent. The conclusions derived in the thesis will for example be dependent on factors such as the specific Danish market context, the chosen case companies and the time of the research. Specifically, as we study vertical farming as a contemporary phenomenon, interpreted as an innovation in the Danish market, it impacts how we have approached the entire research process. Therefore, we recognize the fact that the research process and conclusions are reliant on the interpretations, values and beliefs of us as researchers. This implies that the relationship between us and our research object is interactive and participative, why our objective is not to seek one definite truth (Saunders, 2019). Instead, our focus of interest is to uncover what is unique, specific and deviant in the context of Nordic Harvest and Infarm in Denmark. Interpretivist research is often criticized for being too subjective and biased by the researchers (Dudovskiy, 2019),

yet we do not consider this to undermine the validity and generalizability of our research, which will be discussed further in section 4.5 regarding evaluation of the research approach.

Whereas ontology is concerned with the perception of reality, epistemology refers to the assumptions about knowledge and how acceptable and valid knowledge is constituted and communicated (Saunders, 2019). The epistemological stance of this research therefore impacts how we construct knowledge. As an example, the focus of our data collection has to a large extent been to understand perceptions and interpretations, rather than measurable facts and causal explanations. This approach has been chosen as we acknowledge the fact that "different people of different cultural backgrounds, under different circumstances and at different times make different meanings" (Saunders, 2019: 149). We have therefore interviewed different stakeholders within the vertical farming industry in order to capture the richness of their world views and contexts. Hence, we consider it essential to collect what is meaningful to the individual interviewees, in order to understand their different subjective realities. By exploring this complexity of the multiple expert perspectives, we aim at generating a holistic and meaningful interpretation of vertical farming in a Danish context at this specific point in time. Moreover, the methods that are typically deployed in an interpretivist approach are qualitative analysis, in-depth investigations, small samples and inductive reasoning (Saunders, 2019). These are all in line with the chosen methods of this thesis, which will be elaborated and discussed in much more detail in the remaining parts of this chapter.

4.2 Research Approach

In the following section we argue for the choice of research approach used in the thesis. Firstly, we present and reflect on our chosen research design. Next, we present how we have used a case study as research method and why we consider this format to be useful for the purpose of this thesis. Lastly, we present our theoretical considerations related to the theoretical framework.

4.2.1 Research Design

The research design involves the approach taken to gather data in order to enable an answer of the research question. A central decision is whether to undertake an exploratory, descriptive or causal approach, which are the three overall classifications of research design (Malhotra et al., 2017). The objective of an exploratory research is to attain insights and understandings, and it is characterized by a flexible research process and small samples. Similar to our interpretivist approach, the methods

used are typically qualitative interviews, expert surveys and secondary data (ibid.). On the other hand, the objectives of both descriptive and causal research are to measure, which are often done through hypothesis testing and examination of relationships. These types of research are characterized by large samples, structured research processes and methods such as quantitative data analysis, surveys, experiments and secondary data (ibid.), which have not been employed in this thesis. Descriptive and causal research differ as the first seeks to describe a phenomena of interest and the latter seeks to identify causal relationships between factors and events (Burns & Bush, 2013).

The research of this thesis has adopted an exploratory research design in order to examine how vertical farming may obtain the potential to gain ground in Denmark, and whether it might impact sustainable development. This will be researched through a qualitative case study of Infarm and Nordic Harvest (section 4.2.2) with a strong theoretical framework (section 4.2.3), supported by primary data in the form of interviews (section 4.3.1) and secondary data (section 4.4). The objective of the thesis is therefore rather to understand than to measure, which is consistent with our exploratory research design. The theoretical framework is deemed strong since it is built specifically for the purpose of this thesis and enables the unit of analysis to be researched in a way that is consistent with the research question. Moreover, it contributes with a coherent and theoretically based challenging of the concept of vertical farming. In addition, the exploratory approach is considered meaningful due to the newness of the market, implying that data availability and prior knowledge are rather limited. The research process has therefore been driven by a strong research interest to explore and understand the subject, as outlined in chapter 2. This also serves as reasoning for the interviews with industry experts that have been conducted. These are performed with a small, non-representative sample that has been carefully selected in order to maximize output from ‘quality’ individuals (Malhotra et al., 2017).

Linked to the exploratory research design, the thesis is following an overall inductive approach, which will be outlined in the coming section. However, elements of deduction were first incorporated in the study, since the initial stages were aimed at exploring relevant academic literature and gathering information on vertical farming and sustainable development. This led to learnings that served as knowledge base for building the theoretical framework. Ultimately, it enabled us to form some general assumptions, which were used to steer the primary data collection as they were used to formulate the interview guide with the aim of empirical examination. Therefore, this process involved

starting with theoretical hypotheses before engaging in empirical observations. This approach has allowed for ongoing alterations of both the interview guide and the theoretical framework, which corresponds well with the iterative nature of the exploratory approach, where the research focus may be adjusted continuously as novel insights are uncovered (Burns & Bush, 2013). Considerations of the theoretical framework will be further elaborated in section 4.2.3.

While these deductive elements are of significant importance for the study, an inductive approach is deployed as the overall research approach, as stated above. This is motivated by the general objective of the thesis, which is to understand the role of vertical farming in Denmark, examined through an empirical study of two case companies. Therefore, the purpose is to derive conclusions from the empirical observations of the research. An inductive approach entails searching for how certain events and phenomena are interrelated, and thereafter to develop new knowledge based on the observed combinations (Malhotra et al., 2017). This involves a risk of deriving conclusions based on incomplete proof (ibid.). As mentioned above, we have attempted to mitigate this risk by the integration of deductive elements through the theoretically grounded data collection. An evaluation of the overall research approach will be discussed further in section 4.5, as previously stated.

4.2.2 Case Study

In order to conduct the research on vertical farming in Denmark, we have built a case consisting of the two case companies Infarm and Nordic Harvest. The thesis can therefore be characterized as a case study, which is a research strategy that focuses on understanding the dynamics within a given setting and can involve either single or multiple cases (Eisenhardt, 1989). As the considerations behind the choice of case companies were explained in section 3.4, this section focuses on how we have constructed the case as well as the benefits and drawbacks of this research strategy. As case studies often combine various data collection methods to strengthen the output of the analysis (ibid.), we have decided to establish our case based on four different data inputs. These include: 1) Interviews with industry experts in or in close contact with the case organizations, which is considered primary data, 2) Field trips to Nordic Harvest and selected Irma stores, which is considered primary data that supports the interviews, 3) Information retrieved from Infarm and Nordic Harvest's company websites, which is considered secondary data created internally by the case companies, 4) Press coverage regarding Infarm and Nordic Harvest retrieved from various online platforms, which is considered secondary data created by external stakeholders outside the case companies.

Using complementing data sources to study the research phenomenon can be considered data triangulation, which is a way to ensure that the weaknesses of some data types are outweighed by the strengths of others (Andersen, 2013). Thus, this multifaceted approach has provided us with a broad organizational understanding of both Infarm and Nordic Harvest, consisting of both primary and secondary data as well as both internally and externally generated data. Overall, we therefore consider the case study format highly relevant to gain an in-depth understanding of the dynamics in the Danish vertical farming market and thereby enable to the answering of the research question.

According to Eisenhardt (1989), there are several strengths related to using a case study as a research strategy. Case studies increase the likelihood of generating novel theory due to a constant exposure to contradictory realities that forces researchers to rethink their own perceptions (ibid.). Therefore, Eisenhardt (1989) disagrees that using case studies limit researchers to their own preconceptions, which is often argued to be a drawback of using case studies. Instead, it is reasoned that case studies hold the potential of generating new theory that is less biased than other research methods (ibid.). This is in accordance with the argument of Flyvbjerg (2006), who emphasizes the value of generating knowledge through a case study format by presenting the common misunderstandings related to case study research. Selected misunderstandings of Flyvbjerg (2006) will be further elaborated in section 4.5, where an evaluation of the chosen research design is carried out. A weakness of using a case study approach is the typical large amount of rich data, which can challenge the process and create increased complexity if attempting to capture all details (ibid.). To avoid this, we have thoroughly argued for both selections and deselections throughout the thesis, and we have thereby increased the research transparency. Lastly, it might be argued that the lack of quantitative testing may lead to an inability to assess which relationships are most important and whether they are specific to the case, which consequently can result in narrow theory generation (Eisenhardt, 1989). We acknowledge this challenge and will take it into account when deriving conclusions from the case study. Furthermore, we will reflect on the generalizability of our specific findings in section 7.4.

Moreover, the chosen research strategy possesses the strength of linking theory closely to the empirical observations (ibid.). In this thesis, a central part of our research question is concerned with how vertical farming can obtain the potential to gain ground in Denmark. With use of a theoretical framework, the established case is considered an empirical example that can be analyzed in order to

comprehend how vertical farming may create traction and to obtain an understanding of its potential to contribute to the sustainable development.

4.2.3 Theoretical Considerations

As mentioned above, the case study will be researched in coherence with a strong theoretical framework, which constitutes an essential element of the research approach. This entails that we have built a theoretical framework consisting of carefully chosen academic literature, which serves two main purposes: act as guideline for the data collection and act as foundation for the analysis. This means that the theoretical framework has steered the data collection process, especially in terms of formulating several of the questions in the interview guide (section 4.3.4). This ensures cohesion between the theoretical considerations and the collected data, and thereby creates interaction between various parts of the research. Due to the evolving nature of the research process, the theoretical framework has been continuously adjusted in order to incorporate learnings from the data collection, as mentioned in section 4.2.1. As for the second purpose, the theoretical framework forms the structure of the analysis. The framework is structured around theory from Gary P. Pisano (2015) on the significance of innovation strategies, which consists of three distinct levels that will act as guidelines for the analysis. The three levels will collectively lead to an assessment of the innovation strategies of Infarm and Nordic Harvest.

Additional theories are incorporated in each level to facilitate an in-depth and multifaceted analysis. Three general criteria have guided the selection process of these theories. We have made sure that all three criteria are represented throughout the theoretical framework, but they are not necessarily present in each of the chosen articles. The criteria are as follows: 1) A specific academic emphasis on sustainability, in order to focus specifically on sustainable business models and industries, 2) A focus on recent literature, to ensure that the theories are not outdated in relation to the new and innovative industry of vertical farming, 3) A focus on management of innovation in order to support an analysis of vertical farming as an innovation. Overall, all literature in the theoretical framework should contribute to answering the research question, in order to make sure that all theories are meaningful and relevant for the scope of the research. In addition, all literature is aligned with the research epistemology of the thesis, as described in section 4.1.2. The details on the specific selections of literature in the theoretical framework will be presented and reflected on in chapter 5. Furthermore, the framework and subsequent analysis will be based on an underlying assumption, which will be

explained and rationalized in the same section. The findings of the theoretically based analysis will ultimately be used as input and starting point in the following discussion.

4.3 Primary Data Collection

The primary data collection has mainly taken place as conduction of seven interviews, including six in-depth expert interviews and one field expert interview. To support the data received from the interviews, we have conducted the aforementioned small-scale field trips in order to encounter vertical farming in real life (section 3.3). We visited the large-scale farm of Nordic Harvest in Taastrup, where we experienced the production facilities at firsthand and had the opportunity to encounter the case company from the inside and meet several of the employees. The field trip took place the 11th of February 2021 and consisted of a tour around Nordic Harvest's facility followed by an interview with the CCO Flemming Dyring (Appendix 2).

Instead of performing a similar trip to the Infarm Hub in Taastrup, we chose to visit various Irma stores in the Copenhagen region. The store visits allowed us to encapsulate the in-store farms and products of Infarm, which involved testing the shopping experience from a consumer perspective and tasting the products. During one of the store-visits we conducted a brief interview with the responsible employee for fruit and vegetables in that specific store (Appendix 5), which is referred to as the field expert interview. Our methodological considerations related to the expert interviews, the ethical considerations, the choice of interview participants, the interview guide and the treatment of interview data will be presented in the following sections.

4.3.1 Expert Interviews

Specifically, we have conducted a total of seven expert interviews involving eight participants, as one of the interviews included two interviewees. All interviews have had a semi-structured approach guided by an interview guide and have lasted approximately between 30-60 minutes. Five of the interviews were conducted virtually using Microsoft Teams due to the pandemic circumstances caused by Covid-19. In contrast to phone interviews, using Microsoft Teams has provided us with the possibility to see our interview participants and thus observe non-verbal cues during the interviews, similar to a face-to-face setting (Iacono et al., 2016). This format has proven to be useful for the purpose of our research, as it has allowed us to interact with participants in other geographic locations than Copenhagen. Only two interviews were performed face-to-face, which were the field

interview in Irma and the interview with the CCO of Nordic Harvest, that took place during the company visit in Taastrup with all necessary Covid-19 precautions taken. An in-depth interview format is a way to uncover the interviewees' beliefs, attitudes and feelings towards the research topic through conversation (Malhotra et al., 2017). For the purpose of this research, this format is considered useful due to the complexity of vertical farming, as it has allowed us to ask follow-up questions and provided us with sufficient time to create a holistic understanding of how the interview participants discern vertical farming from their individual perspectives.

Interviewing can be a very time-consuming technique, but is a good way to gather valuable data (Berg, 2001). All interview participants are considered industry experts, as they either work directly in the vertical farming industry or possess a job with connection to the industry. Interviewing experts is a way to explore ideas, make new connections in data and generate new perspectives in relation to the research problem (Malhotra et al., 2017). Thus, using expert interviews as a part of the research has been useful in order to expand our knowledge about vertical farming as a topic, but also to provide us with different perspectives on the industry. One potential challenge of obtaining information from experts is that some individuals claim to be knowledgeable about a certain topic but might in fact lack knowledge (ibid.). To limit this risk, we have carefully chosen our interview participants, which is elaborated on in section 4.3.3. Another potential challenge is that it might be difficult to locate, gain access and obtain help from certain experts (ibid.). During the research period we have received a number of rejections from potential interview participants (Appendix 9). However, we have overcome this challenge with endurance, persistence and use of network. This has resulted in access to the eight industry experts, who are all considered relevant for the purpose of the study. Lastly, interviewees are prone to be biased by the specific context they operate in (Malhotra et al., 2017), which we as interpretivist assume will affect their interpretations and answers to the interview questions. As an example, we experienced that the interviewees often had a very positive attitude towards the companies that they work in. Thus, we are aware of this context-dependency throughout the interviews and will therefore consider the specific situation of the interviewee when deriving conclusions.

4.3.2 Ethical Considerations

As the knowledge produced in an interview situation is affected by the human interaction in the specific situation (Kvale & Brinkmann, 2009), we consider it necessary to briefly reflect upon the

ethical aspects of our conducted interviews. According to Kvale & Brinkmann (2009), it is important to consider ethical questions during the entire research process. This includes considerations about whether the interviews could implicate potential negative consequences for the participants in case of publication of the research or whether anonymity is desired (ibid.). To ensure this, we have prior to all interviews asked the interview participants for allowance to record the interviews and have provided them with the choice of anonymity.

4.3.3 Choice of Interview Participants

The interviewees that have participated in our interviews have all been carefully chosen. In order to ensure a multifaceted perspective on the subject, we have interviewed a range of stakeholders with different associations to the vertical farming industry in Denmark. Thus, we have sought to triangulate the interviews by covering a company perspective, a retailer perspective and a market perspective. The eight different interview participants and the reasonings behind the selections are presented in the following and summarized in Table 3 below.

As previously mentioned, an interview has been conducted with the CCO of Nordic Harvest, Flemming Dyring. The objective of this interview was to learn about Nordic Harvest as an organization, which constitutes an essential part of building the company case for the thesis. This included insights regarding Nordic Harvest's current activities, vision, ambitions and market understanding. Moreover, the aim was to gain insights from a large Danish player and to experience its' production facilities. Dyring was specifically chosen due to his status as CCO since the primary ambition was to learn about the commercial and organizational side of Nordic Harvest, instead of focusing on the technological side. Dyring has played a vital role in acquiring investors for Nordic Harvest and is now managing the day-to-day work (Appendix 2). Dyring therefore represents the company perspective and is considered a highly relevant interview participant.

Furthermore, we have attempted to contact employees at both the Danish and German Infarm office but have not been able to set up an interview due to time constraints within the company (Appendix 9). Instead, we contacted Irma, the grocery retailer where Infarm is sold in Denmark, which led to interviews with three different internal stakeholders. This proved very useful in terms of both learning about Infarm's partnership model and understanding the Danish retail perspective. Firstly, we interviewed the CSR Director at Coop, Thomas Roland. Coop is a retail business consisting of several

Danish grocery chains, including Irma (Coop, n.d.). Roland is deemed a suitable participant since he is responsible for sustainability related practices at Coop, and thereby Irma, and since he was a part of establishing the partnership with Infarm (Appendix 1). Roland provided us with the contact details of Lars Bo Hansen, Category Manager at Coop. Hansen is responsible for managing the herbs and greens category across the Coop chains, including herbs and lettuces (Appendix 3) and was therefore considered highly useful in terms of understanding trends and dynamics within this category. Lastly, we were referred to Michael Buus Nielsen, Concept Manager at Irma. Nielsen is responsible for the partnership with Infarm and act as the primary point of contact (Appendix 6) and was thus interviewed due to his unique insights in partnering with Infarm. As briefly mentioned in section 4.3, we conducted an additional interview in the field with an anonymous employee from the fruits and vegetable department in an Irma store, which was aimed at understanding some of the practicalities concerning the partnership, supporting the retailer perspective.

Moreover, an interview with Lasse Vilmar, Chief Executive Grower (CGO) at Growup Farm, has been conducted. This was chosen in order to gain a company and market perspective from a different and somewhat smaller Danish player. Vilmar holds longstanding experience with growing technologies in the microgreens industry and has expanded his traditional business with vertical farming production (Appendix 4). Lastly, a joint interview was conducted with two stakeholders from Landbrug & Fødevarer (The Danish Agriculture and Food Council). The interview participants were CEO Anne Arhnung and Director of the Future Farming department, Jacob Lave. The purpose was to get a thorough understanding of the market perspective and to learn about their assessment of the role of vertical farming in the Danish agriculture industry. Landbrug & Fødevarer is the largest agricultural organization in Denmark (Landbrug & Fødevarer, n.d.) and Future Farming works with trends that impact the future of agriculture, food production and consumer behavior in a 5–10-year perspective (Seges, n.d.). These interviewees were therefore chosen to understand some long-term implications of vertical farming in Denmark. Table 3 provides a summary of the interview participants, as well as the corresponding selection criteria and primary contributions to our research.

Interview participant	Company	Selection criteria	Contribution
Flemming Dyring, CCO	Nordic Harvest	Represents company perspective, works at case company	Insights about Nordic Harvest, and value creation for customers, employees, business partners and societal stakeholders
Thomas Roland, CSR Director	Coop	Represents retail perspective, close connection to case company	Insights about partnership with Infarm from a sustainability perspective, and sustainability related value creation for customers
Lars Bo Hansen, Category Manager	Coop	Represents retail perspective, close connection to case company	Insights about partnership with Infarm from category perspective, product related value and trends/dynamics within the herbs/greens category
Michael Buus Nielsen, Concept Manager	Irma	Represents retail perspective, close connection to case company	Direct collaboration and insights about partnership with Infarm, value creation for customers
Anonymous Employee	Irma	Supports retail perspective, close connection to case company	Understanding practicalities concerning the partnership with Infarm
Lasse Vilmar, CGO	Growup Farm	Market and company perspective (outside case companies)	Understanding market dynamics, product related value
Anne Arhnung, CEO	Landbrug & Fødevarer	Represents market perspective	Understand vertical farming in the context of Danish agriculture, including political and societal stakeholders and long-term implications
Jacob Lave, Director of Future Farming	Landbrug & Fødevarer	Represents market perspective	Understand vertical farming in the context of Danish agriculture, including political and societal stakeholders and long-term implications

Table 3 Interview Participants. Own representation

4.3.4 Interview Guide

To ensure that the data from the expert interviews is contributing to the research in a meaningful way, each has been conducted with use of an interview guide (Appendix 8), which is a way to structure the conversation taking place during an interview (Kvale & Brinkmann, 2009). According to Malhotra et al. (2017), preparing a list of topics to be covered during the interview is helpful in order to ensure that the interview maintain its focus on the research problem and that all relevant topics are covered. In addition to this, an unstructured approach that allows for flexibility during the interview may be a

lucrative approach of compiling insights from the industry experts (Malhotra et al., 2017). With this in mind, we developed an interview guide consisting of generic questions grouped into relevant topics. To ensure a constant focus on the research question, the questions in the interview guide were formulated with the theoretical framework in mind, as previously explained (section 4.2.3).

All questions in the interview guide have been formulated in an easily understandable language in order to obtain the best possible outcome of all interviews. Based on the individual interviewee, we adjusted the interview guide to fit the particular purpose by carefully selecting and adjusting the relevant questions. Moreover, we included additional questions for each interview with the aim of attaining more specific insights from the participant and thereby reach the full potential of each interview. Kvale & Brinkmann (2009) argue for the importance of including different categories of questions in an interview situation, such as introductory questions, follow-up questions, and direct questions. As an example, we have incorporated direct questions in our interview guide such as "According to you, what is the biggest challenge of running a vertical farm in Denmark?", which is included with the aim of understanding the perspective of the interviewee. Overall, the interview guide has not been followed rigorously, but has instead acted as a comprehensive guideline. The generic interview guide has been translated to English and is attached in Appendix 8. The semi-structured approach combined with the use of an interview guide is thus considered to be useful way of generating insights about our research topic.

4.3.5 Treatment of Interview Data

As a part of the research process, all interviews have been transcribed. Transcribing entails transformation of data from the oral interview conversation into written language. This transformation involves a risk of losing nuances since elements such as tone of voice and non-verbal communication cannot be captured (Kvale & Brinkmann, 2009). However, this has not been considered a significant challenge in our research process as we do not seek to uncover underlying meanings or discourses in the language of the interviewees. Instead, we seek to understand central aspects and trends of the vertical farming industry from different stakeholder perspectives to be able to analyze how vertical farming can obtain the potential to gain ground in the Danish market and whether it can impact the sustainable development. This means that we are not looking for homogeneity across the different expert interview, but instead we use the expert interview to form a complete understanding of our research topic.

The transcribed format of the interviews has eased the process of finding information within the interviews. All interview participants are Danish speaking, why all interviews have been conducted in Danish. Thus, the transcriptions attached in Appendix, 1, 2, 3, 4, 5, 6 and 7 are in Danish in order to ensure access to original quotes. However, quotes used in the thesis have been translated to English. In addition to providing input to the analysis, the interviews constitute an essential part of our exploratory approach as we have used the interviews to obtain an initial knowledge about the newness of the industry and the complex technology involved in vertical farming. This knowledge base has been expanded through the research process concurrently with the collection of more data. Thus, our treatment of interview data has established a good starting point for the subsequent analysis.

4.4 Secondary Data Collection

The secondary data of the thesis has been collected from multiple sources with the aim of supporting and ensuring validity of the primary data of the research. Secondary data is per definition data that has been collected for other purposes than the research purpose (Malhotra et al., 2017). Consistent with the exploratory research design of this thesis, Malhotra et al. (2017) argue that relevant secondary data should be located and treated prior to the collection of primary data, since it may provide key insights for diagnosing the research problem and planning the primary data collection. Moreover, secondary data is often easily accessible, inexpensive and allows for more insightful interpretations of primary data. Disadvantages of secondary data include risk of inaccuracy, unreliability and not being current, as well as the fact that the data might be inappropriate for the specific research. Secondary data is an essential part of this research in terms of understanding both vertical farming, the industry in general and the two case companies. The following section will elaborate on the specific types of sources that have been used in the research as well as reflections on the quality hereof.

The secondary data employed in the thesis is mainly external data, as access to internal data from the case companies is very limited, which again links to the relative newness of both players and the newness of the market itself. Consequently, this means that comprehensive and internally collected data and market insights are not available from within the case companies. This emphasizes the relevance of our study, as well as the significant role of external secondary data sources. The collected external data include multiple websites, online articles, journal articles, industry reports, conferences, live webinars and media such as documentaries, podcasts, YouTube videos and TED talks. The

industry reports have contributed with deeper understandings of market conditions and trends, as well as technical know-how on agriculture and vertical farming. In terms of the various media sources, the main purpose has been to serve as a starting point of the research as they have been used to explore the topic of vertical farming and establish a foundation of knowledge. Some of these are used as references throughout the thesis whereas others are merely used as background information. The media sources may be perceived as somewhat alternative references for academic research but have been employed as a mean to emphasize the newness of the vertical farming industry, as the selection of peer reviewed academic writings are still rather limited.

Moreover, we have gained access to video recordings and presentations from the conference Vertical Farming in a Nordic Context hosted by the Innovation Network for Bioresources, Food & Bio Cluster Denmark and University of Copenhagen in November 2020 (University of Copenhagen, 2020). The purpose of this conference was to increase cooperation and accelerate vertical farming in Scandinavia. This conference has played a vital role in the thesis in terms of understanding the concept of vertical farming, the technology and specifics for the Danish context. Besides this, we have attended a live webinar Q&A hosted by Freight Farms in the US (Appendix 10). This allowed us to experience a live tour inside the production and seeding areas of a container farm and has contributed with insights on the container farm segment (Freight Farms, 2021).

The internal secondary data that has been collected include company websites and a quantitative report from each of the case companies. We have received a report of research conducted by Voxmeter for Nordic Harvest on vertical farming and the attitudes of Danes. This report consists of charts, statistics and conclusions based on a survey on attitudes towards vertical farming, health, ecology, climate and greens. This research has been a key contribution to understanding the Danish context from a consumer perspective and to support the findings from the primary data collection on the same subject. Moreover, we have received weekly based sales numbers on Infarm products in Irma stores from week 21 2020 to week 6 2021 (Appendix 11), provided by one of the interviewees from Coop. As the actual numbers are confidential, we only present the development of the sales for the purpose of this thesis. Thus, these two internal secondary data sources have not been generated within the Infarm or Nordic Harvest. However, we consider them as internal since they are provided by our interviewees representing the companies and are generated specifically for the companies.

Lastly, the company websites of Nordic Harvest and Infarm have been used to gain knowledge on the case companies and support the collection of primary data regarding these.

4.4.1 Quality of Secondary Data

The various data types presented in above section prove that secondary data is an essential part of our research. However, as mentioned in the beginning of section 4.4.1, secondary data includes some challenges, which we consider critical to reflect on in order to certify that the data is reliable and valid for the specific purpose. According to Malhotra et al. (2017), secondary data can be evaluated using different criteria, which are as follows: specifications and research design, error and accuracy, currency, objective, nature and dependability. An assessment based on these criteria has therefore been performed on all data sources, some of which will be exemplified in the following.

The objectives and sources of origin of the data have been examined in order to identify potential causes for biases or unreliability, which we have done by questioning why and by whom the data has been collected (Malhotra et al., 2017). As an example, it has been ensured that the industry reports used in the thesis are from trustworthy, updated and relevant sources, such as Statista and the research portal of Landbrug & Fødevarer. Hence, this data has been retrieved from databases with high dependability and contributes with reliable and proficient understandings of trends and facts within the agricultural industry. Furthermore, as the technology and market for vertical farming is rapidly evolving, it has been considered necessary to be cautious about the timings of the secondary data. Therefore, a selection criterion for the secondary data used throughout chapter 2 has been to locate the most current literature and media. This has been done in order to shorten the time between data collection and publication, and thereby ensure up-to-date and valid descriptions of the technical concepts of sustainability and vertical farming.

Moreover, the media sources of documentaries, podcasts, YouTube videos and TED talks have been carefully evaluated in order to assess whether they are eligible for academic research. This assessment has especially emphasized the criterion of dependability, which included ensuring that the podcasts, documentaries and TED talks in particular are from industry experts or professionals with relevant experience. A few examples hereof include a podcast with Anders Riemann from Nordic Harvest (Iværksætter Historier, 2021), a documentary featuring Dr Despommier (Rozinga, 2017) and a TED Talk presented by Stuart Oda, founder and CEO of the vertical farming company Alesca Life (Oda,

2019). Thus, the senders of these media sources are considered to guarantee high levels of integrity and expertise due to the featured participants combined with an assessment of the credibility of the platforms they are published on. However, these kinds of assessments are more complicated for YouTube videos due to the format of the media. YouTube is an open-source video platform where anyone can post content, why we have been particularly aware of the senders and quality, in order to avoid videos with low dependability. In addition, this media offers less transparency as there are no requirements to expose information about the specific senders of the videos (YouTube, n.d.). Therefore, the credibility has been determined by critically assessing the content of the videos and by exposing ourselves to a large variety of different media sources within the same topics, and thereby cross referencing the information. Besides, this approach has allowed for the findings to be validated against different perspectives and has expanded the horizon of the research.

The internal secondary has been evaluated on the same criteria as the external data. Here, an examination of the sources of origin have been considered necessary, as neither of the internal data reports are generated within the case companies. This has been done in order to make sure that the data is reliable and relevant for the thesis. The sales report on Infarm products are generated by Irma and is based on scan data from the stores with the purpose of tracking the sales development. Since these numbers represent quantities of products sold at certain prices, they are considered a credible source in terms of understanding the sales. The report concerning the attitudes of Danes on vertical farming is created for Nordic Harvest by Voxmeter, which is an acknowledged and independent analysis institute, providing customer and market analyses for public and private companies (Voxmeter, n.d.). The objective of the research was for Nordic Harvest to gain a deeper understanding of its potential consumers and is therefore considered relevant for the purpose of this thesis.

Overall, these internal secondary data sources are thus deemed high on dependability, objectives and accuracy. Lastly, the company websites of Nordic Harvest and Infarm represent original sources, as the companies themselves are the publishers, which indicates high credibility. However, we have been especially cautious for potential biases since company websites may often be used to sell and promote a brand, which may impact how the company is presented (Malhotra et al., 2017).

4.5 Evaluation of the Research Approach

Due to the interpretivist stance presented in section 4.1.2, we do not seek one objective truth (Saunders, 2019). In the following section, we instead aim to validate the conclusions of the conducted research by assessing the validity, reliability and generalizability, which according to Kvale & Brinkmann (2009) is an essential part of evaluating the quality of the research. Validity and reliability will be assessed in the first paragraph, and generalizability will be assessed in the second paragraph.

Validity refers to whether the intention of the research is fulfilled, meaning whether we actually study what we claimed to study, while reliability refers to the consistency and credibility of the conducted research, which implies that the research can be easily repeated (Kvale & Brinkmann, 2009). We have sought high validity by thoroughly exploring the concepts of sustainable development and vertical farming in chapter two, prior to conducting the analysis. This has ensured an in-depth understanding of the involved concepts and thus enhanced our ability to conduct the research in a meaningful manner. Furthermore, we have carefully selected a fair number of interviewees from relevant fields (section 4.3.3), which has contributed to an improved ability to study what we intended to study (Malhotra et al., 2017). In order to obtain high validity, reliability can be considered a prerequisite (Kvale & Brinkmann, 2009). Throughout the thesis we have explicitly and precisely explained our choices and thereby increased the transparency of the conducted research. However, the qualitative nature of the research, including the semi-structured interviews, reduces the ability for other researchers to repeat the study in an accurate manner, as the individual interviews are highly dependent on the specific situations. Nevertheless, we argue that the deductive elements of our research design (section 4.2.1) ensures that interview questions are based on a theoretical understanding, which is considered to positively affect the credibility and precision. However, this should be considered in the context of the interpretivist research philosophy, where the aim is not to seek one ultimate truth (Chen et al., 2011).

According to Kvale & Brinkmann (2009), generalizability refers to whether research conclusions can be transferred to other situations. Similar to validity and reliability, generalizability is linked to our epistemological approach. Our interpretivist stance implies that our aim is not to produce knowledge that can be directly transferred to other situations, but instead to understand the potential of vertical farming in the specific context of the Danish market. However, we still consider it relevant to include

considerations related to the generalizability of our case study. According to Flyvbjerg (2006), it is a misunderstanding that research reliant on context-independent theoretical knowledge is more valuable than research reliant on context-dependent practical knowledge. It is argued that "predictive theory and universals cannot be found in the study of human affairs. Concrete, context-dependent knowledge is, therefore, more valuable than the vain search for predictive theories and universals" (Flyvbjerg, 2006: 224). Based on this argument, we consider our research conclusions to be of high quality and relevance, despite the fact that they are dependent on the specific case context.

In addition to the above-mentioned misunderstanding, Flyvbjerg (2006) furthermore argues that it is a misunderstanding that case studies cannot contribute to scientific development because it is not possible to generalize on the basis on an individual case. Flyvbjerg (2006) suggests that case studies may be central to scientific development through generalization, both as a supplement or as alternative to other research methods, but that it depends on the specific case and how it is chosen (Flyvbjerg, 2006). As our cases have been deliberately chosen and described throughout the thesis (section 3.1, 3.2, 3.4 and 4.2.2), we consider the findings of the study to be of relevance and may hold the potential of being applicable to other situations, despite an interpretivist research philosophy. However, we will return with a further assessment of the generalizability of our research findings, as a final stage of the discussion in chapter seven (section 7.4).

5. Theoretical Framework

The structure of the theoretical framework is based on Pisano (2015)'s three levels of innovation strategies. Accordingly, the framework is therefore divided into three sections: 1) Value creation, 2) Value capturing, and 3) Innovation types and resources. The choice of using Pisano (2015) as the overall structure is motivated by the fact that it corresponds well with the use of case study as research method and is furthermore considered a relevant theory when taking the newness of the vertical farming industry into consideration. This is elaborated on in the following section.

Through our research question we seek to understand how vertical farming can obtain the potential of gaining ground in Denmark, which indicates that we have incorporated a market perspective in our research scope. It may be argued that this conflicts with Pisano (2015)'s company perspective on innovation strategies. However, our case study format implies that our research question is answered through a case study of two companies, which is in accordance with how Pisano (2015) studies innovation strategies. Thus, it can be argued that Pisano (2015)'s unit of analysis corresponds well with our chosen research format. Furthermore, the reason for analyzing vertical farming through a company lens is ascribed the newness of the industry. As the Danish vertical farming industry is still emerging and only consists of a few established players, we argue that researching the market through the lens of Nordic Harvest and Infarm may be an appropriate indicator of the market dynamics, while at the same time understanding the context of the case companies. Thus, the newness of vertical farming in Denmark has not only influenced our choice of research approach, but moreover guided the choice of main theory for establishing our theoretical framework.

Prior to elaborating on Pisano (2015)'s three theoretical levels, namely value creation, value capturing, and innovation types and resources, a section regarding innovation strategies will lay the foundation for an enhanced understanding of these levels. This will be done by presenting both the main points from Pisano (2015), and by explaining and reflecting on the underlying assumption of the thesis. Conclusively, all sections included in the theoretical framework chapter will be summarized in Figure 11, which will serve as guideline throughout the subsequent analysis of the case companies.

5.1 Innovation Strategy

According to Pisano (2015), a lack of innovation strategy can be considered the main explanation for why innovation initiatives often fail and why successful innovations might have a difficult time sustaining their performance over time. An innovation strategy is an articulated commitment towards a coherent innovation objective, including activities aimed at supporting organizational growth. Moreover, it may be what separates successful innovations from unsuccessful innovations (Pisano, 2015). Pisano (2015) argues that a good strategy promotes group alignment within the company, clarifies priorities and objectives and ensures focus on the right efforts. Despite the fact that companies typically define overall business strategies, they often lack articulation of strategies that ensures alignment between their business strategies and the innovation efforts. This implies that innovation efforts often become a mix of different innovation practices that are not tailored to the specific situations (Pisano, 2015).

Pisano (2015) suggests that a company's ability to innovate derives from its innovation system, which involves structures and processes that determine aspects such as how the company finds innovative solutions, how it searches for new knowledge and how ideas are transformed into business concepts. An innovation strategy helps facilitate trade-off decisions, which is important due to the existence of many conflicting priorities within an organization. Different organizational perspectives are considered crucial for the ability to successfully innovate, but in order for diversity not to become self-defeating, aligned priorities and directions are critical (Pisano, 2015). To sum up, Pisano (2015) argues that one company's innovation strategy will not work equally well for other companies due to other competitive circumstances and needs. However, an explicitly articulated innovation strategy that is closely linked to both the value propositions and the business strategy will aid a company's capacity to innovate (ibid.). The process of developing such an innovation strategy will be further elaborated in remaining sections of the theoretical framework.

While Pisano (2015) focuses on innovations created within existing companies, we focus on case companies constituted by the innovation itself. Reflecting on this difference, we do not consider Pisano (2015) sufficient as the only theory for building our theoretical framework. Hence, we have included additional academic literature, which is chosen based on the criteria presented in section 4.2.3. This has provided us with the possibility to fully explore the three theoretical levels including value creation, value capturing, and innovation types and resources, while at the same time taking the

theories' strengths and weaknesses into consideration. Thus, we argue that the approach has entailed a theoretical framework tailored to the specific research scope of this thesis.

5.1.1 Underlying Assumption

As explained above, a solid innovation strategy is considered a key element for an innovation to succeed (Pisano, 2015), and thereby to obtain the potential to gain ground. As outlined in section 1.2, we consider vertical farming to have gained ground once it has become widely known, prevalently accepted and broadly distributed, implying that it has achieved a certain size. Being successful can be considered a main objective for many innovating companies, and it is assumed to be a prerequisite for the innovation to have an impact in the respective market. Based on this, the thesis is built on the underlying assumption that in order for vertical farming to gain ground and positively contribute to the sustainable development in Denmark, it needs to be successful, which requires a solid innovation strategy. This underlying assumption serves as foundation for how we approach the research question.

In order to develop a solid innovation strategy, Pisano (2015) presents three evaluating questions that should be answered. Collectively, these represent an explicit understanding and articulation of how to achieve sustainable competitive advantage. The evaluating questions include: 1) How will innovation create value for potential customers?, 2) How will the company capture a share of the value its innovations generate? and 3) What types of innovation will allow the company to create and capture value, and what resources should each type receive? (Pisano, 2015). These three questions are considered the starting point for the ability to successfully innovate and positively benefit from the innovations, why the structure of the theoretical framework is based on these.

In the following three sections, value creation, value capturing, and innovation types and resources are explained. Each section will initially present and elaborate on the evaluation question relevant for the specific section. As mentioned in the above section, additional academic literature is included in each section in order to further unfold the three concepts and thereby ensure a holistic exploration of the questions.

5.2 Value Creation

As mentioned above, the first question that should be articulated in an innovation strategy is "How will innovation create value for potential customers?" (Pisano, 2015: 7). According to Pisano (2015),

identifying the specific type of value created by the innovation is a key aspect, as it often determines the required capabilities. Examples of value that may be created include increased customer spend, customers saving money, societal benefits, improved product performance and improved product durability (ibid.). This is a rather broad list of value types, which Pisano does not offer a more specific definition of. Therefore, Lepak et al. (2017) is introduced in order to establish a precise understanding of value and value creation, which contributes with a classification of two different types of organizational values, use value and exchange value. Firstly, use value is described as "the specific quality of a new job, task, product, or service as perceived by users in relation to their needs" (Lepak et al., 2007: 181). This definition indicates that use value is dependent on the individual since it emphasizes user perception. Secondly, exchange value is expressed as the monetary amount realized during the exchange of goods or services (ibid.). Overall, this means that value creation consists of elements that are both monetary, subjective and context-dependent, meaning that perceptions of what is valuable differ across different users. Hence, this definition is in line with the context-dependent focus of the interpretivist beliefs of this thesis.

Similar to Pisano, Lepak et al. (2017) focus on customers as the object of interest and on a unidirectional flow of value creation. However, this is not considered sufficient for the sake of this thesis, as our exploratory research has indicated that the value created by vertical farming contains more facets and impacts more stakeholders. A broader and more sustainability specific understanding of value will therefore be introduced in the following in order to contribute to a comprehensive analysis of value creation within the case companies. Yang et al. (2017) provide four key concepts aimed at identifying value creation opportunities through sustainability. These concepts include 1) Life cycle thinking, 2) Multiple stakeholders, 3) Uncaptured value and 4) Economic, social and environmental value (Yang et al., 2017). Life cycle thinking refers to an assessment of the impact of a product throughout the entire life cycle, which enables an identification of value opportunities in different stages. Multiple stakeholders refer to an understanding of who to identify opportunities for. Efforts related to sustainability should contribute to value creation for the various stakeholders involved in a business model, while at the same time satisfying customers' needs and contributing positively to the society and environment. Uncaptured value is defined as value creation opportunities that are not captured in the existing business model and opportunities where additional value might be created (ibid.). These come in four different forms: value surplus, value absence, value missed and value destroyed. Lastly, economic, social and environmental value refer to what the value consists

of, which emphasizes that a monetary perspective on value is too simplistic in the context of sustainability (ibid.).

Thus, these four concepts collectively form a framework for a sustainability focused analysis of value creation. However, we do not consider all concepts to be of equal importance for the thesis, why we will deliberately choose the elements that are most meaningful for our research. The concept of economic, social and environmental value is regarded as significant as this thesis acknowledges that value is not merely monetary in the case of vertical farming, since we consider it of high importance to integrate all three elements of the triple bottom line, which is consistent with our understanding of sustainability (section 2.1). Moreover, multiple stakeholders are considered highly significant as well, which will be reasoned and elaborated on in the following section. Meanwhile, the remaining two concepts will be reflected upon but will achieve less attention throughout thesis, since we find them less essential for the scope of the research question.

5.2.1 Stakeholder Perspective

As briefly stated in above section, our explorative research has implied that vertical farming creates different kinds of value for different groups of people. This has been revealed through the data collection that takes account of both company, retailer and market perspectives. We consider this an interesting and rewarding aspect to investigate further, why we are supplementing the theory of Pisano (2015) with stakeholder theory. For this reason, Freudenreich et al. (2019) is included to contribute with an examination of stakeholders in the context of sustainability, and how value creation differentiates across these. This theory will therefore be used to elaborate on the concept of multiple stakeholders introduced by Yang et al. (2017) and to facilitate a proficient analysis of value creation across relevant stakeholders in the Danish vertical farming industry.

Freudenreich et al. (2019) study value creation from a stakeholder theory point of view. Throughout the article, stakeholders are emphasized as being in mutual relationships with the focal company, entailing multidirectional flows of value. Stakeholders are thus depicted as both recipients, creators and co-creators of value. Instead of one-sided value creation from business to customers, stakeholder theory suggests that value is created collaboratively and benefits both the business and all of its stakeholders (Freudenreich et al., 2019). Distinguishing between different kinds of value across stakeholders is especially meaningful in sustainability-oriented business models, since sustainability-related issues often require collaboration of several diverse stakeholders (ibid.). This theory is

therefore considered to enable an in-depth analysis of the stakeholder value creation in the case of vertical farming.

In addition to value creation, Freudenreich et al. (2019) distinguish between how value is created and for whom it is created. The first involves different activities carried out by different groups or individuals, and the latter involves the collective efforts of the stakeholders that make out the core of value creation. Value is therefore defined according to the recipient stakeholder in stakeholder theory (Freudenreich et al., 2019). This aspect is consistent with the interpretivist stance of the thesis, since it acknowledges that different stakeholders hold different needs and values, implying that each stakeholder is likely to have different understandings of what constitutes value. The value creation framework (Figure 8) supports a theoretical and empirical analysis of the different types of value and combinations hereof that are exchanged in each stakeholder relationship. Each section in Figure 8 represents the particular relationship between the focal business and a stakeholder group, while the arrows represent examples of the value created (Freudenreich et al., 2019). Five generic groups of stakeholders are depicted in Figure 8, namely customers, business partners, employees, societal stakeholders and financial stakeholders. These all interact with the focal business through different activities towards an overall joint purpose (ibid.). Furthermore, Freudenreich et al. (2019) argues that "analyzing the value flows in stakeholder relationships allows a business to determine whether a contribution to sustainable development is being achieved and whether all stakeholders are supporting this contribution" (Freudenreich et al., 2019: 12). This paves the way for the later assessment of whether vertical farming may influence sustainable development in Denmark and thus emphasizes the relevance of including this theory.

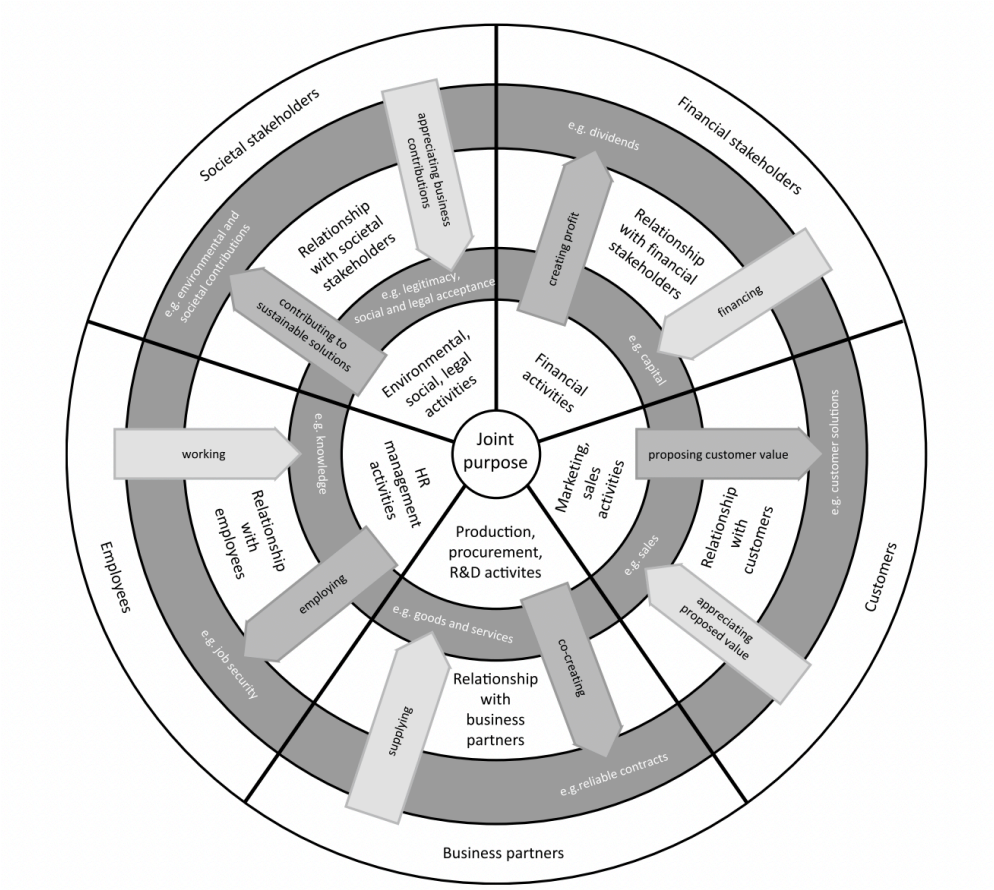


Figure 8 Value Creation Framework (Freudenreich et al., 2019)

5.3 Value Capturing

Simply creating value is not sufficient for an innovation to succeed and it cannot be assumed that the innovating firm will also capture the value, as innovators are often outperformed by competitors (Teece, 1986). Therefore, the second question involves how a company captures a share of the created value and hence positively benefits from the innovation (Pisano, 2015). Thus, this question can be considered a fundamental aspect of turning the specific innovation and the value created into a strategic asset. To understand how value can be captured, Teece (1986) presents three fundamental building blocks: 1) Appropriability regimes, 2) Dominant design paradigm, and 3) Complementary assets, which are factors that influence who wins from the innovation. For the purpose of this research, these building blocks will enable us to understand how Nordic Harvest and Infarm can capture value from vertical farming. Furthermore, these concepts will serve as structure for this section and will each be unfolded and supported by additional literature.

We have decided to include more recent literature in order to accommodate the fact that the vertical farming industry is new, innovative and technology-driven. While Teece (1986) focuses on value capturing from an economic perspective with a main focus on economic profit, we perceive value capturing in a broader manner by relying on the definition of Yang et. al (2017), similar to the notion of value creation. According to Yang et al. (2017), value capturing can be considered the benefit delivered to a company and its stakeholders including both monetary value as well as environmental and societal value, which is in line with Lepak et al. (2017)'s definition of use and exchange value.

5.3.1 Appropriability Regime

A company's ability to capture value from an innovation is impacted by the regime of appropriability, which refers to factors such as the nature of technology and legal instrument (Teece, 1986). These factors determine to which degree innovations and knowledge are protected from competitors. Patents, copyrights and trade secrets are all legal protection mechanisms, which are used to avoid imitation. However, legal instruments do not always confer perfect appropriability. Instruments such as patents are often "invented around", especially when it comes to patenting process innovations (Teece, 1986: 287). The nature of technology refers to whether knowledge is tacit or codified, which also influences the degree to which it can be imitated by others. Tacit knowledge is by nature less exposed to being imitated compared to codified knowledge. Overall, the degree of protection varies from appropriability regimes being tight, implying that innovations are easy to protect, to weak appropriability regimes, implying that innovations are difficult to protect (Teece, 1986).

Similar to Teece (1986), Shenkar (2010) argues that products and processes are not protected by patents, but patenting may in fact ease the process of imitation as it requires a certain degree of disclosure. Usually, imitation is considered as something negative, but according to Shenkar (2010), imitation may be more important to business growth than innovation. Imitation should thus not be considered a low-level activity but instead an advanced and complex process. This is because imitation does not necessarily mean copying, but instead improving by coming up with something cheaper or better (Shenkar, 2010). However, one of best ways of preventing imitation is by continuously investing in innovation, which could entail both product and process innovations (Pisano, 2015). According to Grant (2016), lead time is an additional aspect that affect imitation. Lead time involves the time it takes for other companies to catch up with the innovator, which can be used to build new features or capabilities and thus prolong the competitive advantage (Grant, 2016).

Overall an assessment of appropriability regimes in relation to vertical farming can enable an analysis of the role of tacit and codified knowledge as well as the dynamics of imitators and competitors within the Danish vertical farming market.

5.3.2 Innovation Stages

The evolution of an innovation and the point in time when an innovation is accepted as an industry standard affects a company's value capturing possibilities. Teece (1986) explains this by introducing two stages, namely the preparadigmatic stage and the paradigmatic stage. The preparadigmatic stage involves the point in time when there are multiple players with different solutions and yet no single dominating standard. This stage is followed by the paradigmatic stage, which implies the emergence of one dominant design that is accepted and referred to as the 'normal' (Teece, 1986: 287). In addition, dominant designs may also exist in terms of processes and when business models are competing to become the dominant one (Grant, 2016). In addition, the preparadigmatic and paradigmatic stages can be used to describe the evolution of an industry, where the early industry stages involve fluid product designs, loosely organized processes, capital used in production and competition in terms of product design instead of price. Once a dominant design emerges, the price becomes an increasingly important factor for competitive success due to companies' attempt to decrease costs, which may involve an increased number of process innovations (Teece, 1986). However, a dominant design does not necessarily provide the innovating company with a profit advantage (Grant, 2016). The innovating company may have introduced the innovation, but if imitation is easy, other companies might be able to easily modify the innovation and even end up as the industry standard (Teece, 1986). Therefore, this emphasizes the importance of considering an innovation's appropriability regime, as outlined above (section 5.3.1).

Throughout the thesis we have explicitly stated our awareness about the newness of the vertical farming industry in Denmark, which has shaped how we approach the research. Vertical farming, both as phenomenon and as an industry, is evolving while we are conducting our research, why we consider it highly relevant to include theory about innovation stages within our theoretical framework and thus reflect on how the aspect of time may affect vertical farming. Therefore, we expand the concept of dominant design paradigm (Teece, 1986) with theory of industry life cycles (Grant, 2016; Klepper, 1997). In order to reflect that, this section of the theorical framework is referred to as innovation stages.

The importance of time and how it affects an innovation is emphasized by Klepper (1997) in a study on industry life cycles, which focuses on the evolution of industries. Industry life cycles depict how industries evolve over time and can therefore be compared to patterns of product life cycles (ibid.). The life cycle of an industry is usually longer than the product life cycle, as it may contain multiple generations of a product. The industry life cycle encompasses four phases, namely the introduction phase, the growth phase, the maturity phase and the decline phase (Grant, 2016). In the introduction phase, market penetration and sales volume are low as only a few customers have knowledge about the industry's products. The uncertainty can be considered high due to the novelty of the technology and the lack of experience, which often implies increased costs and low quality (ibid.). In this phase many companies enter the industry, which intensifies the competition related to product innovation (Klepper, 1997). In the growth phase, product designs become more stable, production processes are improved, and an increased number of technical improvements lead to an acceleration in market penetration. The number of companies that entry the industry drops compared to the introduction phase. The maturity phase is characterized by increasing market saturation, stagnation in growth, stabilization of market shares, less significant innovations, and a further decline in entry of companies. The decline phase is when the industry is challenged by novel industries with substituting products that are technologically more advanced (Grant, 2016; Klepper, 1997). The four phases are depicted in Figure 9.

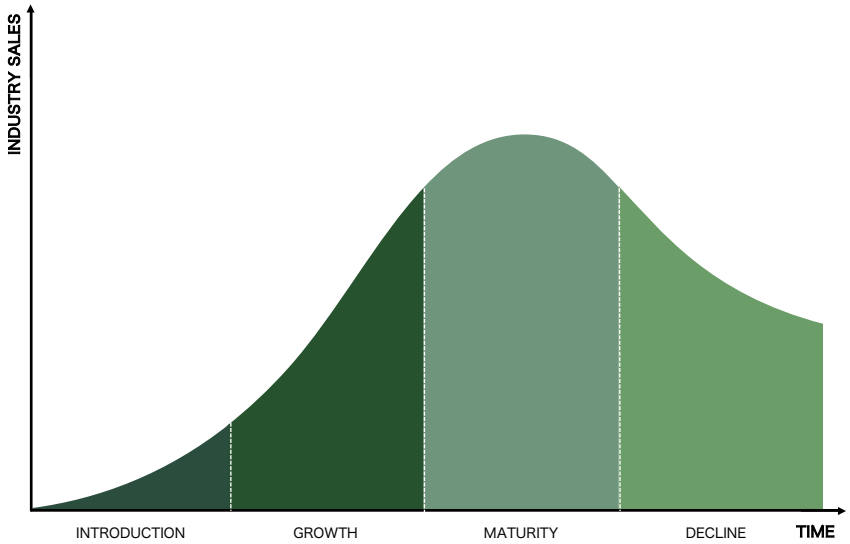


Figure 9 The Industry Life Cycle. Own representation, adapted from Grant (2016)

5.3.3 Complementary Assets

Use of complementary assets is a way for companies to strengthen their competitive position in the market (Pisano, 2015). According to Teece (1986), a successful commercialization of an innovation often requires that the innovation is accompanied by other assets or capabilities linked to the innovation, which could include services such as marketing and customer support (Teece, 1986). One way for companies to access complementary assets is through alliances with other companies (Grant, 2016). Complementary assets can be either generic, specialized or cospecialized. Generic assets imply that the complementary assets are not tailored to the specific innovation, specialized assets involve a unilateral dependency between the innovation and the asset, and cospecialized assets imply bilateral and mutual dependency between the innovation and the complementary asset (ibid.). Grant (2016) argues that on one hand, the innovator has an enhanced chance of capturing value when the complementary assets are generic, due to the possibility of working well with different types of assets. On the other hand, specialized and cospecialized complementary assets can be considered a way to limit imitation (Grant, 2016). An analysis of the complementary assets of Infarm and Nordic Harvest will provide us with the possibility of identifying and evaluating which assets that are valuable for vertical farming companies to operate in Denmark.

Throughout this section, it has become evident that the opportunities for companies to capture the created value, and thus obtain a competitive advantage, depends on various aspects. Whether a company's innovation strategy can be deemed solid is moreover determined by the chosen types of innovations and how resources are allocated, which is the focus of the coming section.

5.4 Innovation Types and Resources

Recalling that the last question that should be articulated in a solid innovation strategy is "What types of innovations will allow the company to create and capture value, and what resources should each type receive?" (Pisano, 2015). This question refers to a deliberation of the amount of efforts that should be invested in technological innovation versus business model innovation, which is exemplified in the innovation landscape map in Figure 10 (Pisano, 2015).

5.4.1 Innovation Landscape Map

The degree to which an innovation entails technological changes and the degree to which it entails a business model change, are represented as the two primary dimensions in Figure 10 (Pisano, 2015).

This matrix can therefore help identify how an innovation corresponds with a company's existing technical competencies and business model. Additionally, the matrix supports the decision-making process of which dimension to utilize most resources on (ibid.). In this thesis, the innovation landscape map will support an analysis of vertical farming as an innovation, aimed at understanding how Nordic Harvest and Infarm are allocating its resources to creating and capturing value in the Danish market.

In order to facilitate this analysis, four different categories of innovations are proposed: routine innovations, disruptive innovations, radical innovations and architectural innovations (Pisano, 2015). Routine innovation refers to an innovation that leverages both existing business model and technical competencies. Examples include new versions of current products, which appeal to the company's existing customer base. Disruptive innovations require new business models but may leverage existing technology. These innovations are often those that disrupt industries and thereby challenge prevailing companies. As a complete contrast, radical innovations merely involve new technical competencies, which is the case when technological advancements fit well with current business models. Lastly, architectural innovations are the most challenging to pursue as they require disruptions of both existing business model and technical competencies. Therefore, this entails offering a product or service that calls for development of both completely new competencies and new ways of earning profits (Pisano, 2015). Overall, when working strategically with these four innovation categories, it is a matter of balance and mix. Routine innovations generate a majority of profits, while different types of innovations can eventually become complements rather than substitutes. The innovation strategies should therefore evolve over time in order to maintain competitive, meaning that they should continuously experiment, learn and adapt (ibid.).

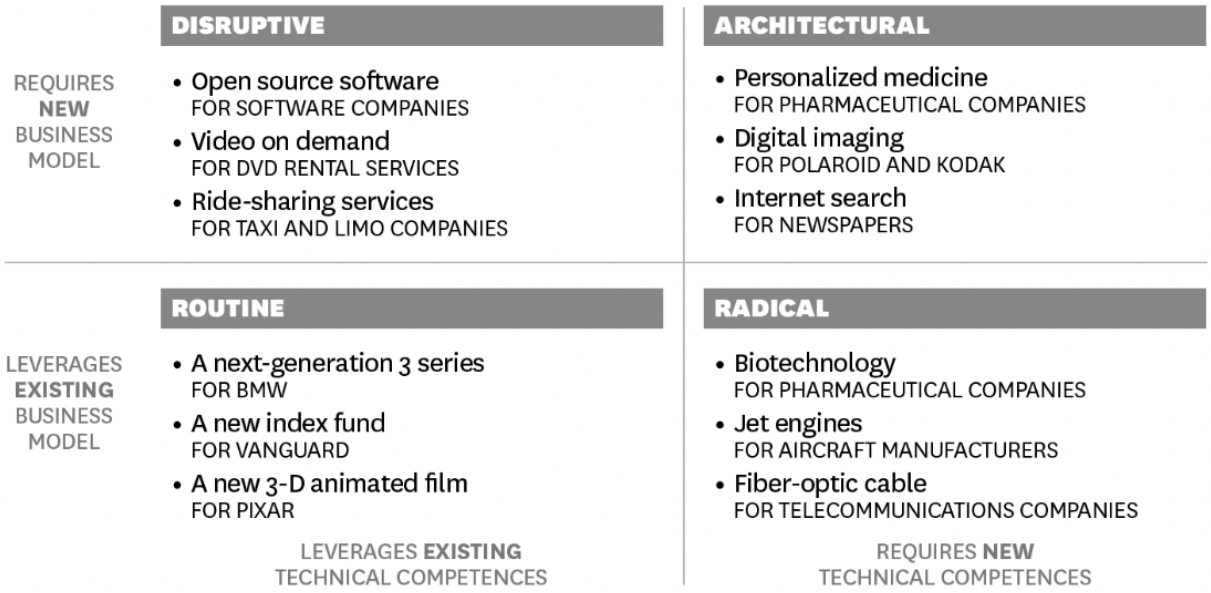


Figure 10 Innovation Landscape Map (Pisano, 2015)

5.4.2 Green Context

According to Calza et al. (2017), the innovation landscape map is deemed useful in explaining green innovations as well, which vertical farming was identified as in section 1.2. The concept of green innovations can be further expanded into four generic classifications, which are environmental technologies, organizational innovation for the environment, product and service innovation offering environmental benefits and green innovation systems (Calza et al., 2017). Moreover, green innovations are differentiated from standard innovations by the externalities they create. Potential positive externalities include cleaner technologies that may benefit broader societies, whereas negative externalities include knowledge spillovers leading to reduced investments incentives (ibid).

Similar to the reasoning of Pisano (2015), all of the different types of green innovations require different competencies and resources. This explains why Calza et al. (2017) propose that the innovation landscape map can be directly applied to the context of green innovations, which is especially the case when operating in non-green industries. A green industry is where firms' core businesses revolve around environmental protection, which could be in terms of material recycling or manufacturing of green products. Companies that are not operating green industries are therefore likely to require large investments to acquire changes in both business models and technology when

generating green innovations, which emphasizes the applicability of the innovation landscape map (Calza et al., 2017).

In the above sections, value creation, value capturing, and innovation types and resources have been explored in order to form our theoretical framework. The innovation strategy framework (Figure 11) summarizes the sections and provides an overview of the different parts. In addition, the figure serves as structure for the following analysis of Infarm and Nordic Harvest and thereby ensures a connection between the theoretical concepts and our empirical findings. In order to demonstrate how the framework will guide the analysis, we have illustrated the evaluation questions of Pisano (2015) in accordance with the three levels of analysis as well as the outlined sub-levels (Figure 11), which will be examined in chapter 6.

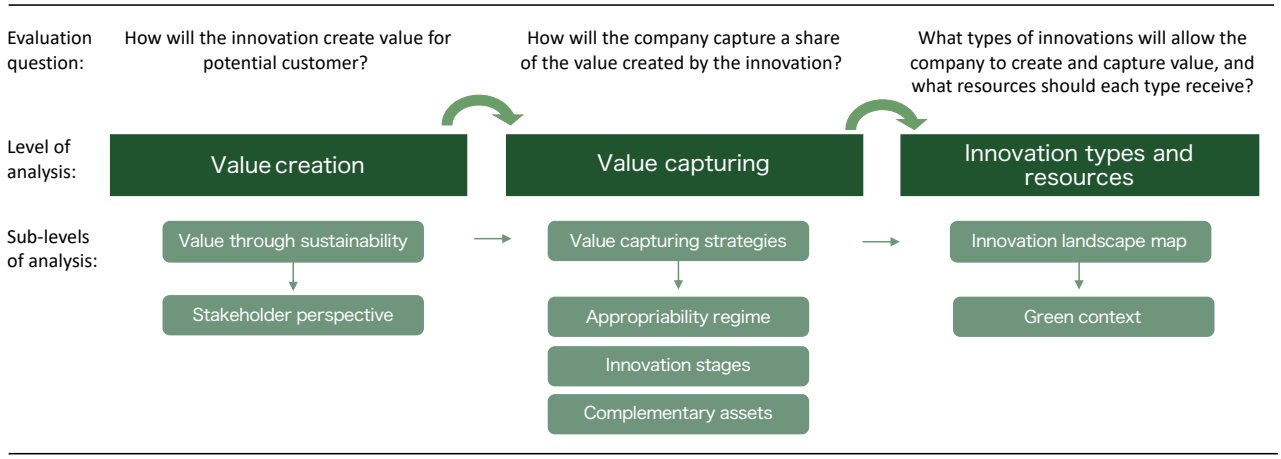


Figure 11 Innovation Strategy Framework. Own representation

6. Analysis

The analysis of Infarm and Nordic Harvest is structured based on Figure 11, meaning that it takes its starting point in the theoretical framework. The analysis therefore consists of the three main levels of the framework, namely value creation, value capturing, and innovation types and resources, which will all be explored through an in-depth analysis of the case companies. The overall purpose of the analysis is to examine the innovation strategies of Infarm and Nordic Harvest in order to assess their abilities to gain ground in the Danish market.

6.1 The Value Created

As already introduced, the first level of analysis will take its point of departure in the question of Pisano (2015) regarding value creation of the innovation. The following analysis will therefore start by examining Nordic Harvest and Infarm in relation to value creation opportunities through sustainability, as presented by Yang et al. 2017. As described in section 5.2 of the theoretical framework, the primary focus will be the two key concepts of multiple stakeholders and economic, social and environmental value, which will be collectively and thoroughly examined subsequently to a concise life cycle assessment and an analysis of uncaptured value. Thus, the theoretical concepts will in combination with our interview findings, field trip findings and secondary data provide us with a profound understanding of the value created in relation to our case companies.

6.1.1 In a Sustainable Context

Firstly, the aim of the following section is to examine life cycle thinking and afterwards the uncaptured value opportunities of the case companies.

Life Cycle Assessment of Vertical Farming

Life cycle thinking is a way for companies to "discover sustainability-focused value opportunities across the entire product life cycle, and perhaps identify new ways to both maximize value and minimize environmental and social impacts" (Yang et al., 2017). An assessment of a product's life cycle is therefore an important aspect of value creation in a sustainable context. However, it will receive less attention as the scope of our research is not to extensively examine the technical aspects of vertical farming, which is often the aim of these assessments. A life cycle analysis is used to assess the potential environmental impact of vertical farming, including both negative and positive impacts, which involves an assessment of all inputs and outputs. Here, it is important to note that these types

of assessments are specified to the particular system that is analyzed and are very sensitive to the different inputs and outputs, meaning that the findings may vary significantly from system to system (Bruun, 2020). Thus, the findings may indicate some general patterns on vertical farming, but we acknowledge that they are highly context-dependent, in line with our research philosophical stance.

The relevance of conducting a life cycle assessment is supported by CSR Director at Coop, Thomas Roland (Appendix 1), who states that very few have actually calculated the impact of the entire life cycle of vertically farmed products, including the establishment of the production facilities. According to Roland, the calculations of vertical farming are often too simplistic, to which he adds that "if you consider the entire life cycle, the establishment of the seeding facility and material costs for such a facility, and the facilities in stores. Aluminum, glass, rare minerals, electronics, data and such are used, right. So try to include all of that in the total life cycle of the products, you have to" (Appendix 1: 07:38). Roland thus sheds light on the importance of considering in-store farming in a comprehensive manner prior to concluding on the impact. Moreover, it is argued that inputs such as water use, land use, pesticides and fertilizers will decrease compared to traditional farming. As outlined in section 2.3.1, one of the primary opportunities of vertical farming is the elimination of agricultural runoff. In terms of life cycle thinking, this indicates that the emission outputs to the aquatic environment caused by traditional farming could be completely eliminated in vertical farming. Nevertheless, our participation in the conference Vertical Farming in a Nordic Context revealed that inputs such as infrastructure and fossil fuels are likely to increase (Bruun, 2020). Infrastructure may increase due to the need of buildings and growing equipment, whereas fossil fuels may increase due to the high energy consumption of vertical farming. However, this will be dependent on the energy system used (ibid.). In order to examine a broader perspective of some of these inputs, an assessment of the future changes in city planning, transportation, energy systems and land use is deemed relevant (ibid.), which will be reflected on in the coming sections.

Transportation of food products is said to be reduced by vertical farming. However, transportation should be considered in a more complex manner than merely that the notion of moving production closer to consumption will decrease transport, since it might cause side effects such as increased inner city commuting (Bruun, 2020). Even though Infarm's products are produced and harvested inside the stores, which eliminates food miles, it may not be as simple as that. The first step of Infarm's production process is the seeding, which takes place at the Infarm Hub in Taastrup. The seeds are afterwards transported to the stores, where they will grow into plants (Appendix 3). In addition,

Infarm employees drive around to all of the stores to provide the services of harvest and delivery of products, where in-store farms cannot meet demand. This implies that while production is moved almost as close to consumption as possible, it still causes increased commuting around Copenhagen. Infarm is attempting at mitigating the environmental impact of this by using electrical cars (Appendix 5). At a first glance, the system of Infarm thus seems to reduce transportation even more than Nordic Harvest, as the products are not even transported from Taastrup to Copenhagen. However, it may not be as simple as it appears, although both systems significantly reduce transportation compared to greens imported from foreign countries.

Furthermore, vertical farming transforms use of land from horizontal agricultural fields to vertical buildings. From an environmental sustainability perspective, a renewable energy system is needed in order for the production not to increase the use of fossil fuels (section 2.4.2). A main contributor of renewable energy is solar cells, which often move the production of energy from vertical buildings to horizontal fields of solar cells. Thus, the exact opposite of vertical farming (Bruun, 2020). The potential increased need for solar cells that vertical farming may cause, might paradoxically take up space that would otherwise have been freed up by vertical farming. Nordic Harvest is 100% driven by wind power, which can be understood as a way of mitigating this challenge. Moreover, it is in line with Despommier (2009)'s notion of utilizing the natural environment of the vertical farms, as Denmark is a leading nation in wind power (Danish Wind Industry Association, 2014). Nevertheless, just like transportation, this implies that the reduction of land use may not be as simple, which also emphasizes the importance of assessing the life cycle of the exact system of interest. Overall, the life cycle assessment has made it clear that the evaluation of vertical farming in a Danish context is not as straight forward as it might seem. Furthermore, it has become clear that vertical farming does impact the environment, but in a different way than traditional farming does. Thus, directly comparing these two can be very challenging. While still acknowledging the opportunities of vertical farming outlined in section 2.3.1, this assessment has provided us with a more multifaceted understanding of the implications.

Uncaptured Value

As outlined in the theoretical framework, there are four main forms of identifying additional value creation opportunities in current business models. These are value surplus, value missed, value absence and value destroyed (Yang et al., 2017). Especially the first two forms are identified as relevant to consider in the case of Infarm and Nordic Harvest, whereas our data collection has not

indicated that the last two are of same significance. Value surplus is something that exists but is not required, such as waste, overproduction or repeated work (ibid.). Due to the inherent focus on fully controlled systems in vertical farming, value surplus may be of particular high importance. If a system is not managed perfectly in terms of controlling conditions for optimal plant growth, it could result in wasted energy or nutrients. As an example, if the plants are exposed to more wavelengths from LED lights than necessary, it can lead to over-usage of energy. Consequently, it may harm both the environmental and economic value creation, in terms of the wasted use of energy and thereby increased electricity costs. Similarly, if demand forecasts are not accurate, it may lead to overproduction of products, which we consider especially crucial in an industry focused on sustainable production and where shelf life of products are rather short, even though it might be longer for vertically farmed plants. For Infarm, the sales data from Irma has revealed that a significant number of products get scrapped in the stores (Appendix 11). This is products that have not been sold before shelf lift runs out, thus representing food waste. This value surplus therefore indicates an evident opportunity for Infarm in collaboration with Irma to optimize the production model and forecasts, aimed at reducing waste and thereby minimize the amount of uncaptured value.

On the other hand, value missed is something that exists but is not exploited, such as underutilization of by-products or inefficient use of resources (Yang et al., 2017). As previously mentioned, Nordic Harvest seeks to utilize everything from production by using plant roots to produce bio-fertilizer, by selling it to research and by just producing crops where the entire plant can be used or re-used (section 3.1). Use of postharvest plant materials was identified as an additional opportunity of vertical farming in section 2.3.1 and can be interpreted as a way for Nordic Harvest to fully utilize by-products, and thereby reduce the value missed while maximizing value creation. On the contrary, this is considered less feasible in the current business model of Infarm where products are sold directly from production in stores, without cutting off the roots. As a result, the roots are likely to be thrown out by consumers, and therefore become under-utilized. Thus, there are several different factors to account for when seeking to create value through vertical farming, including the full product life cycle and future changes in the surrounding systems, as well as through identification of surplus and missed value. The following will go into more detail on the value creation opportunities of Nordic Harvest and Infarm, by considering multiple stakeholders and the three elements of sustainable value from the triple bottom line.

6.1.2 Value Creation for Stakeholders

In the stakeholder theory of Freudenreich et al. (2019), presented in our theoretical framework (section 5.2.1), it was argued that value creation depends on the type of stakeholder involved. Moreover, it was argued that each stakeholder is considered both a recipient, a creator and a co-creator of value in the relationship with the focal firm. Thus, value creation is considered to be a collaborative process that takes place between companies and the relevant stakeholders (Freudenreich et al., 2019). The five stakeholder groups of Freudenreich et al. (2019), outlined in section 5.2.1, will constitute the structure of the stakeholder analysis, which aims at exploring the value creation between Infarm, Nordic Harvest and relevant stakeholders. Main emphasis will be put on the customers, societal and financial stakeholders due the company, customer and market perspectives of the data collection phase and the overall focus on sustainability.

Customers

In academic literature, customers are often considered a key stakeholder group (Freudenreich et al., 2019). The relationship between customers and the focal firm is typically centered around the products or services offered by the firm. If the products or services conform with the needs of the customers, they will be willing to take part in the value exchange (ibid.). Customer needs can be related to the specific quality of the product or service, which is determined by the perception of the specific customer, referred to as the use value (section 5.2). Alternatively, they can be related to the involved money exchange, referred to as the exchange value (section 5.2). Additionally, customer value creation can also be related to economic, social and environmental value (section 5.2). When exploring the stakeholder group of customers in the Danish vertical farming industry, we consider it necessary to distinguish between role of customers, meaning the retailers selling Nordic Harvest's and Infarm's products, and the consumers, meaning the end consumers who purchase the products. This distinction is important because it adds a layer of complexity, as it implies that the examined B2B relationship between the case companies and the retailers is affected by the B2C relationship between the retailers and the consumers.

Currently, Irma is the only customer of Infarm in Denmark (Appendix 6), which implies a value exchange between Infarm and Irma. In terms of value created from Irma to Infarm, Irma provides Infarm with a sales channel and thus the link to the consumers, who purchase the Infarm products. Moreover, Irma has a strong brand associated with high-quality products that are environmentally friendly, organic or innovative in some way (Birch, 2009). Roland emphasizes this brand by stating

that “Irma would like to be a supermarket with a wider range of gourmet and flavors, and a wider range of quality and freshness. I believe that Infarm fits very well into this profile of Irma” (Appendix 1: 24:21). The quality brand of Irma may implicate positive spillover effects for Infarm implying that Infarm will be associated with the gourmet profile of Irma and thus be perceived as a high-quality product in the Danish market. This might not be the same in other countries depending on the profiles of the chosen retail channels. In addition, Irma may provide Infarm with sales data and insights on consumption preferences among Danish consumers, which is considered to have high value for Infarm in order to understand its target group in Denmark. It is assumed that the exchange of information between Infarm and Irma is strengthened by the strong partnership between the two companies (Appendix 6).

However, the fact that Infarm’s products are only available in Irma may have a limiting effect on Infarm’s sales development and expansion possibilities in Denmark, as Irma stores are only located in the Copenhagen region (Coop, n.d.). Yet, it was revealed during the interview with Roland that Coop evaluates on an ongoing basis whether in-store farming could have potential in its other store concepts (Appendix 1), which could be a plausible way of increasing the involved economic value. It can moreover be argued that the exclusivity is very valuable for Irma, as Irma is the only place where consumers can purchase Infarm’s products. The interview with Roland moreover revealed that the repurchase rate of Infarm’s products is high, which indicates that consumers are returning to the Irma stores to buy Infarm products, influencing the economic value for both Irma and Infarm positively. According to Nielsen, the collaboration with Infarm has provided Irma with an opportunity to be the frontrunner in Danish retail in terms of being the first retail store to introduce both vertically farmed herbs and lettuces (Appendix 6), which may strengthen Irma’s sustainability-oriented profile additionally. Moreover, Nielsen elaborates by “If there are others in the market, then it’s easier to explain to the consumers what it is, what it does and what it’s good for. If you are the only one in the market, then you are unique, but you are the sole communicator” (Appendix 6: 24:47), thus illustrating the trade-off in terms of being the first retailer to offer the products.

Despite the strong partnership between Infarm and Irma, resulting in high mutual dependence, it may be crucial for Infarm to consider how the B2C relationship between Irma and consumers influence the partnership. As Irma is highly dependent on consumer demands and preferences, it is argued that this will affect Irma’s choice of suppliers and partners. This places Infarm in vulnerable position with

only a single customer in Denmark and emphasizes how vital Irma is for Infarm in terms of success or failure. The fact that Infarm has already been tested in other markets, emphasized by Roland (Appendix 1), may have provided Infarm with a strong leverage to establish the relationship with Irma, as Infarm can offer Irma the value of a proven concept. It is therefore argued that the value created with the customers depend on the applied business model. As opposed to the service model of Infarm, the relationship between Nordic Harvest and its customers is considered to be a regular supplier-buyer relationship with products sold through retailers or food services. However, it is challenging to analyze the value created from the customers to Nordic Harvest due to the products not being sold in any stores yet. However, it was revealed during the interview with Flemming Dyring, the CCO of Nordic Harvest, that Nordic Harvest seeks to be perceived as a high-end brand, which entails avoiding discount supermarket chains (Appendix 2).

Due to the use of hydroponic growing techniques, both Infarm and Nordic Harvest can provide fresh produce with an intense taste and free of pesticides to their customers. This is interpreted as key customer value, emphasized by the fact that most of the interviewees have mentioned these aspects during the data collection (Appendix 1, 2, 3, 4, 6). As the value of this product offering is influenced by the perception of both customers and consumers, the use value is argued to differ depending on the type of customer. However, despite these differing perceptions, insights from Voxmeter (Appendix 12) reveal that freshness and a concern for pesticides are among the most crucial aspects for Danish consumers when purchasing greens (section 2.6), which indicate that these value types are of great significance. Additionally, Infarm's in-store farms provide Irma with use value related to displaying the greens in an innovative way and thereby inviting consumers to see the production. This may even enhance consumers' knowledge about vertical farming, which can lead to increased value creation for both Infarm and Irma. In order for consumers to experience the taste and freshness of the products, Infarm offers free samples of lettuces in selected stores, which might as well potentially adopt new consumers and increase sales (Appendix 5). This can therefore be considered a value creation activity benefitting both Infarm and Irma.

In addition to the above outlined value types, the product offerings of Nordic Harvest and Infarm provide Danish retailers with an opportunity to substitute some of the traditionally produced greens in their existing assortments with more sustainably and locally produced greens. It can be argued that this is a way for retailers to create environmental value as the introduction of vertical farming would

implicate less import of herbs and lettuces from other countries. The opportunity for vertical farming to potentially substitute traditional assortments will be discussed further in section 7.3. Overall, the stakeholder group of customers is considered of significant importance for both Infarm and Nordic Harvest, in line with much academic literature.

Societal Stakeholders

The group of societal stakeholders is interpreted as of high relevance for this thesis, as vertical farming seeks to address various macro societal and environmental challenges (section 2.3.1). Societal stakeholders namely represent needs in the societal and natural environment. Examples of this broad group include different actors that represent governments, academia, media and the environment (Freudenreich et al., 2019). It is therefore reasoned that to address the societal and environmental challenges, it will be meaningful to engage and create value with key stakeholders from this group. Hence, the primary aims of these relations are probably not to realize exchange value, but rather to pursuit environmental and social value. For Infarm and Nordic Harvest, some of the main societal stakeholders identified include the media, politicians, councils, industry standards and the natural environment itself, which they either directly or indirectly engage with.

Nordic Harvest has put a lot of emphasis on engaging with media, in which we identified two different but interlinked activities. Firstly, Nordic Harvest has collaborated with the communication agency Kudos, who has created Nordic Harvest's visual identity, website, product packaging and advised Nordic Harvest in terms of Danish and international media, resulting in a total of 130 articles in five months (Kudos, n.d.). Secondly, Nordic Harvest has operated with high transparency by inviting stakeholders such as large newspapers, TV broadcasters, politicians and Landbrug & Fødevarer to see and experience the production site. All these encounters have even been published in TV, articles or social media by the invited parties, as exemplified in Appendix 13. Similarly, Nordic Harvest has participated in conferences, podcasts and university research. Through these activities, it is argued that Nordic Harvest seeks to raise awareness of vertical farming, aimed at enlarging and creating value for the new industry, thus contributing to establishing the industry in Denmark. At the same time, Nordic Harvest receives increased attention through the media, which is likely to contribute positively to both its business and brand. The same is true for Infarm, although the media coverage seems to be sparser in the Danish context. Infarm participates in conferences as well and raises awareness through press releases sent out by Coop (Coop, 2020, 2021). However, it seems as though

Infarm does not engage actively with the Danish media. Instead, the German headquarter participates frequently in various international media (Askew, 2018; Bloomberg Technology, 2019) and publishes self-authored articles on its company website (Infarm, n.d.-c).

Furthermore, the fact that Nordic Harvest works actively to be certified with the ISO 22000 standard is interpreted as a relation with a societal stakeholder. According to Freudenreich et al. (2019), a company may engage in "collaborative processes with its societal stakeholders to raise industry standards" (Freudenreich et al., 2019: 14). ISO 22000 is a food safety management industry standard, which sets requirements for food production companies. The aim of the standard is to secure high food safety for the world, which benefits both producers, regulators, retailers and consumers (ISO, 2018) through "keeping food safe from farm to fork by ensuring hygienic practices and traceability at every step" (ISO, 2018). According to Dyring, it requires extensive work and energy for Nordic Harvest to achieve the certification but argues that it will pay off due to the high quality associated with ISO 22000 (Appendix 2).

Similarly, the Berlin-based production site of Infarm has received the Global Food Agricultural Practices (GlobalG.A.P.) certification, which is a recognized standard for safe and sustainable food production. This certification represents the ability of Infarm to combine hydroponics with agricultural best practices, while it indicates that vertical farming as an innovation is being increasingly recognized and accepted (Infarm, 2020). Thus, we argue that the companies receive the use value of products and production methods certified with a certain quality, which contributes positively to the brands of Infarm and Nordic Harvest. This may even create value for the industry in general or other stakeholders, such as customers and business partners, by being able to promise a stamp of quality. On the other hand, both ISO and GlobalG.A.P. receive the value of strengthening and broadening their industry standard, through the inclusion of vertical farming producers. Moreover, a joint social value is created by ensuring high food safety for consumers, which even taps into the opportunity of vertical farming to control food safety and security (section 2.3.1). Additionally, Infarm complements this value creation with sustainable value due to the sustainable food production focus of GlobalG.A.P.

This focus on sustainability may lead to a consideration of the natural environment in itself as a societal stakeholder to vertical farming. As outlined in section 2.3.1, vertical farming is meant to provide several benefits for the natural environment, interpreted as sustainable value creation.

Therefore, we find it meaningful to consider the natural environment as a societal stakeholder. An example of how vertical farming creates sustainable value for the environment is the fact that water usage is reduced significantly, which benefits the world's freshwater supply. Conversely, the natural environment is argued to create sustainable and economic value for Infarm and Nordic Harvest by contributing to the relevance of vertical farming. The magnitude and urgency of the world's climate challenges emphasize the need of adapting more sustainable practices, which may increase the potential for Infarm and Nordic Harvest to sustain their business models, both in the Danish and in international markets. Thus, vertical farming creates value by contributing with sustainable solutions to relieve the natural environment, and the natural environment creates value by stressing the urgency of vertical farming. Building on this, the 17 UN SDGs are argued to institutionalize this stakeholder relationship, as several of the SDGs offer articulated conceptualizations of environmental challenges related to vertical farming. The UN is therefore identified as an indirect societal stakeholder since several of the opportunities of vertical farming seem to tap into some of the goals. The SDGs that we deem most relevant for vertical farming are zero hunger (2), industry, innovation and infrastructure (9), responsible consumption and production (12) and climate action (13). These represent goals that vertical farming may contribute positively to. An in-depth discussion of whether vertical farming holds this potential in Denmark will follow in chapter 7.

In addition, Landbrug & Fødevarer, and specifically the branch of Future Farming, is also identified as an indirect societal stakeholder to Nordic Harvest and Infarm. Landbrug & Fødevarer promotes common interests and tasks of Danish farmers (Landbrug & Fødevarer, n.d.), while the purpose of Future Farming is to research impactful trends within the future of agriculture and food production, and securing and maintaining sound business conditions for farmers (Seges, n.d.). This implies that Future Farming is able to create value for vertical farming by raising awareness within the Danish agricultural industry, given that it identifies a future potential in vertical farming. Additionally, as for traditional farmers, Future Farming may promote the business-related interests of vertical farmers, which can benefit companies like Nordic Harvest and Infarm. In turn, vertical farming is argued to create value for Future Farming by contributing with innovative approaches. Vertical farming may be one of the future potentials within the agricultural industry, which Future Farming seeks to gain knowledge about and evaluate the potential off. During our interview with the Director of Future Farming, Jakob Lave, he expressed that the value chain in Danish agriculture is very short, which is positive since it reduces the steps from research to change. Lave elaborates on this by stating that

"this may die out if we, as the agriculture and food sector, do not stay on top of the trends. That is, to be curious about what we can do in high-rise buildings" (Appendix 7: 23:42). Thus, Lave emphasizes the importance of assessing the potential of vertical farming. The main value that is exchanged in this relationship is hence interpreted as use value, since it concerns promotion of interests and innovative contributions.

Business Partners

The stakeholder group of business partners may include stakeholders such as suppliers, logistic partners or consultants, and the activities are often linked to the creation of the product or service (Freudenreich et al., 2019). It is argued that this stakeholder group is particularly valuable for Nordic Harvest due to the partnership with YesHealth Group. This involves the supply of all production equipment and education of Nordic Harvest's employees in the production set-up (Appendix 2), which can be considered a value creation activity. Thereby, YesHealth Group and Nordic Harvest have in collaboration attempted to configure the optimal and most suitable large-scale vertical farming solution for the Danish conditions, involving the use of YesHelath Group employees (Appendix 2), which will be elaborated on in the section regarding employees. It is assumed that the value that YesHealth Group receives from Nordic Harvest is a monetary payment in exchange for the equipment as well as the fact that Nordic Harvest has enabled the expansion of YesHealth Group's business to Denmark, and potentially to other Nordic countries (Appendix 2). Overall, this contributes to YesHealth Group's vision of sustainably expanding its network of vertical farms (YesHealth Group, n.d.). Moreover, YesHealth Group has received a lot of media attention due to the partnership with Nordic Harvest, which is also assumed to be of high value for the company. As mentioned in the section regarding societal stakeholders, the media attention can be linked to the collaboration with the communication agency Kudos. Therefore, Kudos can likewise be considered an important business partner for Nordic Harvest, contributing with important value creation activities.

As stated in the section regarding customer stakeholders, the relationship between Infarm and Irma is described as a partnership between the two companies (Appendix, 6). Therefore, it is argued that in addition to being Infarm's customer, Irma is considered a business partner on the Danish market as well, emphasizing the high dependency between the companies. Hansen supports this by saying, "The collaboration has involved short-term risks and costs for both parties, but we have a mutual belief that it will pay off in the long run (Appendix 3: 16:22). In order for Infarm to mitigate the risk of high dependency on a single partner, as opposed to a large number of customers, the partnership

model is assumed to involve contracts, which Nielsen describes as “long-term investments” (Appendix 6: 22:34). This would involve that the Infarm products cannot be unexpectedly delisted from the stores, which likewise reduces Irma’s risk of a sudden supply stop. This is considered to have high value for both companies, especially for Infarm as it puts the company in a less vulnerable position when expanding, despite the high dependency on Irma. In terms of additional business partners, both Nordic Harvest and Infarm are assumed to be dependent on various suppliers for providing production necessities such as seeds, plant nutrients and fertilizers. However, Nordic Harvest produces its own fertilizers in-house (Appendix 2), making them less dependent and thereby less exposed to the described risks of Infarm’s partnership model. To our knowledge, there is no available data on the specific types of fertilizers used by Infarm, why it is assumed that in-house fertilizer does not apply for Infarm.

Employees

The stakeholder group of employees is crucial to value creation due to the knowledge, capabilities and activities they contribute with. This includes all activities that are related to the management of knowledge resources (Freudenreich et al., 2019). The value that the employees create for Infarm and Nordic Harvest is therefore their knowledge, capabilities and labor, realized through the activity of working. As mentioned above, several employees from YesHealth Group have moved from Taiwan to Denmark for several months to provide specialized capabilities in setting up the system for Nordic Harvest (Appendix 2). Therefore, this example constitutes the use value that is created by employees for Nordic Harvest. In this knowledge exchange, it is assumed that YesHealth Group provides the main part of the knowledge due to previous experience in the vertical farming industry. However, it was revealed during the interview with Dyring that YesHealth Group also obtained new knowledge due to the new geographic location, which provided insights that the company had not experienced in the Taiwanese setting (Appendix 2). As an example, the cold weather conditions in Denmark implied challenges with humidity on the walls, which were new to YesHealth Group (ibid.).

In return for the value created by the employees, both case companies are assumed to pay fair salaries and provide training, social benefits and holidays, which are interpreted as both exchange value and social value. Furthermore, Infarm and Nordic Harvest are purpose-driven companies, which is argued to create value for employees by allowing them to work for a greater purpose. This is interpreted as use value, since the perceived value of working for a purposeful company is presumed to differ from employee to employee. Relatedly, the Irma employee from the field interview states that Infarm

invited Irma employees, including the store personnel, to see the production in Taastrup (Appendix 5). This is argued to be a value creating activity, since it included training in the production methods and allowed the employees to experience a vertical farm in person. This activity may establish a sense of purpose and motivation among the employees. Moreover, ensuring that the people who sell the products obtain basic knowledge about the products and how they are produced, may drive increased sales and thus realize higher exchange value for Infarm. Although the employees of Irma are not employed at Infarm, they have been included in the employee stakeholder group due to the close partnership between Irma and Infarm.

Financial Stakeholders

This stakeholder groups is included due to the importance of investments and financial resources in sustainability-oriented contexts (Freudenreich et al., 2019). Financial stakeholders may include investors, shareholders and banks with the common denominator of having a financial interest in the company (ibid.). A financial interest does not necessarily entail a lack of sustainability-related interest, as these in some cases are combined. Therefore, the value exchange in relationships between financial stakeholders and companies are not solely monetary, as the value might derive from aspects such as an enhanced portfolio for the investor, obtained by investing in a specific company or purpose (ibid.).

As mentioned in the company introduction (section 3.1), Nordic Harvest has raised around 62 million DKK from a broad range of international and Danish investors, including Vækstfonden and Danmarks Grønne Investeringsfond. Thus, the exchange value in the relationship between investors and Nordic Harvest involves funding for Nordic Harvest to construct the large-scale farm. In exchange, it may provide the investors with a later financial gain. Moreover, it can be argued that several additional non-monetary gains exist, such as the possibility of being present in the food tech industry, which is considered to be a promising industry (Accenture, 2017), or contributing to a sustainable future. According to Vækstfonden, the investment in Nordic Harvest aims at maintaining Denmark's front position in terms of high-quality food production and moreover supports a shift towards more sustainable production methods by investing in green innovation (Vækstfonden, 2020). It can be argued that this supports a realization of non-monetary gains and it further indicates that Vækstfonden's interest in Nordic Harvest is not limited to a financial interest, but aims at creating environmental value. At the conference Vertical Farming in a Nordic Context, Eric-Alan Rapp, Investment Partner at Vækstfonden emphasized the importance of including a long-term perspective

in terms of vertical farming investments. Rapp acknowledges the current challenge of the high costs involved in operating large-scale farms, but emphasizes the importance of enabling innovating companies to succeed, by stating that "we need to make sure that we give the companies the abilities to succeed, which means the funding to succeed and the mindset to think ambitiously to try to create and solve problems on large scale" (Rapp et al., 2020: 16:03). This suggests that the green innovation investments often go beyond the exchange value involved, which emphasizes Vækstfonden's ambition to create value with Nordic Harvest while promoting a broader sustainable agenda.

To our knowledge, there are no traceable links from the financial stakeholders of Infarm to the operations in the Danish market, as Denmark is just one out of many locations. This means that it is not publicly available how the investments of Infarm are distributed across markets. However, it can be argued that investments have provided Infarm with capital in order to expand into new markets, including Denmark. In 2020, Infarm raised 170 million dollars, which increased Infarm's funding to a total of more than 300 million dollars (Infarm, n.d.-b). According to one of the investors, Infarm's innovative approach and use of technology is a way to create value throughout the supply chain, which will benefit both retailers and consumers. Furthermore, the investor argues that investing in Infarm is a way to remedy the increasing demand for sustainable, environmental-friendly and healthy food (ibid.), which is in line with the opportunity of vertical farming to meet the increasing demand for better food (section 2.3.1). Similar to Nordic Harvest, this statement suggests an existence of different value types, which according to theory can be considered an hybrid approach (Freudenreich et al., 2019), indicating that the investors pursue social, environmental and economic aims simultaneously.

Overall, the theoretical framework highlights that different types of value are created across different stakeholders and contexts. By thoroughly exploring each of the five generic stakeholder groups in relation to Infarm and Nordic Harvest, it has become evident that this distinction is true in both cases. In addition to an evaluation of each of the stakeholders, Freudenreich et al. (2019) stress the importance of determining and coordinating value creation in line with the joint purpose, which all stakeholders are tied to and motivated by. The above analysis has revealed that all stakeholder groups realize different degrees and combinations of economic, social and environmental value, as summarized in Figure 12. This indicates that both Infarm, Nordic Harvest and all associated stakeholder groups work collectively towards a joint purpose of expanding vertical farming in the

Danish market with the aim of a sustainable transition. The obtained understanding of how and which value is created in the case companies, enables the second part of the analysis about how Infarm and Nordic Harvest can capture a share of this value.

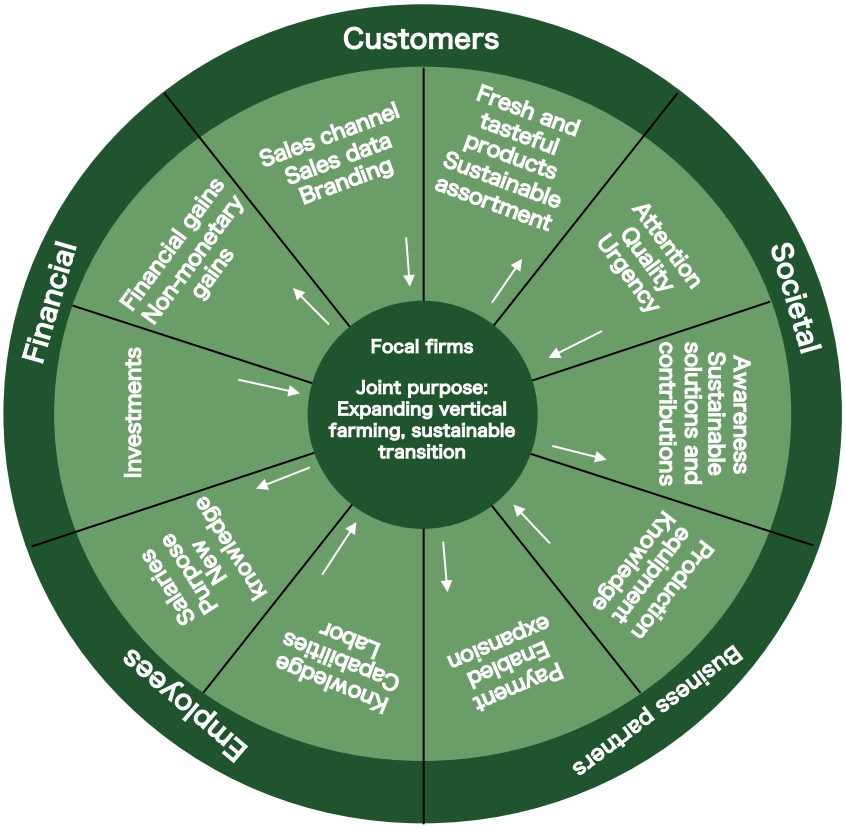


Figure 12 Vertical Farming Value. Own representation, adapted from Freudenreich et al. (2019)

6.2 The Value Captured

Based on above analysis on value creation, the second part of the analysis will take its point of departure in the second evaluative question of Pisano (2015), namely how the company can capture a share of the value created by the innovation. This is due to the fact that it cannot simply be assumed that the innovators are necessarily the ones benefitting from the innovation. Therefore, the concepts of appropriability regime, innovation stages and complementary assets will act as guiding framework for the analysis of the value captured by the firms. Hence, the following analysis will offer an in-depth analysis of these three concepts in relation to Nordic Harvest and Infarm, aimed at understanding how they may capture value, including shares of the value types that were identified in the previous analysis (section 6.1).

6.2.1 The Role of Imitators

As presented in the theoretical framework, appropriability regime is a measure of the degree to which innovation and knowledge is protected from imitators. This is determined by factors such as legal instruments and the nature of technology, where the first includes patents, copy rights and trade secrets and the latter includes whether knowledge is tacit or codified. Hence, these ultimately determine whether the appropriability regime is tight or strong, making the innovation either difficult or less difficult to imitate or substitute (Teece, 1986).

Appropriability Regime

Within the frame of this thesis, legal instruments have not played a significant role in the data collection. Meanwhile, none of the findings of the research have indicated that legal instruments are a main priority for any of the actors in the Danish market, as none of the interviewees have mentioned it during the interviews. According to the Danish Patent and Trademark Office, Infarm has patent in Denmark on a technical component within a plant growing system (Infarm, 2019b), whereas Nordic Harvest is not registered for any patents (Danish Patent and Trademark Office, n.d.). In terms of secrecy, the production of Infarm is visible to everyone in Irma stores through the glass in-store farms, and Nordic Harvest operates with high transparency by inviting stakeholders to the production site, which suggests that neither of the companies conceal their growing technologies. These findings support that patents and secrets are not of great importance for vertical farming as of today, which could be due to the newness of the industry. Moreover, it indicates that other factors are prioritized in terms of protecting the innovation of vertical farming.

Regarding the nature of technology, both tacit and codified knowledge seem to be of relevance for vertical farming, which affect the ease of imitation. According to Teece (1986), codified knowledge is easier to transmit or receive, whereas tacit knowledge is difficult to articulate. The hydroponic growing systems that both Infarm and Nordic Harvest utilize may be inferred as codified knowledge, since the basics of the technology is publicly available for everyone to learn and is not in itself a new invention. This indicates that the technology of vertical farming is rather easily imitated. However, the many components of the systems suggest that the opposite may be true. Setting up a vertical farming system for commercial use involves high levels of complexity in terms of configuring the growing techniques to the specific context and achieving control and efficiency, aimed at optimal conditions for growth of the specifically chosen crop types. This complexity is stressed by the fact that Riemann has spent seven years developing Nordic Harvest from idea to final product in stores

(Hebsgaard, 2020). Hence, it is implied that the codified systems include complex elements that limit the ease of imitation. In addition, modifying the system of YesHealth Group to fit the Danish context happened via a test-and-learn approach over several months (Appendix 2). The knowledge derived hereof is interpreted as tacit due to how it was developed, making it difficult to articulate and thereby imitate.

Implications of Imitators

According to Shenkar (2010), imitators are drivers of business growth and imitation represent advanced and complex processes (section 5.2.1). In an international perspective, neither Infarm nor Nordic Harvest are the first to develop in-store or large-scale hydroponic vertical farms (section 2.5). Instead, the ambitions of both companies are to build models that are more efficient and advanced. This suggests that both companies can be understood as imitators in the international setting, while both are among the first to innovate in Denmark. Consequently, it implies that the case companies may be able to capture value through the means of imitating companies, which are able to build something better and cheaper, according to Shenkar (2010). However, both companies are studied as innovators, due to the Danish market being the thesis scope. Nevertheless, our data collection revealed that potential entry of competitors is not considered a problem for the Danish market, according to several of the interviewees. As an example, Vilmar, CGO of Growup Farm, states that "I definitely consider it an advantage that more (red. players) are entering the market" (Appendix 4: 17:59). Dyring, CCO of Nordic Harvest, echoes this by expressing that "Just spread the message, because this is the future way of doing it and the market is huge" (Appendix 2: 09:32). This is explained by the newness of the industry, since an increased number of competitors are likely to expand the overall market size and potentially increase knowledge and acknowledgement among Danish consumers and organizations. An increased size of market and number of knowledgeable stakeholders may represent an increased economic value potential that Nordic Harvest and Infarm are able to capture a share of. This is argued to especially impact customers and financial stakeholders, as these may be more willing to engage with vertical farming companies if the industry is growing.

However, an increasing number of imitators may as well cause harming effects for Nordic Harvest and Infarm. According to Dyring, if new vertical farming players enter the market with products of low quality, it will risk damaging the existing players. The low degree of knowledge in the industry is likely to trigger a generalization of vertical farming products, leading to stakeholders distancing themselves from the focal firms (Appendix 2). The ISO 22000 and GlobalG.A.P. certifications of

Nordic Harvest and Infarm contribute to high quality guarantees, which will probably not apply for all additional players. As an example, the share of the use value created for Infarm through positive brand associations with Irma is likely to be reduced as a consequence of potential negative associations with low quality competitors. However, the lead time in the industry seems to be rather long since only a few players have currently entered the Danish market, as outlined in section 2.6. This prolongs the time for Infarm and Nordic Harvest to maintain their strong positions before imitators are able to catch up. However, this lead time may decrease concurrently with a potential increasing number of imitators, depending on how tight or weak the appropriability regimes are of existing players.

Ultimately, it is reasoned that the appropriability regimes of Infarm and Nordic Harvest include elements of both tight and weak systems. The limited protection mechanisms utilized by the companies suggest a weak regime, whereas the complexity of both the codified and tacit knowledge suggests a tight regime. Furthermore, the role of potential imitators is for the most part meant to impact the value capturing opportunities positively, due to low degree of knowledge among stakeholders. Thus, most of the findings of this section are to a great extent related to the newness of the industry in Denmark, which will be analyzed in more detail in the following examination of innovation stages.

6.2.2 Newness of the Industry

As outlined in the theoretical framework, point in time influences a company's value capturing possibilities since the particular stage of the industry plays an important role for the value types that can be captured (section 5.3.2). Conducting an in-depth analysis on the innovation stages of vertical farming is considered both important and relevant due to our recurrently stated awareness about the newness of the industry in Denmark. Therefore, the aim of this section is to unfold this newness and its effect on Infarm and Nordic Harvest's value capturing possibilities, with use of our theoretical framework as research tool.

The Introduction Phase of Vertical Farming

In section 2.5, the international entrepreneurial landscape was presented, which was followed by an introduction of the Danish context. It became clear that the Danish market for vertical farming is relatively new compared to an international setting, involving a low degree of knowledge among

many stakeholders. This indicates that the industry is at an early stage in Denmark, which with use of Teece (1986)'s terminology can be described as the preparadigmatic stage with no existence of an industry standard. We consider it important to use the concepts and terminology of Teece (1986) to analyze both the existence of a dominant growing system in Denmark as well as the operations of Nordic Harvest and Infarm.

In terms of growing systems, all established players in Denmark use variations of hydroponics, including Nordic Harvest and Infarm. This finding emphasizes a dominance of the hydroponic technique in the Danish market, which could be interpreted as the emergence of a dominant design, indicating the presence of a paradigmatic stage. However, as explained in section 2.2.2, hydroponics is the most widely used system in the international entrepreneurial landscape and is considered the least challenging technology to adopt, compared to both aeroponics and aquaponics. When taking both aspects into consideration, it can thus be argued that the dominance of hydroponics in Denmark does not necessarily entail the presence of a dominant design.

Despite hydroponics being the most prevalent growing system, it is argued that the operations of Nordic Harvest and Infarm indicate the presence of a preparadigmatic stage. It seems like both companies are experimenting with different product variations and are focusing on introducing optimized products rather than being the cheapest. This have however caused challenges for both companies such as a postponed product launch for Nordic Harvest (Nordic Harvest, n.d.-c) and a failed first introduction of lettuces for Infarm (Appendix 3). Based on the theorical framework, these examples can be interpreted as preparadigmatic or introduction characteristics.

As previously outlined (section 5.3.2), the novelty of the technology and the lack of experience often imply increased costs and low quality (Grant, 2016). In the case of both Nordic Harvest and Infarm, the recent entry of the industry in Denmark entails a lack of experience, which might lead to increased costs such as the mentioned launch challenges. However, it is argued that both companies have maintained an integral focus on ensuring high product quality, as not doing so would counteract the product related use value created for customers and thereby limit the value capturing possibilities. Although theory emphasizes price as a less important competitive factor in early stages (ibid.), the interview with Hansen revealed a consumer price sensitivity on some of Infarm's products, which led to a price reduction on some of the most common herbs, such as parsley (Appendix 3). Overall, these

findings indicate that the two aspects of price and product cannot be studied in such a divided manner in the case companies, despite the theory of Teece (1986) prioritizing product over price in early stages. Thus, being aware of both aspects may be crucial for Infarm and Nordic Harvest in order to capture a share of the value created in the relationship with customers.

Building on the identification of an early innovation stage, the low degree of consumer knowledge on vertical farming (Appendix 12) further supports this finding. According to Voxmeter (Appendix 12), less than 2% of Danish consumers are familiar with the Infarm brand, which we assume is even lower for Nordic Harvest due to its products not being in stores yet. Lastly, an early stage presence is further supported by the fact that the economic value provided to Nordic Harvest by investors has been used to establish the production facilities (Vækstfonden, 2020), which typically occurs in the introduction phase (Teece, 1986).

Implications of the Introduction Phase

The findings in the above section have emphasized the likelihood of vertical farming being in an initial phase in Denmark. Following this, we consider it important to analyze how it influences the value capturing opportunities of Nordic Harvest and Infarm and thereby the implications of a presence in the introduction phase.

An implication of the newness of the industry in Denmark was revealed during the interview with Vilmar. As previously stated, he considers the entrance of new players in the industry as a positive development. According to Vilmar, this would be a way to faster mitigate the challenges in terms of regulations and authorities not favoring the vertical farming industry (Appendix 4). It may be assumed that a similar positive attitude towards an increasing number of competitors may change in the future. The challenges for vertical farming caused by legislations were further supported by Nielsen, who expressed that "it is not completely clear which laws apply to vertical farming, is it food legislations or agricultural legislations?" (Appendix 6: 09:30). Likewise, Riemann questions the current regulations of the EU since vertical farmers do not receive any agricultural aid. Furthermore, he perceives the distribution of the aid as illogical, as it is determined by the number of hectares rather than the efficiency per hectare (Strandfelt, 2021). This affects Nordic Harvest and Infarm since cannot receive the same financial support as other farmers, implying that current measurements might need reevaluation. In consequence, they become less competitive when compared to traditional producers, and thereby less capable of capturing economic value. An additional challenge regarding capturing

economic value was expressed by Dyring when explaining about the funding process of Nordic Harvest (Appendix 2). In the initial funding phase, Nordic Harvest experienced several rejections during the search for capital due to the difficulty of classifying vertical farming according to the categories of investors (ibid.). This implies that vertical farming does not fit into the existing classifications of institutions such as investors and legislators, as well as in terms of organic certifications.

As neither of the growing techniques involve soil, which is required by the EU in order to be deemed organic, it is not possible for vertical farmers to obtain organic certifications (Nordic Harvest, n.d.-a). Thus, this exemplifies the level of innovation of vertical farming, since it cannot be accounted for in the established certifications of the existing farming industry. This is considered challenging for both Infarm and Nordic Harvest as 98% of the Danish population knows or has heard of the Danish organic stamp (Ministeriet for Fødevarer, 2013). The characteristic red stamp is trusted by many Danish consumers (Økologisk Landsforening, n.d.), and as previously mentioned, 26% of all Danish consumers always choose organic when purchasing greens (Appendix 12). Michael Nielsen of Irma raises similar concern regarding the consumers, due to the appreciation of the organic certification: "as a consumer, you will probably think that it is strange. When it is not organic certified, you don't want it, because you only want organic products" (Appendix 6: 08:23). Despite the ability to provide consumers with products of high quality, it can be argued that the lack of organic certification can reduce Nordic Harvest's and Infarm's possibility of capturing value in relation to consumers, as some consumers might deselect vertically farmed products due to their limited knowledge on growing techniques.

This implication is not limited to the consumers, as the lack of organic certification might limit the potential to collaborate with alternative stakeholders such as public institutions and restaurants. Many public institutions have shifted from using conventional products to solely organic products, and the Danish Government has allocated 56 million DKK in subsidies for organic conversion of public kitchens in the 2020 Organic Action Plan (Ravn, 2013). The planned transition towards using organic food in public institutions and kitchens does not account for soil-free growing methods and thereby excludes producers such as Nordic Harvest and Infarm. For restaurants this implies that using Infarm or Nordic Harvest products would eliminate chances for obtaining organic certifications, which can be used as marketing and to attract certain customer groups (Miljø- og Fødevareministeriet, n.d.).

Most of the interviewees agreed with the challenge caused by the lack of organic certification. Roland considers it plausible that some consumers might choose organic certified products over vertically farmed products and that some consumers might perceive vertical farming as 'unnatural' due to the indoor controlled environment (Appendix 1). According to Arhnung, the distinction between "what is natural and what is artificial. This will probably become more blurred in the future" (Appendix 7: 08:21). This indicates that the general perception of natural and organic produce may change over time. Whether it is necessary to rethink organic certifications and agricultural aid in order to positively benefit vertical farming in Denmark will be discussed in chapter seven.

6.2.3 Assets for Competitiveness

The presence of complementary assets related to Nordic Harvest and Infarm will now be examined as the final part of the analysis regarding value capturing strategies. As outlined in the theoretical framework, complementary assets are often a necessity for successful commercialization of innovations, why we find it relevant to identify and evaluate potential assets that the case companies operate with in Denmark. The above analysis on innovation stages revealed that high product quality is a key aspect of value capturing for both Nordic Harvest and Infarm, accompanied with a critical focus on price. All other things aside, it is interpreted that the products of both case companies are highly similar in terms of quality, freshness, taste and assortment, sold at similar prices in retail channels. This indicates that aspects of product and price may level the competitive playing field between the companies. As a result, complementary assets could be crucial in terms of strengthening competitive positions and maximizing value capturing. The aim of the following is therefore to analyze selected generic, specialized and co-specialized assets of Infarm and Nordic Harvest.

Generic Assets

As reflected on in section 6.1.1 regarding life cycle assessments, it is considered of key significance to have access to renewable energy sources for the concept of vertical farming to make sense in terms of environmental sustainability. This access is therefore considered an important generic asset for Infarm and Nordic Harvest since the production of renewable energy is not tailored to vertical farming, although both companies are dependent on its existence and availability. Having access to renewable energy thus enables the companies to capture of some of the sustainable value that is created with stakeholders. As an example, capturing the value that is exchanges with financial stakeholders, in terms of investing in sustainable production methods, is argued to be partly realized

through accessing renewable energy. This is due to the fact that renewable energy mitigates the environmental challenge of the large energy consumption of vertical farming (section 2.4.2), which is thereby supposed to enable sustainable productions. Due to the difference in business models, it may be more difficult for Infarm to control the source of energy, as it is assumed that the in-store farms are dependent on the energy source used in Irma. On the contrary, Nordic Harvest has full control over the large-scale farm, which utilizes 100% wind energy (Nordic Harvest, 2020). Furthermore, the technical development of efficient LED lights is identified as a generic asset for both case companies, as the LEDs are a key component of plant growth and economic viability of the productions (section 2.2.2), which thereby affects the capability to capture economic value. Lastly, retail channels such as supermarkets and food services are interpreted as generic complementary assets as they enable the distribution of products to consumers, which realize the exchange and use value created in the relationship with the customer stakeholder group.

Specialized Assets

Specialized assets are tailored to the specific innovation and involve unilateral dependency, which in the case of Nordic Harvest and Infarm could be exemplified as their marketing activities. Both companies are fairly new in the Danish market, and operate in a new industry with a low knowledge base among consumers. This implies that not only are both ought to brand themselves and their products, but they also need to educate consumers and other relevant stakeholders in the concept of vertical farming. These two focus areas are critical to attract customers and thereby capture both use and exchange value in this stakeholder group, emphasizing the importance of marketing activities as specialized assets. An example hereof is Infarm's initial failed launch of lettuces in Denmark, described in section 6.2.2. According to Nielsen, this failure can to a large extent be explained by a lack of combining the launch with efficient marketing activities (Appendix 6). As a consequence, Infarm and Irma have not been able to capture a large share of economic value within lettuces. On the other hand, the in-store farms of Infarm can prove relevant in terms of educating consumers, since they are able to see the production and thereby experience a vertical farm up close. Moreover, our field trips to Irma stores have shown that Infarm offer small flyers with educating information on products and recipes, combined with the sampling of products. These assets are considered especially relevant due to the current early industry stage, although the importance may decrease over time as consumer knowledge increases.

Likewise, Nordic Harvest has published a folder with information on vertical farming, which answers the most commonly asked questions regarding products and sustainability (Nordic Harvest, 2021). This is available through the company website and social media channels and is considered an attempt to provide educational material for consumers and thereby increase the base of potential consumers to capture value from. While the educating activities of Infarm and Nordic Harvest may be useful in increasing value capturing opportunities, it may be less efficient in terms of preventing imitation. This is considered the case as education in vertical farming is likely to expand the market, but not to limit the gain to a certain brand or producer. Lastly, the harvesting and maintenance services as well as the cloud-based system of Infarm are identified as specialized assets, since the value that can be captured from the products rely on the availability of these assets. On the other hand, it may be argued that these assets are mutually dependent on the existence of Infarm's products, meaning that they could be interpreted as co-specialized as well. Either way, these assets enable Infarm to capture value from placing the farms inside stores.

Co-Specialized Assets

The physical in-store farms of Infarm are vital in terms of distributing and marketing its products, and thereby fulfilling the company's vision of distributing farms instead of produce (Jørgensen, 2020). At the same time, the in-store farms are built for the specific purpose of realizing Infarm's business model and are thereby not able to create value without the products and services of Infarm. A mutual dependency is therefore identified between Infarm and the in-store farms, why they are interpreted as co-specialized assets. This means that Infarm is able to capture exchange value both from the complementary asset, in terms of leasing the physical farms to Irma, and from the product, in terms of selling the herbs and lettuces. Hypothetically, in case the in-store farms were tailored to vertical farming in general but were utilized by different producers, it would entail that the farms were specialized assets with unilateral dependence. This would imply that the companies could capture value from the products, but not per se from the farms.

In the same line of reasoning, the exclusive partnership between Infarm and Irma may be interpreted as a co-specialized asset. Once the companies have entered the partnership, Irma becomes dependent on Infarm in terms of product delivery as well as harvest and maintenance, while Infarm becomes dependent on the retail services of Irma. Similarly, the partnership between Nordic Harvest and YesHealth Group is argued as a way for both companies to gain access to assets such as tailored technical know-how and specific growing equipment, and is therefore interpreted as a co-specialized

asset. As the first sizable large-scale vertical farm in Denmark, YesHealth Group is dependent on Nordic Harvest as a crucial step in its expansion into Europe, according to the company's CCO (Cunningham, 2020). In addition, the Chairman of YesHealth Group states that "adding to our technology that we've developed in-house over the past decade, YesHealth Group will now be able to harness real-world data from Denmark with its unique climate and environment, and improve our technology at an even greater speed and efficiency" (ibid.). This indicates that the partnership even allows the group to gain extensive practical experience with its technology and collect valuable data, which may be used to enhance value capturing in both Denmark and other potential European markets. At the same time, Nordic Harvest is dependent on the expertise of YesHealth Group in terms of knowledge, technology and equipment, allowing Nordic Harvest to set up Europe's largest vertical farm in a relatively short amount of time. The co-specialized assets associated with this partnership may therefore prove crucial in terms of gaining competitive advantage, limiting imitation and capturing value, due to the unique resources and insights it provides for both parties.

Generally, the role and importance of complementary assets thus differ significantly for Nordic Harvest and Infarm. This indicates that differences in business models influence how complementary assets may be utilized to capture value and gain competitiveness. In example, the business model of Nordic Harvest implies higher control of the generic assets in terms of renewable energy, which strengthens its opportunity to capture sustainable value. Meanwhile, the co-specialized assets of Infarm's in-store farms provides opportunities to capture additional value in terms of leasing and services. Conversely, it was reasoned that the appropriability regimes of Infarm and Nordic Harvest are highly comparable, resulting in similar abilities to manage imitation. However, the early industry stage of vertical farming causes challenges in terms of aspects such as legislative systems and low knowledge, which have limiting effects on both companies' ability to capture economic value.

6.3 The Resources Allocated

In the first and second part of the analysis we have identified and evaluated the value created by Nordic Harvest and Infarm, and how they may capture this value. According to Pisano (2015), the logical next step is to consider which types of innovations and resources that are required in order to facilitate the value creation and capturing. This logic builds on the understanding that the innovation should be based on the desired value creation and value capturing opportunities, instead of vice versa. The following analysis will include an assessment of the innovation landscape map (section 5.4.1) in

relation to Nordic Harvest and Infarm, as well as considerations of the related implications. Firstly, we will reflect on how we adapt the framework to the purpose of this thesis, including setting the scene in terms of the Danish context.

6.3.1 Green Innovations in a Non-Green Industry

The innovation landscape map examines innovations in relation to companies (Pisano, 2015), whereas we use the framework to analyze innovations as the case companies in relation to an industry. This correlates with how we have incorporated a market perspective in our use of the theory of Pisano (2015), as outlined in section 5. Throughout the thesis, we have until now examined Nordic Harvest and Infarm specifically within the Danish vertical farming industry, whereas we on several occasions have compared vertical farming to traditional agriculture, for example in terms of growing techniques and the organic certification. In this final stage of the analysis, we now intend to broaden the perspective by shifting our focus from the vertical farming industry to the traditional Danish agriculture industry. This is considered important since the choice of industry will directly impact whether new business models and technical competencies are needed, and thus how the case companies are located on the innovation landscape map. The products of Infarm and Nordic Harvest compete with the greens of traditional farming, why we consider it meaningful to examine vertical farming in the traditional Danish farming industry.

This is further supported by the fact that vertical farming is a new industry that enters a long-standing and well-established industry of farming in Denmark. Jakob Lave emphasizes this by saying that "we are a historically strong agricultural nation in Denmark, which we are of different reasons, but the historical reason is that we have the world's best climate zone to produce food in" (Appendix 7: 13:39). This is in line with the aforementioned tension field between traditional and vertical farming, which we sought to examine (section 3.3). With use of the concept of Calza et al. (2017), we thus examine vertical farming in a non-green industry, since traditional farming does not revolve around environmental protection. As explained in section 5.4.2, applying the innovation landscape map of Pisano (2015) is especially relevant when examining green innovations in non-green industries. Therefore, the aim of the following sections is to analyze the innovations of Infarm and Nordic Harvest within this context.

6.3.2 Innovations of Infarm

Applying the lens of traditional farming, it can be argued that Infarm's business model is significantly different compared to the existing supplier-buyer model. As outlined in the case introduction of Infarm (section 3.2), the business model involves in-store farming combined with services and maintenance, which is considered a new way of providing greens to consumers. Moreover, it implies a new way of collaborating with retailers through long-term partnerships, involving new types of value creation (section 6.1.2). In addition to a notably different business model, it is argued that Infarm has developed new technological competencies in terms of for example the growing system in the farms and the cloud-based AI system that controls the plant data (section 3.2). In terms of the innovation landscape map (Pisano, 2015), the new business model in combination with new technological competencies places Infarm as an architectural innovation. This implies that Infarm invests significant resources in both dimensions.

According to Pisano (2015), architectural innovations are the most challenging for established players to pursue due to the major shift in terms of both competencies and business model. As we assume that it would be difficult for traditional farmers to pursue a similar strategy, it is argued that it provides Infarm with a differentiated competitive position in the non-green playing field. Pisano (2015) furthermore highlights the importance of acknowledging the evolvement of innovation strategies, implying a shift in the innovation landscape map. To our knowledge, Infarm has not yet launched any new versions of its current technologies in the Danish market, which is considered reasonable due to the relatively short presence in the Danish market (section 3.2). However, it is considered plausible that Infarm over the next years might present new generations of the in-store farms or improve its current set-up in the Danish market, meaning a shift to the routine innovation quadrant. This would entail an unchanged focus in terms of customers, but the improvements would most likely be to increase the involved use and exchange value. An increased exchange value is supported by the fact that routine innovations typically generate the majority of profits in comparison with the other innovation types, due to a steady stream of improvements (Pisano, 2015). In terms of enhancing both the use and exchange value created for customers, Infarm could develop in-store farms that are able to produce lettuces as well, since the current version is not able to "grow lettuces and herbs in the same farm, therefore lettuces are transported from Taastrup", according to Nielsen (Appendix 6: 13:57). This would imply that Infarm would be able to offer the customers more products, which have been produced in stores. Based on reasoning of Pisano (2015), routine innovation may prove essential

for Infarm in the future for strengthening its position in the Danish market involving both increased value creation and capturing.

6.3.3 Innovations of Nordic Harvest

Similar to Infarm, Nordic Harvest has developed new technical competencies and growing systems compared to traditional farming. This is exemplified through the hydroponic large-scale farm of Nordic Harvest, developed in partnership with YesHealth Group. Consequently, it implies that Nordic Harvest will be placed to the far right along the horizontal axis of the innovation landscape map, as either an architectural or radical innovation. As mentioned in section 3.4, Nordic Harvest is considered to operate with a typical supplier-buyer model, as it produces finished products in terms of lettuces and herbs, and sells these to retail and food service customers. Hence, the business model of Nordic Harvest is deemed highly similar to the one of traditional farming of greens. This indicates that Nordic Harvest is able to leverage an existing business model of the industry while acquiring new technical competencies, which positions Nordic Harvest as a radical innovation. According to Pisano (2015), the challenge of radical innovations is purely technological. Thus, it entails that Nordic Harvest is able to focus its resources solely on advancing its technical system, which may strengthen the ability to enhance value creation and capturing, instead of reinventing established business models.

However, a considerable challenge of vertical farming is that current viable crop types are rather limited to leafy greens, due to quick turnovers and high margins (section 2.4.3). A way for Nordic Harvest to accommodate this challenge in the future could be to expand the production with new crop types, such as staple crops like corn or wheat. These types of crops often require some sort of processing in order to be turned into finished products that can be sold to customers. Consequently, this requires an additional step between the supplier and buyer, as the exchange value would be realized between the supplier and the processor, instead of between the supplier and the buyer, as it is for Nordic Harvest today. This additional step would place Nordic Harvest one step lower in the value chain, potentially implicating decreased exchange value for its produce. Thus, an expansion to staple crop types would probably implicate a new business model for Nordic Harvest. Assuming that the production of these crops may leverage existing technical competencies, implies that Nordic Harvest can focus its resources on business model development. Thus, it suggests a future potential to shift to disruptive innovations in the innovation landscape map. Yet, this expansion is assumed to

require an advancement of the LED lights and efficiency of growing systems in a way that enables economically viable production of staple crops. In addition, it would require that the by-products of the staple crops can be fully utilized, in order to comply with Nordic Harvest's commitment of using the entire plants.

The same expansion is deemed less feasible for the business model of Infarm, as it would involve that that the produce is transported from the stores to the processing, and then back to the stores, which is counterintuitive to the vision of Infarm and vertical farming in general. A feasible crop type expansion would probably require Infarm to set up a large-scale farm with a high production capacity, thus implying extensive investments in architectural innovations compared to its current operations. Overall, the innovation of Nordic Harvest is thus interpreted as radical, while a potential future expansion into staple crop types would however implicate a disruptive innovation, assuming that the existing technical competencies can be leveraged to produce these crops. Figure 13 represents the current innovations of Infarm and Nordic Harvest in terms of the innovation landscape map, whereas the arrows represent the future potentials that have been outlined in the analysis. However, the illustrated examples represent selected suggestions, which neither of the companies will be limited to. As an example, it is assumed that routine innovations are within reach for Nordic Harvest as well. This could be in the form of new vegetable crop types that do not need processing, which may be beneficial in terms of generating profits.

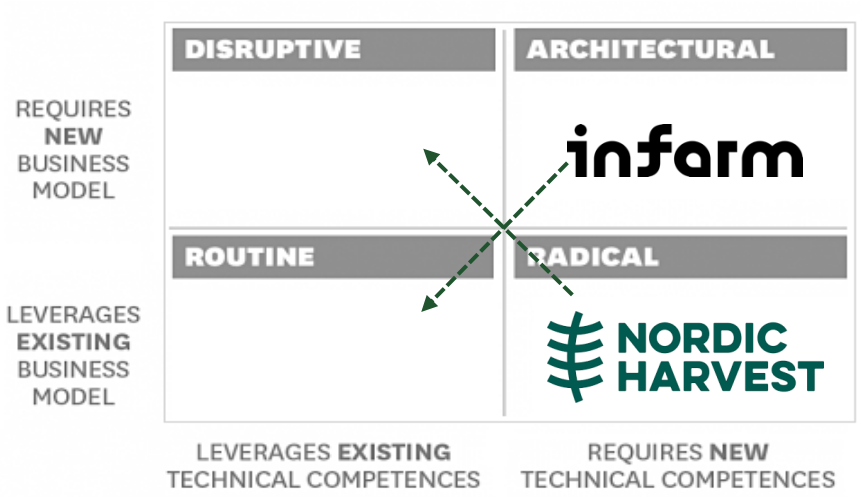


Figure 13 Innovations of Case Companies. Own representation, adapted from Pisano (2015)

6.3.4 No System Fits All

Building on the findings of the above analysis, it is concluded that vertical farming companies can be located in different quadrants of the innovation landscape map while still creating and capturing value. This is in line with the notion of Pisano (2015), saying that there are no superior innovation types, since the trade-offs between business model and competency development are dependent on the specific context. As an example, our choice of the traditional farming industry has significantly shaped which findings we have derived. If we had changed the setting by analyzing Infarm and Nordic Harvest in the context of the international entrepreneurial market of vertical farming, it would have entailed an examination of a green innovation in a green industry. Theoretically, this would mean that neither of the companies would need to invest substantial resources in developing new business models and technical competencies. In such context, both companies would be considered as imitators of other players (section 6.2.1) and as routine innovations. This reflection thus emphasizes the importance of considering the specific context as it constitutes the basis of comparison.

Overall, the analysis shows that there are various ways of establishing vertical farms in the Danish market. This implies that an approach that works in one context will not necessarily work in another context, meaning that no system fits all. Both companies have been challenged by directly transferring systems or products from an international setting to Denmark. In the case of Nordic Harvest, implementing the exact growing system of YesHealth Group led to issues regarding local climate conditions in Denmark, as elaborated in section 6.1.2. Infarm did not adjust its product assortment according to the Danish market, due to the inside-out belief that "this works well in the German and the French market – it will work well in Denmark too" (Appendix 6: 19:51), as mentioned by Nielsen. As a consequence, the mustard lettuce mix and the Tuscan kale were withdrawn since it did not match with the Danish consumer preferences. Moreover, Nielsen revealed that Infarm was additionally challenged by local adaptions due to the water conditions in Copenhagen, by stating that: "In Denmark, the level of calcium in the water is very high, which of course changes the way things grow. There may even be a difference in the calcium levels across Greater Copenhagen, which as well can have an impact" (Appendix 1: 21:30). In hindsight, both Nordic Harvest and Infarm have introduced previously proven concepts but have been challenged by local conditions in Denmark.

Throughout the three levels of the analysis, we have examined the innovation strategies of Nordic Harvest and Infarm. This has involved an in-depth analysis of how the companies create value and are able to capture a share of the value, and lastly, we have explored the involved innovation types

and required resources. Overall, it is concluded that both companies, despite different business models, are able to provide their customers with fresh lettuces and herbs grown in an innovative and sustainable way, which generate various types of value across different stakeholder groups. In terms of value capturing, the biggest difference between Infarm and Nordic Harvest has been identified as their use of complementary assets, whereas high similarity has been identified regarding appropriability regimes and innovation stages. Tying it all together, it has become evident that both Nordic Harvest and Infarm operate with a solid innovation strategy, indicating that they are capable of gaining ground in the Danish market. According to Pisano (2015), not all companies are required to develop new business models or technical competencies in order to successfully innovate. The different positions in the innovation landscape map have revealed that Nordic Harvest is able to create and capture value as a radical innovation, whereas Infarm delivers similar value as an architectural innovation by investing resources in a new business model. Thus, this indicates that the innovation strategy of Infarm allocates more resources than necessary in terms of gaining ground. In order to profoundly answer the research question of the thesis, the ability to gain ground will be further explored as a part of a thorough discussion of whether vertical farming can contribute to the sustainable development in Denmark. Hence, this will be the main objective of the following chapter.

7. Discussion

The following discussion is built on findings from the entire research process, which ultimately aims at comprehensively answering the research question. In order to achieve this, we seek to discuss and complexify several of our findings through deeper reflections and elaborations. Firstly, based on the understanding that both Infarm and Nordic Harvest possess the potential to gain ground in Denmark, the ability to contribute positively to sustainable development will be explored. Prior to assessing whether vertical farming has this ability, we consider it necessary to discuss the degree to which vertical farming may be deemed sustainable. As elaborated on in section 2.1, we understand sustainability based on the notion of the triple bottom line, which balances the dimensions of people, planet and profit. Through our research, both the interviews and the secondary data collection have revealed a large focus on planet and profit, but a lesser focus on the people dimension. This could indicate that Nordic Harvest and Infarm are not balancing the triple bottom line equally, which may affect the degree to which they can be considered sustainable. On the contrary, it may indicate that the people dimension has received less attention throughout our research process. Therefore, ensuring a larger representation of this dimension in the data collection, may prove beneficial in potential further research. This would enhance our ability to assess the sustainability of the case companies, which will be elaborated on in chapter 8.

7.1 Contribution to Sustainable Development

Nevertheless, the focus of the research question is specifically on sustainable development, which is evaluated in accordance with the 17 SDGs. As stated in section 6.2.1, the goals that we argued as most relevant for vertical farming are zero hunger (2), industry, innovation and infrastructure (9), responsible consumption and production, (12) and climate action (13), which will be assessed individually in relation to a Danish context. Regarding zero hunger, it can seem difficult how Nordic Harvest and Infarm can contribute to ending hunger by selling herbs and lettuces at premium prices (Riemann, 2020) in high-end supermarkets (section 6.2.1). Despite the many opportunities of vertical farming (section 2.3.1), providing a contribution to eliminating hunger is not the case for Infarm and Nordic Harvest today. In order to gain a deeper understanding of the potential to contribute to the SDGs, we therefore examine these in more detail by assessing the sub-goals. One sub-goal of zero hunger is to “ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production” (United Nations, 2015c). It can be argued that

Nordic Harvest and Infarm tap into this sub-goal with their efficient growing techniques that can deliver fresh produce all year round (section 2.3.1), thus ensuring resilient food productions.

In terms of industry, innovation and infrastructure, the architectural and radical innovations of Infarm and Nordic Harvest (section 6.3.2, 6.3.3.) are argued to foster innovation in Denmark, which enables meaningful contributions to this SDG. The contribution is however based on the assumption that both companies will continuously innovate, for example through efficient routine innovations. Nonetheless, this contribution might be limited due to the findings of the life cycle assessment regarding increased infrastructure and changed inner city transportation (section 6.1.1). However, as the sub-goals include factors such as increased resource-use efficiency and environmentally sound technologies (United Nations, 2015d), the case companies are still considered to positively impact this SDG.

According to the goal regarding responsible consumption and production, 13,8% of food is lost in supply chains (United Nations, 2015a). As Denmark has major challenges meeting this SDG (Sustainable Development Report, 2020), a similar pattern is assumed to be the case in Denmark as well. As emphasized in section 2.3.1, vertical farming shortens the food supply chain significantly, which secures high food safety and supply reliability. Given that the production of Infarm occurs within the stores, it leads to a significantly shortened supply chain both in terms of number of steps, and time from farm to fork. Likewise, Nordic Harvest optimizes time by seeding, growing, harvesting, packaging and distributing produce from the same location (Appendix 2). These examples illustrate how the production methods of both companies support responsible production by shortening the supply chain, and thereby substantially reducing potential food loss occurrences. Due to Denmark's poor performance regarding this specific SDG (section 2.1), it is argued that the contribution of Nordic Harvest and Infarm may be particularly influential in terms of pushing Denmark in the right direction. Finally, vertical farming addresses the macro societal problem of climate change, such as by allowing for ecosystem restoration (section 2.3.1), why it is argued that it contributes to the SDG of climate action. A sub-goal hereof is concerned with strengthening the resilience of climate-related hazards (United Nations, 2015b). Since vertical farming can produce crops uninterrupted of extreme weather conditions and seasons, caused by climate change, it contributes to a resilient food supply and thereby climate action. On one hand, similar to the SDG of responsible consumption and production, Denmark's poor performance (section 2.1) implies that an effort in this area may have a

meaningful impact. On the other hand, it is argued that extreme weather conditions are not the most significant challenge in Denmark (section 2.3.1), why this opportunity of vertical farming will be of less importance compared to other countries.

Although we argued that Nordic Harvest and Infarm may not balance the triple bottom line equally, due to a smaller focus on the people dimension, their contributions to the SDGs may indicate otherwise. According to OECD, the 17 SDGs can be categorized according to the triple bottom line. This categorization has revealed that the goal of zero hunger (2) is linked to the people dimension, the goal of industry, innovation and infrastructure (9) to the profit dimension and lastly the goals of responsible consumption and production (12) and climate action (13) to the planet dimension (OECD, 2019). This categorization is depicted in Figure 14 with the four identified SDGs marked with dotted lines. Despite the previous findings emphasizing a non-equal balance of the triple bottom line, it can be argued that this categorization paints a different picture. Since the discussion has made it clear that Nordic Harvest and Infarm contribute to the four identified goals, it can be reasoned that the case companies actually do balance the three dimensions. The balancing of the three dimensions and the contribution to several of the SDGs indicate that Nordic Harvest and Infarm contribute to sustainable development in Denmark. In order to obtain a multifaceted discussion of this finding, we consider it important to reflect on it from the perspectives of the interviewees, which is the aim of the following.

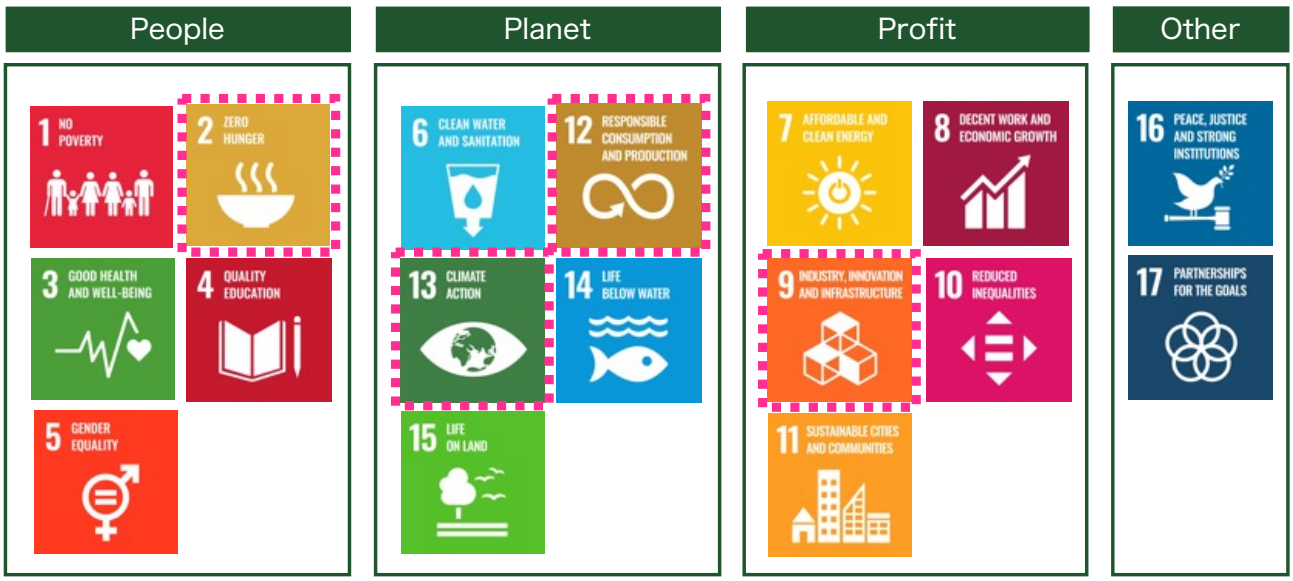


Figure 14 Categorization of SDGs. Own representation, adapted from OECD (2019)

The ability for vertical farming to contribute to sustainable development has been a recurring theme throughout several of the interviews. Lasse Vilmar doubts whether Growup Farm holds the potential to contribute to sustainable development in Denmark, due to its size and the limited awareness among the population. However, Vilmar is certain that stakeholders in direct contact with Growup Farm are influenced positively (Appendix 4). Conversely, Dyring strongly believes that Nordic Harvest contributes by "setting vertical farming on the agenda and influencing the prevalent attitude of a lot of people" (Appendix 2: 37:32). Roland offers a more nuanced view on this contribution. On one side, Roland questions the model of Infarm by stating that "I don't think that the collaboration with Infarm is a textbook example of how vertical farming may make a positive impact for the environment and the way we produce" (Appendix 1: 07:38), which he further explains by: "in reality, it is probably at a too small scale and too many things that we grow with too little intensity" (Appendix 1: 07:38). On the other side, Roland argues that Coop's experimenting with vertical farming is beneficial for sustainable development as it promotes more climate friendly food production approaches. However, he questions the overall impact of Infarm as long as the viable crop types are restricted to leafy greens. Thus, this indicates that the collective opinion among the interviewees is that vertical farming is contributing to sustainable development in a small scale but currently lacks the potential in a large scale. What might challenge vertical farming's potential to substantially impact sustainable development in Denmark, will be discussed in the following section.

7.2 Roadblocks of Gaining Ground

Based on the above, it has become clear that the concept of vertical farming holds the potential of contributing to sustainable development in a small scale. Throughout the research, we have identified several roadblocks in terms of broadening vertical farming in Denmark, which will now be discussed in order to understand what it takes from the Danish systems and institutions to facilitate this. Thus, this is in line with the underlying assumption of the thesis, since we assume that vertical farming needs to gain ground in order to enable an efficient contribution to sustainable development. In section 6.2.2, it was emphasized that the lack of organic certification can be considered a challenge in terms of engaging with various stakeholders, including consumers, restaurants and public institutions. This may represent a roadblock in terms of consumer demand for vertically farmed products. Regarding obtaining an organic certified production, Vilmar states that "of course, if it will be possible for us, then we want to do it, since we know that the demand is there, but otherwise we don't consider it a need for ourselves" (Appendix 4: 41:41). Hence, Vilmar emphasizes that he clearly

considers the organic certification to be consumer need rather than a company need. Moreover, his collaboration with the food service sector has revealed a need in the hospitality industry as well (Appendix 4). Based on this consideration, combined with the fact that 26% of Danish consumers always buy organic greens (section 2.6), we interpret the lack of an organic certification to be likely to prevent many from purchasing the products, which can constrain vertical farming from increasing in size.

In order to accommodate this challenge, we suggest that the Danish organic certification is either broadened or supplemented with a new type of certification. Lave of Future Farming stresses the importance of maintaining the red organic stamp and therefore suggests a new certification that complies with the production methods of vertical farming: "the Danish red stamp is a very strong brand, which we should keep, but does these new systems and approaches indicate that we should develop a new stamp, maybe a blue stamp, or something that can appeal to the new types of consumers, who want these products?" (Appendix 7: 03:26). Vilmar raises a similar concern and emphasizes the misunderstanding of organic produce necessarily being sustainable: "We believe that we lack a certificate saying that something is sustainably grown instead of just an organic stamp, which most of us Danes know of, and which most consumers equalize with climate-friendliness and sustainability, which is completely wrong" (Appendix 4: 14:41). This challenge specifies that there is an apparent need to rethink the current requirements of the organic certification. Dyring supports this by emphasizing how production methods are evolving over time: "we went from conventional farming to wanting a more pure product, this led to organic, and now it will lead to vertical farming, which offers the most pure products of all" (Appendix 2: 07:25). However, as mentioned in section 6.2.2, the Danish certification is dependent on legislations from the EU, which implies that a broadening of the current certificate requires a change from the EU. In order to accommodate this, we suggest that Denmark can develop a new independent certification that supplements the current red stamp, which allows vertical farmers to be formally certified for the use of sustainable production methods.

As touched upon in section 6.2.1, Freudenreich et al. (2019) argue that collaborative processes with societal stakeholders is a way to raise industry standards. Based on this, it is interpreted that this theoretical belief supports the ability of companies to influence existing standards and certifications through collaboration with societal stakeholders. In order to promote changes, it would therefore be beneficial for Nordic Harvest and Infarm to seek support from influential stakeholders, such as

Landbrug & Fødevarer and politicians. As an example, member of parliament, Tommy Ahlers, expresses willingness to support Nordic Harvest in this matter, by stating that "it is our responsibility as politicians to secure that the legislation supports this development and creates fair competitive conditions between the old and the new" (Appendix 13). It is therefore argued that Nordic Harvest and Infarm currently have momentum to establish these collaborations, as vertical farming has "political tailwind at the moment", according to Arhnung of Landbrug & Fødevarer (Appendix 7: 16:51). Another way to facilitate change could be to encourage more actors to enter the market, which according to our findings in the analysis (section 6.2.1) would lead to more favorable than harmful implications. This is based on the assumption that more players in the vertical farming industry would imply a larger potential to impact political stakeholders and thereby legislations.

In addition to the organic certification, Nordic Harvest and Infarm also faced challenges in terms of financial support, such as investors and agricultural aid, due to the difficulty of fitting into existing classifications (section 6.2.2). As previously stated, Riemann questions the current measurements that agricultural aid are based on, favoring number of hectares over efficiency (section 6.2.2). However, rethinking these measurements might not be straight forward, as efficiency is difficult to measure across various types of farming. As an example, providing aid based on efficiency may cause negative side effects such as increased use of pesticides, in order to maximize yield. On the other side, we argued that the current measurements do no foster innovation, as they do not account for new and efficient growing techniques. Thus, this indicates an evident need for a reevaluation that benefits both traditional and vertical farming.

The complexity of obtaining financing may prevent growth of both existing and new players in the vertical farming industry, due to the high operating and start-up costs (section 2.4.1). It is argued that the classifications are probably not going to change, as long as vertical farming is a rather small industry in Denmark. However, for the vertical farming industry to obtain a considerable size that is able to impact legislations, will require financial support. This indicates a paradoxical relationship where industry size is constrained by current classifications, and vice versa. A solution to this paradox will thus be a key contributor in terms of enabling growth of the Danish vertical farming industry, which will even allow for the potential of a more significant impact on the sustainable development. This line of argumentation is supported by Roland, who stresses that "first and foremost, a change of our political and economic system is required, as well as the incentives that control the development, as these are very much market driven right now, which does not promote sustainability,

unfortunately" (Appendix 1: 49:02). Thus, Roland acknowledges the need for structural changes in order for vertical farming to have an impact. Moreover, the current conditions of the market implicate that a majority of our interviewees consider vertical farming to be a supplement to traditional farming rather than a substitute, which will be discussed in the following.

7.3 Supplement or Substitution

Whether vertical farming may hold the potential of substituting a part of the traditional agricultural practices has been a returning subject throughout the data collection. The newness of the industry implicates that both Riemann and Dyring of Nordic Harvest reason that Nordic Harvest's production does not intend to replace the traditional agricultural practices, as of today (Iværksætter Historier, 2021; Appendix 2). However, the previously mentioned reforestation plans of Nordic Harvest (section 2.1) indicate a long-term substitution, which Dyring emphasizes by stating "We are not planning on removing the farms that exist today. Not at all. In the long run, in the very long run, we would like to transform agricultural land into forests" (Appendix 2: 30:40). Moreover, Dyring stresses the magnitude of today's import of greens from other countries, which the products of Nordic Harvest can play an important role in reducing: "we absolutely don't need to import 15.000 tons of greens from Italy every year, driven by trucks all the way through Europe" (Appendix 2: 37:32). Currently, 70% of the herbs and lettuces consumed in Denmark are imported (Nordic Harvest, n.d.-d), why a potential of vertical farming is to substitute a share of this. In addition, vertical farming is argued to be able to partly substitute the Danish greenhouse production (Appendix 1, 7). However, Arhnung raises awareness about the limited number of greenhouses in Denmark, since greenhouses have struggled with economic issues regarding productivity and costs of electricity (Appendix 7). On one hand, this reduces the size of the market that vertical farming may substitute. On the other hand, this represents an opportunity for greenhouses to learn from the vertical farming production methods, which enables vertical farming companies to expand their technologies.

Relatedly, Lave advocates a potential for Denmark to advance its technical competencies of vertical farming, aimed at exporting the technologies to geographical areas with poor agricultural conditions (Appendix 7). This suggestion is argued feasible due to the fact that Denmark is both an agricultural nation as well as among the world's best in terms of digital technology and innovation (Danish Patent and Trademark Office, 2019), why an export of vertical farming technology would allow Denmark to combine these strengths. This represents an alternative opportunity for vertical farming to gain

ground in Denmark as an exporting technology, rather than substituting traditional farming. Moreover, it indicates a potential for technology to obtain an increasingly important role within the established Danish agricultural industry. The establishment of vertical farming in Denmark also indicates a shift in the predominant employment types, since employees at vertical farms are from different educational backgrounds than traditional farmers (Appendix 7). This implies that the industry creates new types of jobs, which has previously been identified as an opportunity of vertical farming (section 2.3.1). Thus, this further suggests that vertical farming may not overlap with the traditional agriculture but will instead act as a supplementing practice due to the employment of people with different backgrounds.

Similar to the opportunities for greenhouses, knowledge sharing between the industry of vertical farming and traditional agriculture represents an opportunity for both industries to supplement each other. Here, the traditional farmers can contribute with practical know-how (Landbrug & Fødevarer, 2018), whereas vertical farmers can assist with technological knowledge and climate efficient solutions. This implies that vertical farming may increasingly create traction by collaborating and coexisting with traditional agriculture, which may enhance the potential to contribute to sustainable development.

As previously stated, Denmark is located in an optimal climate zone for food production (section 6.3.1). Combined with the fact that Denmark does not have any overpopulated megacities with food supply challenges, it may indicate that the urgency of vertical farming is somewhat smaller in Denmark compared to other countries. In line with above argumentation, this stresses the relevance of exporting the technology and thereby impacting sustainable development outside the borders of Denmark. However, as an approach to increase its relevance in Denmark, Lave suggests utilizing vertical farming for production of specialty and area specific foods (Appendix 7). As example, this could entail prolonging the season of Danish strawberries, as these are grown in Denmark during summer but are imported during the remainder of the year (Landbrug & Fødevarer, 2012). Hence, this represents a potential to establish a distinct role for vertical farming within particular foods, as well as an additional potential to substitute a share of today's import. According to a report by Landbrug & Fødevarer (2012), both retail and consumers are increasingly demanding seasonal fruits and vegetables all year round, for example strawberries during winter months. The import of strawberries has heavily increased for several years (Landbrug & Fødevarer, 2012), which again strengthens the potential for vertical farming to tap into this market. Furthermore, as imported foods

contain significantly more residue pesticides than Danish foods (ibid.), which represents a large concern among Danes (section 2.6), it suggests an even bigger potential.

Ultimately, the findings of the above discussion highlight the importance of the customer stakeholder group for the success of vertical farming, which is in line with the findings of the stakeholder analysis (section 6.1.2). The customers are essential in terms distributing the products across the Danish market and thereby reaching the consumers. This is enabled through financial stakeholders, who provide financial aid for start-up and operations. Lastly, societal stakeholders are of significant importance since a main potential of vertical farming is to address macro societal issues, empowered by collaboration with this stakeholder group. Collectively, these stakeholder groups are thus interpreted as crucial for enabling vertical farming to gain ground in Denmark and thereby allowing for a larger contribution to sustainable development.

7.4 Applicability of the Research

To round off the discussion, we consider it important to methodologically reflect on the findings of the analysis by discussing the generalizability and contribution of our research, which is the purpose of this last section. As stated in section 4.5, Flyvbjerg (2006) argues that case studies are central to generating knowledge. Despite our interpretivist research philosophy, we argued that elements of our research may be applicable to other situations, but we however consider it necessary to reflect on which parts that are case specific rather than general. As an example, it has throughout the analysis and discussion become clear that vertical farming does not fit into existing classifications of Danish institutions, which may restrict industry growth. This challenge is identified as a structural problem, which affects both Nordic Harvest and Infarm, and is moreover assumed to apply to other vertical farming actors in the Danish market as well, as these classifications are industry specific. However, apart from the EU regulations, it is not generalizable to an international context, since local legislations are likely to differ in other markets and have not been researched in this thesis.

Furthermore, it is deemed difficult to generalize the use of complementary assets, as the exploitation of these is assumed to be highly company specific. As an example, the partnerships with YesHealth Group and Irma are considered context-dependent due to the specified contracts, business models and people involved. The value created and captured within these relations will therefore not necessarily be the same as in other partnerships. Likewise, the in-store farms of Infarm are considered to create a distinct type of value in the specific combination of farm characteristics, store locations and the

high-end profile of Irma. On the contrary, the product related value regarding taste, freshness and sustainability is assumed to be more similar across vertical farms, indicating a higher degree of potential generalizability. Based on these examples, it is therefore reasoned that our research contributes to scientific development both in terms of case specific findings and findings that may be applicable to the vertical farming industry in Denmark.

Overall, the discussion initially alluded that Nordic Harvest and Infarm hold the potential to contribute to sustainable development by impacting several SDGs. Subsequently, we have discussed selected roadblocks and whether vertical farming is likely to supplement or substitute traditional farming. This has enabled an understanding of the potential future role of vertical farming in a Danish context, as well as the challenges it faces to realize this role. As of today, it is concluded that vertical farming acts as a supplement to traditional farming in Denmark. However, we have identified opportunities for vertical farming to substitute a share of today's import and greenhouse production, as well as a potential to expand its technologies to other industries and geographical areas. Throughout the thesis it has become clear that the newness of the industry implies a large potential for further research, which will be explored in the coming chapter.

8. Suggestions for Further Research

Our thesis has provided an in-depth understanding of vertical farming and its role in the Danish market. However, the research process involving interviews, field trips and broad data collection has shed light on the topic complexity and thereby emphasized the extensive number of unresearched aspects. As mentioned in our methodological chapter, the selection of academic writings in relation to vertical farming is rather limited due to the early stage of the industry (section 4.4). Based on this, it is argued that our academic contribution lays a solid foundation for understanding the potential in Demark through an in-depth assessment of vertical farming. However, the newness of the topic implies a research gap of unexplored perspectives. To expand our knowledge and understanding of vertical farming, three selected research topics are proposed for further research.

Building on our research findings, the first proposed topic for further research is an in-depth examination of the classifications and measurements, which determine aspects such as agricultural aid and investments. Our research has indicated how these are currently challenging the industry of vertical farming in Denmark. Hence, further research could explore aspects such as what it requires to adjust the current measurements, and what they should specifically be adjusted to, in order to accommodate the vertical farming industry. In line with this, our thesis has raised awareness about the fact that vertical farming cannot obtain an organic certification, indicating a need for a supplementing certification for sustainable production methods (section 7.2). Further research may therefore involve an exploration of what a new sustainable production stamp should entail. However, it is argued that this would require a significant change in data collection including new interviewees with a more profound knowledge in terms of the Danish political and legal requirements of these certifications.

Secondly, as vertical farming may increasingly gain ground, we have found that it will enhance its potential to contribute to sustainable development. This notion leads to a suggestion of further researching additional impacts of vertical farming on the SDGs. As an example, given that vertical farming succeeds in reducing agricultural runoff and allows for ecosystem restoration (section 2.3.1), meaningful research could include how it might contribute to the SDGs of life below water (14) and life on land (15). Moreover, further research of the social dimension of vertical farming could involve whether it might impact gender equality (5). As previously described, the rise of vertical farms will involve new employment types within a more technological field compared to traditional farming

(section 7.3). This might entail a shift in the skewed gender balance in the existing male dominated farming industry. The relevance of this suggestion is stressed by the fact that females constitute just 21,7% of the total employment in Danish agriculture (Beskæftigelsesministeriet, 2020). Vertical farming may therefore highlight the role of gender inequalities within farming. In this context, we argue that it will be meaningful to examine the potential of vertical farming to shape the notion of sustainable development, by impacting the content of some of the SDGs. As an example, sustainable cities and communities (11), currently focused on aspects such as affordable housing, access to public transport and air pollution, could include a dimension of access to sustainable food supplies with reduced transportation. Thus, vertical farming may require a rethinking of the SDGs, which we suggest as relevant further research.

Lastly, Nordic Harvest launched its products nationwide in Bilka and Føtex stores on April 26th 2021 (section 3.1). As a result of this launch, we propose further research of customer and product related perspectives of Nordic Harvest. This is motivated by an interest in understanding the degree to which findings and research approaches would change. As an example, the product launch involves the ability to potentially conduct interviews with employees of Bilka and Føtex, as well as to conduct field trips to selected stores. This represents new opportunities to study value creation within the customer stakeholder group, as this area was rather limited for Nordic Harvest in the thesis since products were not yet in stores and information about pending customers was not available. This example further stresses the newness and radically changing industry of vertical farming, why we find it especially relevant to emphasize the importance of expanding the knowledge and understanding of vertical farming, through further research of various perspectives.

9. Conclusion

With this thesis, we set out to research how the innovation of vertical farming can obtain the potential to gain ground in the Danish market and contribute to sustainable development. In order to set the scene of the research, we initially explored the concepts of sustainability and sustainable development, followed by an examination of the concept of vertical farming, including the different types of growing systems and market dynamics. Collectively, this provided a common ground for the fundamental concepts of the thesis, which enabled meaningful research of vertical farming. Our research question was examined through a case study of Nordic Harvest and Infarm, supported by a theoretical framework consisting of carefully chosen academic literature. This approach included a collection of both primary and secondary data, including several interviews with key stakeholders, field trips and conference participations. This led to an in-depth analysis of the innovation strategies of both case companies, aimed at understanding the potentials for Infarm and Nordic Harvest to gain ground in Denmark. Based on the analysis, we concluded that the emergence of vertical farming in Denmark does not just affect the companies and their customers but implicates a broad network of stakeholders, who realize different combinations of economic, social and environmental value. Moreover, it was concluded that the ability of both companies to capture value is challenged by the early stage of the industry, due to low knowledge and the existing classifications not accommodating vertical farming. Ultimately, the analysis revealed that both Nordic Harvest and Infarm operate with solid innovation strategies, which demonstrate the potential of both companies to gain ground in Denmark. However, the strategy of Infarm may invest more resources than necessary in terms of business model development.

The findings of the analysis were unfolded through a discussion of the case companies' contribution to sustainable development. It was inferred that Nordic Harvest and Infarm hold the potential to push the sustainable development within specific areas, due to their contributions to identified SDGs. Hereafter, we discussed how a structural problem of the Danish system represents a roadblock for vertical farming, which revealed a paradoxical relationship between current classifications and industry size. Based on this, it was reasoned that solving this paradox is key for enabling growth of the industry. Moreover, we concluded that vertical farming adopts a supplementing position to the traditional farming industry in Denmark but has the opportunity to substitute a share of today's import and greenhouse production, as well as export its technologies. A realization of this role combined with overcoming the roadblocks, is argued to enhance the potential of vertical farming to positively

impact sustainable development. Lastly, we concluded that vertical farming not only contributes to sustainable development in Denmark but also pushes the concept by emphasizing the role of technology in terms of securing sustainable food production for the future generations. Thus, we have throughout the thesis broadened and complexified the initial statement of vertical farming creating the perfect day, every single day, by shedding light on the multifaceted implications of vertical farming in Denmark and researching whether it is a way to farm for the future.

References

Accenture. (2017). The Future of Food: New Realities for the Industry. Retrieved April 24, 2021, from Accenture website: https://www.accenture.com/us-en/_acnmedia/pdf-70/accenture-future-of-food-new-realities-for-the-industry.pdf

Alesca Life. (2019). Our Tools. Retrieved May 10, 2021, from https://www.alescalife.com/our-tools/

Andersen, I. (2013). *Den skinbarlige virkelighed: Vidensproduktion i samfundsvidenskaberne* (5th ed.). Frederiksberg: Samfundslitteratur.

Askew, K. (2018). Infarm Reinventing Food Supply with Vertical Urban Farms. Retrieved January 28, 2021, from Food Navigator website: https://www.foodnavigator.com/Article/2018/02/06/Infarm-reinventing-food-supply-with-vertical-urban-farms

Berg, B. L. (2001). *Qualitative Research Methods for the Social Sciences*. Allyn and Bacon.

Beskæftigelsesministeriet. (2020). Mænd og kvinder på arbejdsmarkedet 2020. Retrieved May 10, 2021, from https://bm.dk/media/14895/maend-og-kvinder-pa-arbejdsmarkedet_2020.pdf

Birch, F. (2009). Nettos og irmas stærke profiler hjælper dem gennem krisen. Retrieved April 21, 2021, from www.retailinstitute.dk website: https://retailinstitute.dk/nettos-og-irmas-stærke-profiler-hjælper-dem-gennem-krisen/

Birkby, J. (2016). Vertical Farming. *National Center for Appropriate Technology*, 1–12.

Bloomberg Technology. (2019). How Vertical-Farming Startup InFarm Plans to Use $100 Million in Funding. Retrieved May 15, 2021, from Bloomberg website: https://www.youtube.com/watch?v=ppGp_1_bA3Y

Brio Hydroponics. (2020). Hydroponics vs. Aeroponics - Which is Better? Retrieved March 10, 2021, from https://briohydroponics.com/blog/hydroponics-vs-aeroponics

Bruun, S. (2020). Potential Environmental Benefits and Drawbacks of Vertical Farming. Retrieved March 18, 2021, from Vertical Farming in a Nordic Context website: https://video.ku.dk/secret/65324799/fb457c91a72632c95ded6c4a0bb100c9

Burns, A. C., & Bush, R. F. (2013). *Marketing Research* (7th ed.). Pearson Education.

Butturini, M., & Marcelis, L. F. M. (2019). Vertical Farming in Europe: Present Status and Outlook. In *Plant Factory: An Indoor Vertical Farming System for Efficient Quality Food Production: Second Edition* (2nd ed., pp. 77–91). Academic Press. https://doi.org/10.1016/B978-0-12-816691-8.00004-2

Calza, F., Parmentola, A., & Tutore, I. (2017). Types of Green Innovations: Ways of Implementation in a Non-Green Industry. *Sustainability*, *9*(8). https://doi.org/10.3390/su9081301

Chen, Y.-S., Lai, S. B., & Wen, C. T. (2006). The Influence of Green Innovation Performance on Corporate Advantage in Taiwan. *Journal of Business Ethics*, *67*(4), 331–339. https://doi.org/10.1007/s10551-006-9025-5

Chen, Y.-Y., Shek, D. T. L., & Bu, F.-F. (2011). Applications of interpretive and constructionist research methods in adolescent research: philosophy, principles and examples. *International Journal of Adolescent Medicine and Health*, *23*(2), 129–139.

Cognition, E. (2018). Does Vertical Farming Work? Retrieved March 30, 2021, from Youtube website: https://www.youtube.com/watch?v=dnCQuwCtqJg

Coop. (n.d.). Vores butikker. Retrieved April 3, 2021, from https://info.coop.dk/butikker/

Coop. (2020). Krydderurter dyrket i butik er et hit: Nu åbner nyt anlæg i Danmark. Retrieved February 23, 2021, from https://info.coop.dk/kontakt/pressekontakt/pressemeddelelser/krydderurter-dyrket-i-butik-er-et-hit-nu-åbner-nyt-anlæg-i-danmark/

Coop. (2021). Irmas kunder tilbydes nu salater dyrket med vertical farming. Retrieved March 4, 2021, from https://info.coop.dk/kontakt/pressekontakt/pressemeddelelser/interfarm/

Crumpacker, M. (2018). 4 Facts You Need to Know about LEDs and Vertical Farming. Retrieved from Medium website: https://medium.com/@MarkCrumpacker/4-facts-you-need-to-know-about-leds-and-vertical-farming-bb1bed18064d

Cunningham, D. (2020). YesHealth Group and Nordic Harvest Complete First Phase of Construction on Europe ' s Largest Vertical Farm. Retrieved April 28, 2021, from Business Wire website: https://www.businesswire.com/news/home/20201207005006/en/YesHealth-Group-and-Nordic-Harvest-Complete-First-Phase-of-Construction-on-Europe's-Largest-Vertical-Farm

Danielsen, M. (2018). Gødning og sprøjtegift. Retrieved March 18, 2021, from Faktalink website: https://faktalink.dk/godning-sprojtegift

Danish 92 Group, & Global Focus. (2020). Spotlight Report: Denmark's Challenges in Achieving the Sustainable Development Goals. Retrieved May 1, 2021, from https://sdgtoolkit.org/wp-content/uploads/2021/02/Denmark-CSO-SPOTLIGHT-Report_2020_eng.pdf

Danish Patent and Trademark Office. (n.d.). Søg i patenter og varemærker. Retrieved April 27, 2021, from https://www.dkpto.dk/soeg-i-patenter-og-varemaerker

Danish Patent and Trademark Office. (2019). Danmark blandt verdens bedste til innovation. Retrieved from https://www.dkpto.dk/nyheder/2019/august/danmark-blandt-verdens-bedste-til-innovation

Danish Wind Industry Association. (2014). Denmark - Wind Energy Hub. Retrieved May 1, 2021, from https://winddenmark.dk/sites/windpower.org/files/media/document/Profile_of_the_Danish_Wind_Industry.pdf

Danmarks Naturfredningsforening. (2019). Sprøjtegift i drikkevandet. Retrieved May 12, 2021, from https://www.dn.dk/vi-arbejder-for/drikkevand/sprojtegift/

Danmarks Naturfredningsforening. (2020). Ny rapport: Landbrug skal producere mere føde til mennesker og mindre foder til dyr. Retrieved March 14, 2021, from https://www.dn.dk/nyheder/ny-rapport-landbrug-skal-producere-mere-mad-til-mennesker-og-mindre-foder-til-dyr/

Deloitte Consulting. (2019). Future of food: How technology and global trends are transforming the food industry. Retrieved April 20, 2021, from https://www2.deloitte.com/au/en/pages/economics/articles/future-of-food-uber-eats.html

Despommier, D. (2009). The Rise of Vertical Farms. *Scientific American*, *301*(5), 80–87.

Despommier, D. (2020). *The Vertical Farm: Feeding the World in the 21st Century* (Tenth Anni). New York City: Picador.

Dudovskiy, J. (2019). Important Aspects of Interpretivism. Retrieved February 2, 2021, from https://research-methodology.net/research-philosophy/interpretivism/

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (2017). Th e Global Innovation Index 2017: Innovation Feeding the Wold. Retrieved May 1, 2021, from https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2017.pdf%0Ahttps://www.globalinnovationindex.org/gii-2017-report

Ebrahimnejad, R. (2020a). Introduction to Vertical Farming. Retrieved March 18, 2021, from Vertical Farming in a Nordic Context website: https://video.ku.dk/secret/65324340/d4fbdcd2e7bde3767c72b9f5960655a9

Ebrahimnejad, R. (2020b). Re-Engineering America's Fresh-Produce Supply Chain Post Covid-19 for Greater Resilience, Inclusiveness and Sustainability. Retrieved March 18, 2021, from Association for Vertical Farming website: https://vertical-farming.net/blog/2020/04/27/re-engineering-americas-fresh-produce-supply-chain-post-covid-19-for-greater-resilience-inclusiveness-and-sustainability/

Eisenhardt, K. M. (1989). Building Theories from Case Study Reseach. *Academy of Management Review*, *14*(4), 532–550. https://doi.org/10.1016/s0140-6736(16)30010-1

Elliott, J. (2013). *An Introduction to Sustainable Development* (4th ed.). Routledge.

Financial Times. (2019). AeroFarms raises $ 100m as investors rush to indoor farms. Retrieved May 10, 2021, from https://www.ft.com/content/cac48190-9d8a-11e9-9c06-a4640c9feebb

Flyvbjerg, B. (2006). Aalborg Universitet Five Misunderstandings About Case-Study Research Flyvbjerg, Bent. *Qualitative Inquiry*, *12*(2), 28.

Food and Agriculture Organization of the United Nations. (2017). The Future of Food and Agriculture: Trends and Challenges. Retrieved May 1, 2021, from www.fao.org/publications%0Ahttp://www.fao.org/3/a-i6583e.pdf%0Ahttp://siteresources.worldbank.org/INTARD/825826-1111044795683/20424536/Ag_ed_Africa.pdf%0Awww.fao.org/cfs%0Ahttp://www.jstor.org/stable/4356839%0Ahttps://ediss.uni-goettingen.de/bitstream/han

Forbes. (2019). What The 3Ps Of The Triple Bottom Line Really Mean. Retrieved May 11, 2021, from https://www.forbes.com/sites/jeroenkraaijenbrink/2019/12/10/what-the-3ps-of-the-triple-bottom-line-really-mean/#23dabeb25143

Fortune Business Insights. (2020). Vertical Farming - Global Market Analysis, Insights and Forecast, 2019-2026. Retrieved May 10, 2021, from https://ezproxy.uttyler.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=35714437&site=ehost-live&scope=site&scope=cite

Freight Farms. (2021). *Live Tour of the Greenery™ Container Farm*. Boston.

Freudenreich, B., Lüdeke-Freund, F., & Schaltegger, S. (2019). A Stakeholder Theory Perspective on Business Models: Value Creation for Sustainability. *Journal of Business Ethics*, *166*(1), 3–18. https://doi.org/10.1007/s10551-019-04112-z

Grant, R. M. (2016). *Contemporary Strategy Analysis* (9th ed.). Wiley. https://doi.org/10.4324/9781003104339

Granyon. (n.d.). Nordic Harvest – The Future of Close Agriculture. Retrieved March 22, 2021, from https://www.granyon.com/insights/nordic-harvest

Greensgrow. (n.d.). What Is Urban Farming? Retrieved March 23, 2021, from https://www.greensgrow.org/urban-farm/what-is-urban-farming/#:~:text=Simply put%2C urban farming is,they are very different animals.

Grønbæk, V. J. (2021). Grønt nyt på hylderne: Irma sælger salat fra vertikalt. Retrieved April 22, 2021, from https://effektivtlandbrug.landbrugnet.dk/artikler/virksomhedsstof/62996/irma-saelger-salat-fra-vertikalt-landbrug.aspx

Gupta, M. K., & Ganapuram, S. (2019). Vertical Farming Using Information and Communication. *Infosys*.

Hansen, S. T. (2014). Find det optimale høsttidspunkt. Retrieved March 23, 2021, from Aarhus Universitet website: https://dca.au.dk/aktuelt/nyheder/vis/artikel/find-det-optimale-hoesttidspunkt/

Hebsgaard, T. (2020). Hvis klimakampen blev ført an af denne mand, så ville alle mennesker bo i byer om 50 år. Selv vores grøntsager ville gro i højhuse. Retrieved February 3, 2021, from Zetland website: https://www.zetland.dk/historie/sop1m3bB-ae6XddK5-19c83

Iacono, V. Lo, Symonds, P., & Brown, D. H. K. (2016). Skype as a tool for qualitative research interviews. *Sociological Research Online*, *21*(2), 1–15. https://doi.org/10.5153/sro.3952

Infarm. (n.d.-a). How Our Business Operations Managers Are Planting Seeds for Success. Retrieved February 25, 2021, from https://www.infarm.com/en/articles/careers-at-infarm-how-our-business-operations-managers-are-planting-seeds-for-success

Infarm. (n.d.-b). Infarm raises $170M during pandemic to grow largest urban vertical farming network in the world. Retrieved April 22, 2021, from https://www.infarm.com/en/articles/infarm-raises-170m-during-pandemic

Infarm. (n.d.-c). News. Retrieved April 25, 2021, from https://www.infarm.com/en/news

Infarm. (2019a). Infarm — A few of our most frequently asked questions. Retrieved January 28, 2021, from Medium website: https://medium.com/@infarm.com/infarm-a-few-of-our-most-frequently-asked-questions-5221e9f65ae0

Infarm. (2019b). Plantedyrkningssystem. Retrieved April 27, 2021, from https://onlineweb.dkpto.dk/pvsonline/Patent?action=104&sagID=15756115.0

Infarm. (2020). Celebrating GlobalG.A.P Certification and Best Farming Practices at Infar,. Retrieved February 25, 2021, from Medium website: https://medium.com/@infarm.com/celebrating-globalg-a-p-certification-and-best-farming-

practices-at-infarm-32df222b092b

Infarm. (2021). Infarm Heralds the Next Generation of Farming. Retrieved March 22, 2021, from https://www.infarm.com/en/articles/infarm-heralds-the-next-generation-of-cloud-enabled-farming

ISO. (n.d.). ISO 22000 - Food Safety Management. Retrieved March 14, 2021, from https://www.iso.org/iso-22000-food-safety-management.html

ISO. (2018). ISO 22000 - Food Safety Management. Retrieved April 25, 2021, from ISO-standards website: http://www.iso.org/iso/home/standards/management-standards/iso22000.htm

Iværksætter Historier. (2021). Nordic Harvest – Vertikal farm vil være med til at redde kloden. Retrieved April 15, 2021, from Podtribe media website: https://ivaerksaetterhistorier.dk/nordic-harvest/

Jørgensen, T. (2020). Opportunities and Challenges Ahead When Building Vertical Farms in the Nordic countries. Retrieved March 18, 2021, from Vertical Farming in a Nordic Context website: https://video.ku.dk/secret/65324941/09b829415d72a9decd487162ac751154

Jürkenbeck, K., Heumann, A., & Spiller, A. (2019). Sustainability Matters: Consumer Acceptance of Different Vertical Farming Systems. *Sustainability (Switzerland)*, *11*(15), 1–21. https://doi.org/10.3390/su11154052

Klepper, S. (1997). Industry life cycles. *Industrial and Corporate Change*, *6*(1), 145–181. https://doi.org/10.1093/icc/6.1.145

Knudsen, L. (2017). Fakta om kvælstof i landbruget og vandmiljøet. Retrieved March 18, 2021, from Seges website: Landbrugsinfo.dk

Koszyczarek, H. H. (2020). Ny klimaanalyse viser store udfordringer på vej for dansk landbrug. Retrieved March 22, 2021, from https://nyheder.okologi.dk/mark-og-stald/ny-klimaanalyse-viser-store-udfordringer-pa-vej-for-dansk-landbrug

Kristensen, W. R. (2020). Kommende landbrugsfond vil opkøbe 1000 hektar landbrug årligt. Retrieved March 16, 2021, from Agriwatch website: https://agriwatch.dk/Nyheder/Landbrug/article12311487.ece

Kudos. (n.d.). Introduktion af verdens største vertikale farm. Retrieved April 20, 2021, from https://www.kudos.dk/cases/introduktion-af-verdens-storste-vertikale-farm

Kvale, S., & Brinkmann, S. (2009). *Interview: Introduktion til et håndværk* (Second Edi). Copenhagen: Hans Reitzels Forlag.

Landbrug & Fødevarer. (n.d.). Om Landbrug & Fødevarer. Retrieved April 29, 2021, from https://lf.dk/om-os/om-landbrug-og-foedevarer

Landbrug & Fødevarer. (2012). Økonomisk Analyse: Udenlandsk frugt og grønt fortrænger dansk frugt og grønt fra butikshylderne. Retrieved March 18, 2021, from https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwj9uMnb0cTvAhWCl4sKHYNnAK0QFjAAegQIDRAD&url=https%3A%2F%2Flf.dk%2Ftal-og-analyser%2Fforbrugere-og-trends%2Fforbrug-og-detail%2F2012%2Fudenlandsk-frugt-og-gront-fortraenger-dansk&usg=

Landbrug & Fødevarer. (2018). Vores bidrag. Retrieved May 5, 2021, from https://lf.dk/om-os/vores-bidrag

Leahy, E. (2021). Ocado ups investment in vertical farm The online retailer increases its share to 70 per cent in Jones Food Company. Retrieved May 10, 2021, from Fruitnet website: http://www.fruitnet.com/fpj/article/182734/ocado-ups-investment-in-vertical-farm

Lepak, D. P., Smith, K. G., & Taylor, M. S. (2007). Introduction to Special Topic Forum: Value Creation and Value Capture: A Multilevel Perspective. *Academy of Management*, *32*(1), 180–194.

Macovei, D. (2020). Online Vertical Farming Conference: Plant Nutrients and Food Quality in Vertical Farming. Retrieved March 23, 2021, from https://www.verticalfarmingconference.com/speaker/plant-nutrients-and-food-quality-in-vertical-farming/

Malhotra, N. K., Nunan, D., & Birks, D. F. (2017). *Marketing Research: An Applied Approach* (Fifth Edit). Harlow: Pearson.

Manson, J. (2020). Instore Farming: Swegreen and ICA Partner on "Hyperlocal" Veg Scheme. Retrieved March 14, 2021, from https://www.naturalproductsglobal.com/europe/instore-farming-swegreen-and-ica-partner-on-hyperlocal-veg-scheme/

MarketLine. (2020). *Vertical Farming: The Future of Agriculture*.

Miljø- og Fødevareministeriet. (n.d.). Markedsføring med mærkerne. Retrieved April 28, 2021, from https://www.oekologisk-spisemaerke.dk/media/1450/markedsfoering-med-maerkerne.pdf

Miljøminisetriet, & Skov- og Naturstyrelsen. (2002). Danmarks nationale skovprogram. Retrieved March 18, 2021, from https://www.trae.dk/wp-content/uploads/2001/11/danmarks_nationale_skovprogram.pdf

Ministeriet for Fødevarer, L. og F. (2013). Danskerne kender det røde Ø-mærke og har tillid til det. Retrieved April 27, 2021, from https://lbst.dk/nyheder/nyhed/nyhed/danskerne-kender-det-roede-oe-maerke-og-har-tillid-til-det/

Mordor Intelligence LLP. (2020). Vertical Farming Market - Growth, Trends, and Forecast (2020 - 2025). Retrieved April 1, 2021, from https://www.reportlinker.com/p05976765/Vertical-Farming-Market-Growth-Trends-and-Forecast.html?utm_source=GNW

National Geographic. (2014). Staple Food Crops of the World. Retrieved March 18, 2021, from National Geographic website: https://www.nationalgeographic.org/maps/wbt-staple-food-crops-world/

Nextfood. (n.d.). Building and operating your vertical farm. Retrieved March 17, 2021, from https://nextfood.co/

Nielsen, N. A. (2021). *'Vertical farming ' viser potentiale: Skal fremtidens grøntsager dyrkes i højhuse?* 1–21.

Nord-Larsen, T., Johannsen, V. K., Riis-Nielsen, T., Thomsen, I. M., & Jørgensen, B. B. (2020). Skovstatistik 2018; Forest statistics 2018. Retrieved from https://static-curis.ku.dk/portal/files/237702036/Skovstatistik_2018_2_udgave_web.pdf

Nordic Harvest. (n.d.-a). Fordelene. Retrieved April 26, 2021, from https://www.nordicharvest.com/saadangoervi/fordelene-ved-den-vertikale-farm

Nordic Harvest. (n.d.-b). Om os/Visionen. Retrieved February 25, 2021, from https://www.nordicharvest.com/om/visionen

Nordic Harvest. (n.d.-c). Produkter. Retrieved March 3, 2021, from https://www.nordicharvest.com/produkter/alle

Nordic Harvest. (n.d.-d). Vi vil gøre det indlysende at spise bæredygtigt. Retrieved May 4, 2021, from https://www.nordicharvest.com

Nordic Harvest. (n.d.-e). Vores produktion. Retrieved April 29, 2021, from https://www.nordicharvest.com/saadangoervi/produktionen

Nordic Harvest. (2020). Danske Nordic Harvest rejser 62 mio. kr. til en af Europas største vertikale farme. Retrieved February 23, 2021, from https://www.nordicharvest.com/nyt/danske-nordic-harvest-rejser-62-mio-kr-til-en-af-europas-storste-vertikale-farme

Nordic Harvest. (2021). Bæredygtigt grønt fra Nordic Harvest. Retrieved April 17, 2021, from https://assets.website-files.com/5f4cc8f5f40a6418fab4b108/60757e5ef88583b066c16ff5_NordicHarvestPixiBogOpslag.pdf

Oda, S. (2019). Are Indoor Vertical Farms the Future of Agriculture? Retrieved April 15, 2021, from TED Talks website: https://www.ted.com/talks/stuart_oda_are_indoor_vertical_farms_the_future_of_agriculture

OECD. (2019). Measuring Distance to the SDG Targets – Denmark. https://doi.org/10.1787/d9333a95-en

Økologisk Landsforening. (n.d.). OM OS. Retrieved April 27, 2021, from https://okologi.dk/om-os/

Orsini, F. (2020). Sustainable Use of Resources in Indoor Farms with Artificial Lighting. Retrieved March 18, 2021, from Vertical Farming in a Nordic Context website: https://video.ku.dk/secret/65324717/74b3d1dd21d2716b62fd9460faf3fbe0

Pearce, F. (2017). Return of the Trees: How Restoring Natural Forests Can Stem Climate Change and Revive Rural Communities. Retrieved May 2, 2021, from https://www.fern.org/fileadmin/uploads/fern/Documents/Fern - Return of the Trees.pdf

Pisano, G. P. (2015). You Need an Innovation Strategy. *Harvard Business Review*, (June).

PowerHouse Hydroponics. (2018). Vertical Farming Mitigates Food Safety Concerns. Retrieved March 17, 2021, from Sustainable Solutions for Food Security website: https://www.powerhousehydroponics.com/vertical-farming-mitigates-food-safety-concerns/

Rapp, E.-A. R., Marcelis, L., Ebrahimnejad, R., & Fabricius, A. E. (2020). Roundtable Discussion. Retrieved March 18, 2021, from Vertical Farming in a Nordic Context website: https://plen.ku.dk/arrangementer/2020/vertical-farming-in-a-nordic-context/

Ravn, M. (2013). Kvalitativ undersøgelse af økologi i offentlige køkkener: Fra beslutning til praksis. Retrieved April 28, 2021, from https://www.foedevarestyrelsen.dk/Publikationer/Alle publikationer/2013001.pdf?Indgang=Kontrol&Indgangsemne=Lister+over+autoriserede+og+r

egistrerede+virksomheder&

Riemann, A. (2020). Opportunities and Challenges Ahead When Building Vertical Farms in the Nordic Countries. Retrieved March 18, 2021, from Vertical Farming in a Nordic Context website: https://video.ku.dk/secret/65324941/09b829415d72a9decd487162ac751154

Roberts, C. (2020). Stop Eating Pesticides. Retrieved from https://www.consumerreports.org/pesticides-in-food/stop-eating-pesticides/

Rogers, P. P., Jalal, K. F., & Boyd, J. A. (2012). *An Introduction to Sustainable Development*. Earthscan.

Rozinga, G. (2017). The Rise of Vertical Farming. Retrieved May 15, 2021, from VPRO Documentary website: https://conservationfilmfest.org/the-rise-of-vertical-farming/

Salling Group. (2021). Nordic Harvest og Salling Group lancerer vertikale salater og krydderurter i føtex og Bilka over hele Danmark. Retrieved April 26, 2021, from https://sallinggroup.com/kontakt/presse/pressemeddelelser/nordic-harvest-og-salling-group-lancerer-vertikale-salater-og-krydderurter-i-foetex-og-bilka-over-hele-danmark/

Samson, J. (2019). Dansk landbrug | faktalink. Retrieved April 2, 2021, from https://faktalink.dk/dansk-landbrug

Saunders, M. N. (2019). *Research Methods for Business Students* (8th ed.). Harlow: Pearson Education Limited.

Seges. (n.d.). Future Farming. https://doi.org/10.1111/j.1949-8594.1980.tb09693.x

Shenkar, O. (2010). Imitation Is More Valuable Than Innovation. *Harvard Business Review*, (April).

Simply Hydroponics. (n.d.). What is hydroponics? Retrieved March 18, 2021, from https://www.simplyhydro.com/whatis/

Statsministeret. (2021). Mette Frederiksens nytårstale 1. januar 2021. Retrieved May 8, 2021, from https://www.stm.dk/statsministeren/nytaarstaler-siden-1940/mette-frederiksens-nytaarstale-1-januar-2021/

Strandfelt, M. (2021). Vertikalt landbrug kan ikke få EU-støtte: - Man burde få støtte for at fylde så lidt som mulig. Retrieved April 26, 2021, from Effektivt Landbrug website: https://effektivtlandbrug.landbrugnet.dk/artikler/cap-i-danmark/64463/vertikalt-landbrug-kan-ikke-faa-landbrugsstoette-ulogisk-at-man-faar-stoette-fo.aspx

Sustainable Development Report. (2020a). Country Profile: Denmark. Retrieved March 20, 2021, from https://dashboards.sdgindex.org/profiles/DNK

Sustainable Development Report. (2020b). Country Profile: Denmark.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, *15*(6), 285–305. https://doi.org/10.1142/9789812833181_0005

The B1M. (2019). Growing Up: How Vertical Farming Works. Retrieved April 15, 2021, from Youtube website: https://www.youtube.com/watch?v=QT4TWbPLrN8

U.S. Environmental Protection Agency. (2020). Basic Information about Nonpoint Source (NPS) Pollution. Retrieved March 10, 2021, from https://www.epa.gov/nps/basic-information-about-nonpoint-source-nps-pollution

United Nations. (n.d.). The 17 Goals. Retrieved March 20, 2021, from https://sdgs.un.org/goals

United Nations. (2015a). Goal 12: Ensure Sustainable Consumption and Production Patterns. https://doi.org/10.18356/4bd7f86c-en

United Nations. (2015b). Goal 13: Take Urgent Action to Combat Climate Change and its Impacts. https://doi.org/10.18356/0ab994c7-en

United Nations. (2015c). Goal 2: End Hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture. https://doi.org/10.18356/5940d90a-en

United Nations. (2015d). Goal 9: Build Resilient Infrastructure, Promote inclusive and sustainable industrialization and foster innovation. Retrieved May 3, 2021, from UN Chronicle website: https://sdgs.un.org/goals/goal9

United Nations. (2019). Growing at a slower pace, world population is expected to reach 9.7 billion in 2050 and could peak at nearly 11 billion around 2100. Retrieved from United Nations - Department of Economic and Social Affairs website: https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html

University of Copenhagen. (2020). Book of Abstracts: Vertical Farming in a Nordic Context (F. N. Mikkelsen, K. H. Laursen, & A. L. Christensen, Eds.). Retrieved March 18, 2021, from Vertical Farming in a Nordic Context website: https://plen.ku.dk/arrangementer/2020/vertical-farming-in-a-nordic-context/

Vækstfonden. (2020). Danske Nordic Harvest rejser 62 mio. kr. til en af Europas største vertikale farme. Retrieved from https://vf.dk/nyheder/2020/danske-nordic-harvest-rejser-62-mio-kr-til-en-af-europas-stoerste-vertikale-farme/

Vandetsvej.dk. (n.d.). Faglig viden: Vandforbrug i landbruget. Retrieved March 18, 2021, from https://vandetsvej.dk/faglig-viden/vandforbrug/noerdviden/vandforbrug-landbruget

Vesterbæk, P., Preus, N., & Logo-Koefoed, C. (2020). Analyse af danskernes syn på klima og bæredygtighed. Retrieved from Landbrug Fødevarer website: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwid4LHi-83wAhWzD2MBHTrgB6MQFjABegQIBRAD&url=https%3A%2F%2Flf.dk%2Ftal-og-analyser%2Fforbrugere-og-trends%2F2020%2Fdanskernes-syn-paa-klima&usg=AOvVaw1dolbQjH0ya1TjtJ2hmuIw

Voxmeter. (n.d.). Voxmeter: Full service analyseinstitut. Retrieved April 1, 2021, from https://voxmeter.dk

Yamada, M., & Stober, K. (2020). Adoption of Light-Emitting Diodes in Common Lighting Applications. Retrieved March 11, 2021, from U.S. Department of Energy Report website: https://www.energy.gov/sites/prod/files/2020/09/f78/ssl-led-adoption-aug2020.pdf

Yang, M., Vladimirova, D., & Evans, S. (2017). Creating and Capturing Value Through Sustainability: The Sustainable Value Analysis Tool - A new tool helps companies discover opportunities to create and capture value through sustainability. *Research Technology*

Management, *60*(3), 30–39. https://doi.org/10.1080/08956308.2017.1301001

YesHealth Group. (n.d.). Our Vision. Retrieved April 26, 2021, from https://www.yeshealthgroup.com/

YouTube. (n.d.). YouTube About. Retrieved April 12, 2021, from https://www.youtube.com/intl/dk/about/