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Business Model Innovation Associated with Vertical Farming in Sweden

– case study of Swegreen

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Georgi Kassar

Abstract

The pressure on the food supply chain caused by increasing urbanization across the world is a concern. The purpose of this study is to develop understanding of how business model innovation is used with the introduction of a new production technology in the Swedish agri-food sector focusing on the vertical farming. Using an in-depth interview method, a single case study analysis has enabled an in-depth understanding of the business model and how business model innovation can enhance the agri-food sector. Innovating in the vertical farm's business model, can make this sector more attractive to the investors and help in solving many food supplies challenges. This study answered the question regarding the relationship between business model innovation and success in the vertical farming sector. Further studies are needed to establish a better understanding of the phenomena, and more case studies would enrich the findings and enhance transferability.

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1 Introduction

This chapter lays out the background for the chosen topic and illustrates the problems that have emerged. It describes the relevance of the study to the research field, the aim, the research questions, and the study delimitations.

1.1 Background

Although there is no unanimous consent about the business model definition among scholars (Zott *et al.* 2011), many authors attempt to define business model as a collection of components that demonstrate business logic. Every business model consists of a variety of interrelated building blocks that shape different combinations that can be used to determine shift choices (Osterwalder *et al.* 2005; Teece 2010; Ulvenblad *et al.* 2018). Therefore, it is difficult to change the design once the framework is created, the activities are in position, and the resources have been built and optimized, because of a natural resistance to change (Zott & Amit 2010). Business model is also the consequence of a firm's activities and the justification of how to create and capture value from this system of activities. This system of activities consists of arrangements that lead to create and deliver value to the customers while still allowing the firm to capture some of this created value (Zott & Amit 2010; Zott *et al.* 2011).

An important task of the business models is to commercialize the technology used in firms, since the economic value of the technology remains hidden until it is commercialized in some way via a business model (Chesbrough 2010). Therefore, decision makers, when deciding the business model for such business, need to expand their perspective and be innovative in order to find the appropriate business model that can lead the firm to capture value from the technology. Furthermore, business managers should decide how to exploit the technology via a business model that can yield the best return (Chesbrough 2010). However, the creation of the business model is a critical decision for an entrepreneur who starts a new firm, and even more challenging for the managers, in an established firm, to revise their old business model in order to render their firm suitable for the future (Zott & Amit 2010). This is because business models are often shown statically as canvases, as discussed by Osterwalder et al. (2005).

In an ever-changing global landscape, a static form of Business Model is not sufficient to keep competitive advantages. Therefore, it is crucial for the firms to pursue business model innovation (BMI) as a tool to reach a competitive advantage by providing a greater focus on all activities of the business architecture of a firm, not only undertake changes in the value propositions (Bocken *et al.* 2014). Although there is a paucity of literature regarding the exact description of the term business model innovation (BMI), is commonly interpreted as the development of a new business model, based on the extent of novelty; which can be a complete re-invention or partial adaptation (Cucculelli & Bettinelli 2015; Khanagha, Volberda & Oshri 2014; Teece 2010; Mitchell & Coles 2003 see Behnke & Kibbel 2017).

1.2 Problem Background

According to the United Nations Population Division (UNPD), in 2008, half of the world population was expected to live in the urban areas, and by 2050 the number is expected to increase to 70% (*United Nations Population Division | Department of Economic and Social Affairs*). Increasing growth in the urban areas has created several problems such as

environmental pollution, waste disposal, climate change, poorer health and poverty, whereas providing food is fundamental for life and becomes a challenge for cities (FAO 2011). A recent report from the United Nations Food and Agriculture Organization (FAO) on the future growth of the world population, suggest that by 2050, globally, the arable land per person will decrease to one-third of the available amount in 1970; this resultant global problem of land availability occurs due to a long-term decline of agricultural land per person (FAO 2016 see Benke & Tomkins 2017). This decrease is predicted to continue due to the effects of climate change, the increase of the drylands, the reduction in freshwater supply and the growth of the population (Fedoroff 2015 see Benke & Tomkins 2017).

Guaranteeing a sustainable food supply for the world's growing population is a crucial challenge in which the food industry is one of the essential areas that requires action (EUFIC 2015). It is therefore imperative for world food security to find solutions for sustainable agricultural industry to ensure provision of sufficient food to feed the world's population. Whereas, the agri-food sector is defined by the EC (2007) as the combination of the agricultural and food industry. This sector represents 9% of total employment and 4.3% of GDP in the European Union (EU), which makes it an essential part of the European Union economy (Tell *et al.* 2016).

1.2.1 Vertical Farming As One Solution

According to the European Food Information Council (EUFIC), one solution to creating a more sustainable food system is to introduce vertical farming in the urban areas, which offers a complementary system to conventional farming in rural areas with more sustainable aspects (EUFIC 2018).

Vertical farming is a system where plants are grown in a controlled environment where all factors such as temperature, lighting, nutrients, irrigation and air circulation are monitored and controlled (Pandey *et al.* 2009). In other words, vertical farming can be considered as a new technology in the agri-food sector, hence successfully commercializing for this new technology require firms to innovate in their business models over time.

The main critic to vertical farming is the large amount of energy needed to produce the crops (Pandey *et al.* 2009; EUFIC 2018). However, vertical farming has many advantages in reducing the use of water and land, reducing waste and carbon dioxide emissions, decreased use of pesticides, and plants can grow in any climate, compared to the conventional agriculture (Pandey *et al.* 2009). Additionally, since vertical farming systems can operate anywhere such as rural and urban areas, the dependence on transport from rural areas will be less in some parts of the food systems in cities (EUFIC 2018). This in turn will reduce food waste, some of the fuel emissions and the time between harvesting and consuming (EUFIC 2018).

1.2.2 The importance of the problem

Previous research shows a growing interest since the mid-1990s in employing business models as well as business model innovation as descriptive and analytical structures by both academics and practitioners (Tell *et al.* 2016). Furthermore, a growing amount of research evidence articulates that business models and business model innovation are seen as significant to companies' competitiveness, renewal, and growth (e.g. Chesbrough & Rosenblom 2002; Lambert & Davidson 2013; Teece 2010 see Tell *et al.* 2016). This importance is also true in the agri-food sector, in particular due to the various global challenges currently facing the industry (Ulvenblad *et al.* 2018). The agri-food firms have an

opportunity to commercialize the new production technology and increase their competitive advantage with business model innovation. However, since the business model innovation process is complex, applying new business models also entails a high level of risk and possible failure to the firms. Therefore, there is a need to increase the understanding of the business model innovation process and application for researchers and in particular company managers (Ulvenblad *et al.* 2018).

It is worth noting that most of the earlier studies on business models and business model innovation focuses on the media, information technology and biotechnology sectors (Lambert & Davidson 2013). There is limited research on business model and business model innovation in the agri-food sector as discussed by Tell et al. (2016), who list several research gaps in the business model innovation literature, drawing particular attention to the research gap in the agri-food sector (Tell *et al.* 2016).

In this context, the Swedish agricultural industry needs to focus on sustainable business growth in order to meet the demands of a globalized and rapidly changing environment on the one hand and the ethical responsibilities on the other hand (Tell *et al.* 2016). The two are inextricably linked and represent the challenges for the sector.

Therefore, this study aims to develop understanding of how Business Model Innovation is used with the introduction of a new production technology in the Swedish agri-food sector focusing on the vertical farming. It is possible that through innovating in the business model for vertical farming, the organization can develop productivity solutions yet address previously acknowledged challenges. Considering this body of research on the significance and need of business model innovation, this thesis represents an opportunity to address this topic more extensively as applied to the agri-food sector. A case study of a vertical farm in Sweden called Swegreen will be conducted in this study to enables an opportunity to explore the business model innovation in depth, as discussed below.

1.3 Aim and Research Questions

This study aims to develop understanding of how business model innovation is used with the introduction of a new production technology by answering the following questions.

1) What is the business model of a vertical farming venture?
2) How has the firm innovated its business model in response to challenges and opportunities arising from the vertical farming technology?

1.4 Delimitation

This study is situated in the field of business administration and is conducted using a single case study approach. The main focus will be on the Stockholm based company which undertakes vertical farming. The study is framed by the business model applied within the company, the challenges and opportunities arise from the new production technology and the innovation in the business model as a response for the challenges and opportunities.
The research considers the challenges facing vertical farming and the business model innovations, as stated in the literature, to assess how the company deals with any challenges through innovating the business model. The study will not include the production process or any other technical details since the main focus will be on analyzing the business model and

how value is created. Finally, the findings will be related to the existing literature and the findings will add depth and context that enrich the study field and may have transferability but will not have generalizability due to the methodology used.

Unit of analysis

The unit of analysis is the vertical farm "Swegreen" and the main analysis will be on the company's business model.

1.5 Outline

The outline of this study is presented below in Figure 1. The purpose of the outline is to develop a clear view of the structure of the study for the reader. It includes the chapters' numbers and the title of the heading for each chapter. As the study starts with an introductory chapter where the background of the problem, the aim and research questions, and the delimitations of the study are presented. The second chapter explains the method approached in this study to reach the aim. The third chapter includes a literature review. The fourth chapter includes an empirical background of the studied company. Followed by the fifth chapter which is analysing the data collected to get findings that help to address the research questions. The sixth chapter is a discussion to compare the findings from the analysis and what found in the literature. The seventh chapter is concluding the study with the final results, the recommendation for future study and limitations of this study.

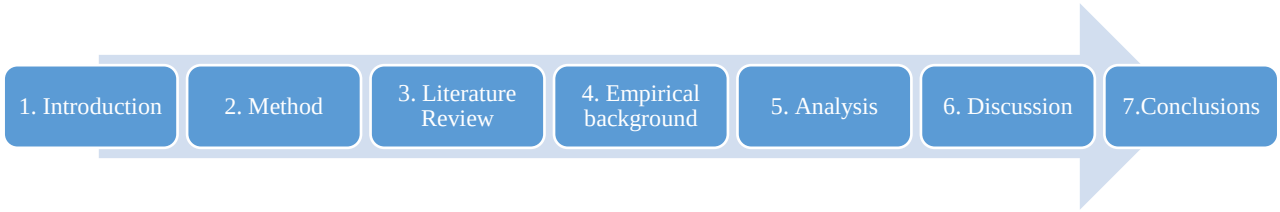

Figure 1: Outline of the study. (Own processing)

2 Method

This chapter presents the method that is used in this study to achieve the study aim. The chapter includes the following headings: research approach, literature review, case study, semi-structured interview, data analysis, and ethical and quality assurance issues. The purpose of figure 2 below is to simplify the methodological key steps that took place during the study and for the reader to have an idea about the method approached in this study.

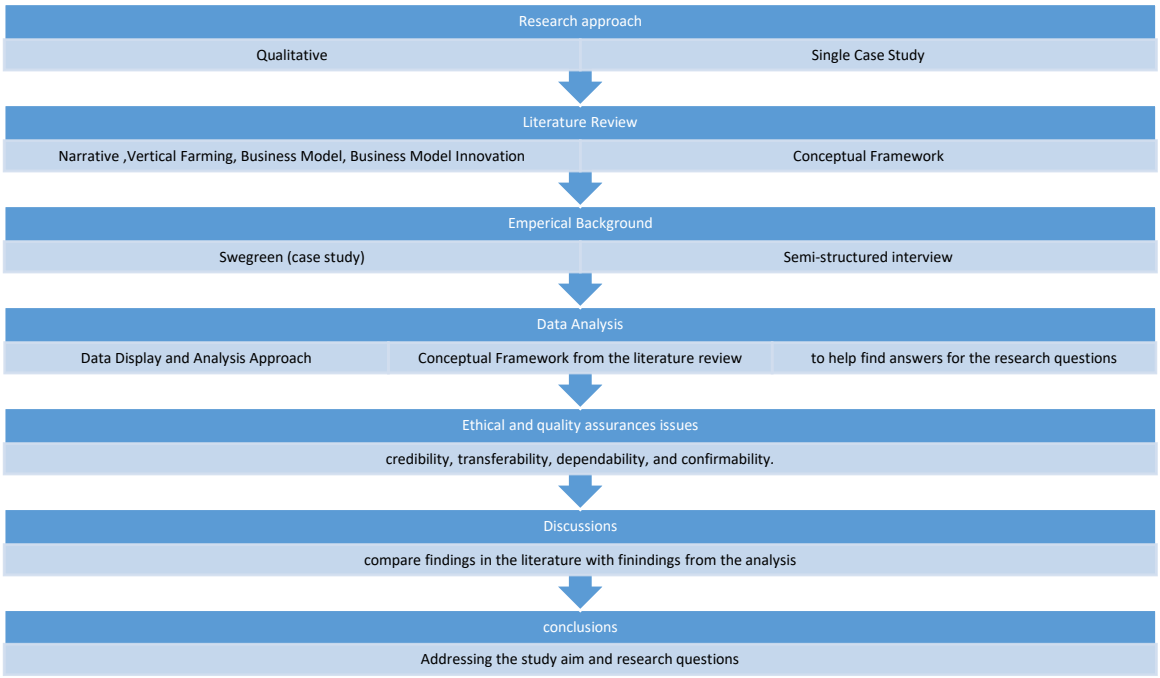

Figure 2: The Method Used in The Study. (own processing)

2.1 Research approach

Therefore, this study aims to develop understanding of how Business Model Innovation is used with the introduction of a new production technology in the Swedish agri-food sector focusing on the vertical farming. A qualitative approach is chosen for this study as the research is concerned with explanation and detailed account of the situation that is being studied (Bryman & Bell 2015). This approach is particularly applicable to understanding the study context and social setting where values and behaviors need to be explored due to the particular environment. There is an opportunity for the researcher, using qualitative methods, to interact with people which enables a comprehensive and deeper understanding of the phenomena under study to be achieved. Some researchers consider this as an advantage of this approach, while others criticize qualitative research arguing that the approach is too subjective and impressionistic since the researcher is highly involved and can affect the credibility of the research (Golafshani 2003).

For this research, where a comprehensive understanding of the phenomenon is needed, the qualitative approach is especially relevant where the approach might be viewed as less structured and where there is space for flexibility. However, employing this flexibility allows for new ideas to be conveyed as data is gathered, which makes it possible to repetitively

review the theoretical approach to build a suitable fit with the overall objective of the study (Robson 2011). Even though this open-ended approach could affect the path of the study, it is not viewed as a limitation, but rather as an opportunity because of its potential for exciting findings to be obtained.

There is a number of arguments about the lack of transparency in the qualitative approach, which might be overcome when there is a clear explanation of the research process. Thus, the probability of mimicking the study's findings is therefore increased, as the research method may be applied more easily for other environments (Bryman & Bell 2015). Furthermore, Bryman and Bell (2015) suggest six process steps for a typical qualitative research study. These steps are; (i) general research questions, (ii) selection of relevant sites and subjects, (iii) collection of relevant data, (iv) interpretation of data, (v) conceptual and theoretical framework and (vi) writing up findings and conclusion. The study reported in this thesis uses these steps starting with a research question as its baseline which has emerged from an analysis of existing literature, identifying a research gap (Robson & McCartan 2016). The importance of the research questions is not only to determine the purpose of the research, but it will guide the theoretical framework and the method for gathering and analyzing the data (Robson & McCartan 2016).

According to Bryman and Bell (2015), the qualitative method focuses on words rather than quantity, and emphasizes on an inductive approach in the relationship between the research and the theory, where the highlighting is essentially on generating theories from the research and the collected data (Bryman & Bell 2015). This study seeks to generate theory from the research findings which can be used for further, possibly, quantitative research.
This research considers the social and natural sciences as varied fields in which each of them has specific information generation criteria (Bryman & Bell 2015). Interpretivism is primarily concerned with qualitative study, facilitating deep contact with the respondent and helping the researcher to obtain insight into social behavior.

This study's epistemological approach is interpretivism. Knowledge is constructed through collecting the data, to shape the theory. The epistemology and the methodology of the study have to be consistent, in order to answer the research questions and to meet the objective of the research (Carter & Little 2007).

The ontological position in this study is constructivism, that is, it aims to view social phenomena that are created by the interaction of social actors continually (Bryman & Bell 2015). Researchers who use this ontological position are introducing a particular version of social actuality rather than one that can be viewed as definitive. Constructivism, therefore, claims that there are other subjective realities out there.

2.2 Literature review

The literature review is fundamental to ensuring the researcher is aware of others research in the field, the limitations of the research, any mistakes and enables the researcher to find a research gap which will be the focus of their research questions. Bryman and Bell (2015) classify the literature review into systematic and narrative, and they argue that a narrative literature review may be more suitable for a qualitative approach due to the flexibility of the review. In the same context, Yin (2013) states that a narrative review allows the researcher to discover a new and more in-depth understanding of the studied topic, because it is less rigorous than the systematic review. Worth noting is that the narrative review might easily

turn to be unfocused and more extensive than a systematic one, that should be taken into consideration while doing the review (Yin 2013).

This study adopts a narrative literature review to obtain an idea of the selected topic and to help establish the conceptual framework employed in the study. To find relevant articles, books, and reports in databases such as Primo and Google Scholar, then, Keywords such as "Agri-food sector," "Urban farming," "Vertical farming," "Controlled environmental farming" " Business model," " Business model development" and "Business model innovation" were used for the search. Boolean operators and or were used to narrow the search. The next step was to read the abstracts and sort the articles and find the most relevant ones to the topic and ensure their quality by picking the peer-reviewed and well-cited articles, in order to increase the trustworthiness of the study.

2.3 Case Study

There are five different approaches for qualitative investigation presented by Cresswell (2013) which are; *narrative research, phenomenology, grounded theory, ethnography, and case study.* This study is conducting a single case study since it will investigate only Swegreen's business model.

According to Bryman and Bell (2015), a case study has the opportunity to describe the complexity of a phenomenon and it allows the researcher to explore a specific area through one or many cases within the system's boundaries. The case study can be multiple case studies, or a single case study as argued by Cresswell (2013). Considering the chosen aim, research questions, and the unit of analysis for this research. This study will investigate the case of Swegreen vertical farm as a single case study and analyse its business model to develop understanding of how the company has innovated its business model to commercialize the production technology and to response to the challenges and opportunities that arise from this new technology. Another reason for choosing a single case study is the current situation of the COVID-19 pandemic, where the author attempted to contact more than four companies in the same industry and only Swegreen agreed to dedicate time for the interview. However, most of the respondents were positive about the idea but they had problem with time as it seems the current situation and the pressure on the global supply chain gave an advantage for the local producers and increased their market share, as I got a replay from one of the companies mentioning that they are expanding their farm at the meantime which can be interrupted as the company is in a good position where they need to expand. Moreover, the aim of the study is not to compare different businesses but to highlight crucial insights of vertical farming business model innovation by analysing the business model for the studied company.

2.4 Semi-Structured Interview

There are two major types of qualitative interviews which called structured and semi-structured according to Bryman and Bell (2015). The main difference between the two is that the structured interviews often offer the interviewee a fixed range of answers.

This study conducts a semi-structured interview with The Head of Innovation and Chief Sustainability Officer, Mr. Sepehr Mousavi, in order to gather insights about the company's business model, challenges and opportunities. Semi-structured interview, unlike structured

interview, focuses on the respondent's own perceptions and interpretations, which makes it more flexible and allow to get detailed answers for a comprehensive understanding (Bryman & Bell, 2015). An interview guide was prepared and sent to the interviewee (see Appendix 1), Before the interview was conducted. This guide can be seen as a tool for the researcher since it gives an overview of what are the information needed from the respondent in order to answer the chosen research questions.

2.5 Data Analysis

In this study, after interviewing the research participant and collecting the data, the author transcribed the data in a word document from all the notes and the voice recording of the interview. Then based on the data relevance to the aim and research questions, these data were highlighted carefully in order to be used in the coding process, while the not highlighted data were copied and saved on a different document in case needed later. The next step was to put the highlighted data under three different headings: vertical farming challenges and opportunities, business model, and business model innovation. Afterwards, the selected data were displayed and visualized in different figures in order to recognize relationships and patterns in the data, as well as drawing conclusions and verifying.

According to Saunders et al. (2009), there are two different positions for data analysis in the qualitative approach. The study can start from a deductive position where the researcher will use the existing theory to shape the approach to be adopted in the data analysis or an inductive position where the researcher will seek to build up a theory that is sufficiently based in the research data (Saunders *et al.* 2009). This study has an inductively based analytical position. However, there is a number of inductively based analytical procedures to analyze qualitative data as discussed by Saunders et al. (2009), these are data display and analysis; template analysis; analytic induction; grounded theory; discourse analysis; and narrative analysis.

In the data display and analysis approach, the process of analysis is combined of three concurrent subprocesses, these are data reduction, data display, and drawing and verifying conclusions (Saunders et al. 2009). Data reduction aims to simplify the collected data in order to help in the coding process, while data display aims to transform the reduced data into a visual display to be analyzed, After that and based on the displayed data, the researcher can recognize relationships and patterns in the data, as well as drawing conclusions and verifying them (Saunders et al. 2009). A similar approach is conducted in this study to analyze the data. Although, after data analysis, the compiled data was sent back to the participant for quality assurance before they were presented in the later chapters.

2.6 Ethical and quality assurances issues

Criteria such as validity, reliability, and objectivity are used in the traditional positivist research paradigm to evaluate the quality of the study (Bryman & Bell 2015). The epistemology in this study is interpretive, therefore, the evaluation based on its trustworthiness is more suitable than the reliability and validity, because they are not built on the assumption that there is a single absolute explanation of social reality (Bryman & Bell 2015). Bryman and Bell (2015) argue that there are infinite or several aspects of reality. Trustworthiness is based on four different criteria; *credibility, transferability, dependability, and confirmability.*

2.6.1 Credibility

Bryman and Bell (2015), state that the understanding of social reality is different among members of the social world. Therefore, the presence of credibility in research is essential to ensure that the sources of data, how data analysis was carried out or if there was any relevant information excluded from the study, and the findings and conclusions from the author are accepted by others (Bryman & Bell 2015). This criterion cannot be fulfilled unless the sources of the study agree or have trust in the researcher's interpretation or reestablishments of the results (Gill *et al.* 2018). Credibility is enhanced by the transparency of the reporting of the research process.

2.6.2 Transferability

Transferability determines if the research's findings apply to other contexts (Bryman & Bell 2015). In order to do this, detailed and constant explanations of the social reality under research are expected. This sub-criterion can be challenging to obtain in qualitative research because it requires an intense analysis of individuals with similar characteristics (Bryman & Bell 2015). That was taken into consideration in the collection of the semi-structured interview, to deliver accurate and detailed responses.

2.6.3 Dependability

This criterion requires the researcher to adopt an auditing approach to ensure that a suitable procedure have been followed (Bryman & Bell 2015). This ensures that a full overview of all steps of the research procedure will be accessible such as interview guide, problem formulation, selection of participants in the interviews, interview transcripts and so on. Such decisions will also be reviewed by an external party to determine the consistency of the results and how the choices have been applied. This report will be examined by a variety of external people, such as the opposition group, the supervisor and employees of the selected firm. This paper is therefore reviewed by third parties with diverse viewpoints and experiences, which support its reliability.

2.6.4 Confirmability

Confirmability deals mainly with the researcher's objectivity (Bryman & Bell 2015). Even though, it is almost impossible to ensure complete objectivity, the research was undertaken with the intention of producing findings that were not motivated by a particular bias or an over-inclination to any hypothesis. The author wanted to preserve objectivity when conducting the analysis and thereby ensure confirmability.

2.6.5 Ethical considerations

It is necessary to take ethical issues into account when performing a qualitative analysis because of the nearness between the researchers and the participants (Bryman & Bell 2015). To avoid crucial details from being misunderstood or missing, the interviews should also be recorded. The material would also be transcribed after the interviews and submitted back to the participants to give them the chance to accept the details that would be included in the report. The researcher must also clarify to the respondent that the interview details would be used for this report. To be willing to maintain the dignity of the respondents and to secure their sensitive details in accordance with General Data Protection Regulation (GDPR).

3 Literature review

This chapter starts with a review of literature that describes different perspectives on business model, business model innovation and vertical farming. Thereafter, a conceptual framework is established to be as an instrument to help in the analytical approach for this study.

3.1 Business model

Business model is not clearly defined in literature as well as in business practice (Trimi & Berbegal-Mirabent 2012). As there is a confusion between the use of the term business strategy and business model, it is necessary to distinguish business strategy from business model before studying the business model in detail (Chesbrough & Rosenbloom 2002). A business strategy includes the way the organization will pursue its goals, the risks and opportunities in the environment, and the limitations of its resources and capabilities, thus recognized as competitor and environmental-centric (Nandakumar *et al.* 2010; George & Bock 2011; Pynnönen *et al.* 2012). Business model instead is much broader than business strategy in that it establishes how firms can potentially create value and exploit opportunities (Morris *et al.* 2005). Earlier research suggests that business models represent the sources of new value creation, potential competitive advantage, and act as drivers of firms' performance (Mahadevan 2000; Chesbrough & Rosenbloom 2002; Voelpel *et al.* 2005; Chesbrough 2010). Therefore, business model is acknowledged as opportunity-centric (George & Bock 2011; Zott *et al.* 2011).

3.1.1 Different ways to define the Business Model

As per Osterwalder, Pigneur and Tucci (2005), the research about business model became popular in the late 1990s around the same period as the rise of the internet, which led Osterwalder and colleagues (2005) to conclude that this subject might stay in correlation with technology (Osterwalder *et al.* 2005). However, after more than 17 years of research, the scholars have not yet agreed upon a single and clear concept of the business model (Morris *et al.* 2005; Teece 2010; Zott *et al.* 2011; Schneider & Spieth 2013). This confusion between concepts and the interpretation of the term business model come from the absence of a theoretical basis (Teece 2010). Researchers can observe the concept of business model from different theories, such as the value system, value-chain or strategic position Micheal E. Porter to decide the value creation via a business model, the resource-based view from Jay Barney as a description of how a business model can create a competitive advantage, or transaction costs economics from Oliver E. Williamson to fix a company's boundaries (Barney 1991; Amit & Zott 2001; Morris *et al.* 2005; Osterwalder *et al.* 2005; McGrath 2010; George & Bock 2011; Schneider & Spieth 2013). Therefore, based on their perspective, the researchers choose their explanation of the business model as a structural template (Amit & Zott 2001; Teece 2010; Deshler & Smith 2011; George & Bock 2011), a system (Morris *et al.* 2005; Chesbrough 2007; Zott & Amit 2010; Sorescu *et al.* 2011), a description (Demil & Lecocq 2010; Berglund & Sandström 2013), a framework (Chesbrough & Rosenbloom 2002; Doz & Kosonen 2010) or a conceptual tool (Osterwalder *et al.* 2005). However, most definitions show that the business model illustrates how firms do their business in order to capture value from their offering.
Table 1, below, is an overview of selected definitions of business model based on the concept chosen by the authors.

Table 1: An Overview of Selected Definitions of Business Model (own processing)

Author	Concept	Definition
Teece (2010)	Structural template	"a business model defines how the enterprise creates and delivers value to customers, and then converts payments received to profits"
Zott & Amit (2010)	System	"business model as a system of interdependent activities that transcends the focal firm and spans its boundaries"
Demil & Lecocq (2010)	Description	"the description of the articulation between different BM components or 'building blocks' to produce a proposition that can generate value for consumers and thus for the organization"
Doz & Kosonen (2010)	Framework	"business models stand as cognitive structures providing a theory of how to set boundaries to the firm, of how to create value, and how to organise its internal structure and governance"
Osterwalder, Pigneur & Tucci (2005)	Conceptual tool	"A business model is a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm. Therefore, we must consider which concepts and relationships allow a simplified description and representation of what value is provided to customers, how this is done and with which financial consequences."

Moreover, looking at the business model as a system of interdependent activities that allows the firm and its stakeholders to create and capture value, is gaining increasing support among literature and scholars (Zott & Amit 2010; Zott *et al.* 2011). The activity system perspective allows the managers when designing the business model to project the firm as a whole unit and thereby get the overall design right, rather than focusing on optimizing details (Ackoff 1994; Zott & Amit 2010). This holistic view of the firm is essential to create the intended fit between the value proposition and the customer need to obtain a sustainable competitive advantage (Chesbrough 2007; Demil & Lecocq 2010; Teece 2010).

3.1.2 Business Model Task

In firms, one of the main tasks of the business model is to commercialize the technology in a way that allows the firm to capture the highest possible value from this technology (Chesbrough & Rosenbloom 2002; Chesbrough 2007, 2010; Teece 2010; George & Bock 2011; Zott *et al.* 2011). In other words, the business model of a firm creates a clear link between technology or innovation, and value creation. This commercialization of the technology or innovation to create economic value out of it, is significant for firms, as recent research has recognized that to create a competitive advantage for a firm is not about technology anymore, but about the chosen business model that ensures the aforementioned fit between the value proposition and the customer demand (Chesbrough & Rosenbloom 2002; Morris *et al.* 2005; Chesbrough 2007; Teece 2010).

In this context, further studies provide evidence about the positive relationship between the applied business model and the company performance (Demil & Lecocq 2010). For instance, Trimi and Berbegal-Mirabent (2012) find out that a suitable business model that maintains the fit between a company's value proposition and consumer demand has enhancing effects on the overall company's performance. Furthermore, by applying a business model that creates the

mentioned fit might also give the firm a competitive advantage that differentiates the firm from its competitors and enhance its strategic position in the market (Deshler & Smith 2011; Pynnönen *et al.* 2012). However, due to the misconception and misuse of the term business model, it cannot be considered as a holistic solution for the firm success, since it does not cover certain important strategic aspects such as "industry's structural attractiveness", "contextual opportunities and threats", "competitors' strengths and weaknesses" (Ghezzi 2014). Therefore, it would be advisable to accompany the use of a business model with other strategic planning and analytical tools in order to ensure success (Ghezzi 2014).

3.1.3 Business Model Components

To get a deeper understanding of the term business model and its applicability in the competitiveness of the firms, the research literature focuses on identifying the components, understanding the configuration of the components and the emerging typologies of the business model, which can help to build the core logic of the business of a firm (Goyal *et al.* 2017). The business model structure involves, or is related to, the strategic components of the choice of customer segments, customer relationship and choice of offerings (Mitchell & Bruckner 2004; Voelpel † *et al.* 2004; Morris *et al.* 2005; Shafer *et al.* 2005; Teece 2010).

Doganova and Eyquem-Renault (2009) argue that there are three main building blocks comprise the business model components framework (Doganova & Eyquem-Renault 2009). These include value proposition, which relates to how the firm design its value offering to the chosen market segment (Magretta 2002). Value chain, which focuses on the partners, customers, suppliers and other actors in the value chain to determine the best channels for delivering the value created by the offering (Timmers 1998; Weill & Vitale 2001; Hedman & Kalling 2003). Revenue model, which focuses on how the business model makes explicit how the firm gain its revenue from the given value proposition and value chain by estimating the cost structure and potential profit (Weill & Vitale 2001; Magretta 2002).

The business model literature popularizes that the architecture and execution of the business model involves the configuration of essential operational and economic elements, along with value creation, value delivery and value capture (Chesbrough & Rosenbloom 2002; Magretta 2002; Osterwalder *et al.* 2005; Seelos & Mair 2007; Hwang & Christensen 2008; Baden-Fuller & Morgan 2010; Demil & Lecocq 2010; Prahalad & Mashelkar 2010; Teece 2010; Zott & Amit 2010). It is noticed that the majority of the research literature does not reflect on the importance of the type of organization structure, the type of leadership, and their significant role in the business model implementation in studying the business model components (Voelpel † *et al.* 2004; Demil & Lecocq 2010; Teece 2010; Goyal *et al.* 2017).

3.1.4 The Static and Dynamic View of the Business Model

The business model is viewed in literature from two different perspectives, the static view examines the business model as an arrangement that determines the offering choices for the potential superior performance for the firm (Demil & Lecocq 2010). In contrast to this, the dynamic view aims to understand the attitude in which a business model develops over time (Demil & Lecocq 2010). To maintain a sustainable competitive advantage, it is the firm's responsibility to strive for business model innovation (Chesbrough & Rosenbloom 2002; Teece 2010; Trimi & Berbegal-Mirabent 2012). Whereas, the static and the dynamic view of the business model complement each other to enable firms to ensure the improvement in the

business models (Demil & Lecocq 2010; Sorescu *et al.* 2011). Teece (2010) supports the dynamic view and drew the attention on the necessity for further development of the business model as it can be imitated by competitors over time. Figure 3 is to summarize the findings from literature about business model.

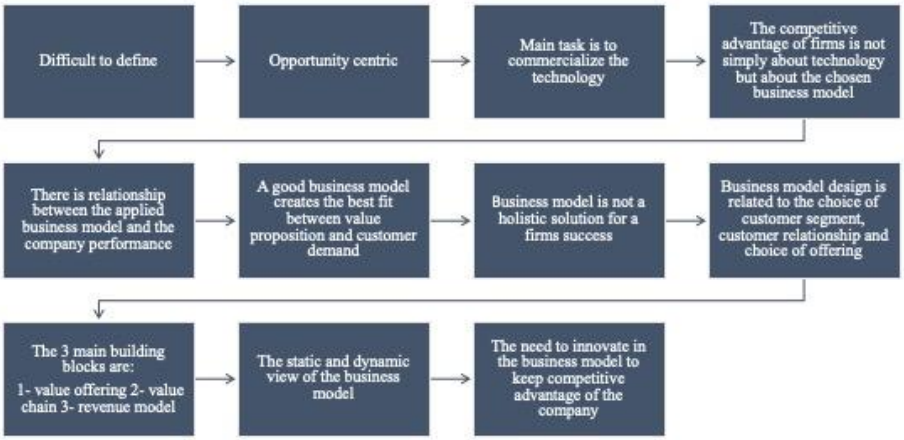

Figure 3: Business model from the literature (own processing)

3.2 Business Model Innovation

The changes in the external environment and expanding insertion of advanced technologies are reshaping the competitive and financial landscape for the companies. These dynamic circumstances are heading the research to focus on analyzing the concept of business model innovation (Goyal *et al.* 2017). There is a recognition that business model is related to the constraining and enabling change factors in the external environment, therefore business model is not a static aspect and needs to be developed and reinvented continuously (Voelpel † *et al.* 2004). The capability of the firms to modify their business models according to the changes in the environment in terms of customer, technology, competition, and macroeconomic trends, leads to the success of the business model innovation (Voelpel † *et al.* 2004).

The main research topics within business model innovation contain drivers and challenges for business model innovation; threat and effect of imitation; impact on incumbent companies and new companies; incremental versus disruptive innovation, single or hybrid business models, and role of strategy and process workflows (Goyal *et al.* 2017).

3.2.1 Definitions of Business Model Innovation

Business model innovation includes redefining the rules of the game of the industry by detecting new gaps regarding customer demand, customer segments, value creation and value delivery, and fulfill this gap to create new markets (Markides 1997). Chesbrough and Rosenbloom (2002)

describe business model innovation as an essential tool that connects between technical and economic domains in the firm when commercializing a new technology. Mitchell and Coles (2003) correlate the firm's performance with business model innovation. They define the business model innovation as an ongoing process that requires managers to improve the business model continuously by raising questions related to the offering, delivery, and revenue flow. Markides (2006) argues that business model innovation might increase the company's market share, either by attracting new customers segment or by encouraging the customers to consume more (Markides 2006). However, from a system design perspective, business model innovation needs to focus on system level design to ensure a high level of interdependency within business model components (Morris 2009; Zott & Amit 2010). The aim of business model innovation is to lead the firm to sustainability and non-imitability; therefore, it should be fulfilling specific customer demand and be hard to adopt by competitors either by having strong intellectual protection or strong relationship with customers or organization dynamics (Teece 2010).

3.2.2 Sources and Stages of Innovating In The Business Model

Trimi and Berbegal-Mirabent (2012) argue that innovation in the business model can be demonstrated in three ways. Firstly, the company's business model itself can be the source to innovate, by modifying one or more of the elements and capturing higher value without changing the main product or service. Secondly, newly presented technology to the firm might cause a change in the business model in order to integrate the technology in the firm's business model and enhance the value capture of the technology. Thirdly, the change in the customers' demand might initiate modification in the business model to meet these changes (Trimi & Berbegal-Mirabent 2012). As innovations in products and services can vary from incremental to radical (Stringer 2000), also innovation in business model has its own scale. Khanagha, et al. (2014) identified three different stages: incremental evolution which can be integrated into the structure, direct transformation which can be integrated or in separate structure with a strong linkage between them, and radical replacement which is totally a separate structure of the business model (Khanagha *et al.* 2014). Figure 4 is to summarize the findings from literature about business model innovation.

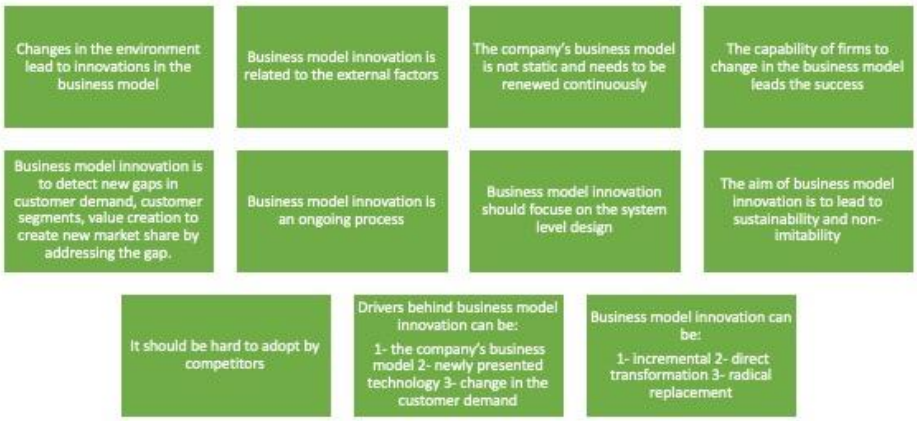

Figure 4: Business model Innovation in the literature (own processing)

3.3 Vertical Farming

This study is focusing primarily on the business model innovation for vertical farming therefore it is important first to distinguish between urban farming and vertical farming. Urban farms, referred to as outdoor farming, depends on soil, and located within the urban boundaries. Urban farms produce food within the urban boundaries to be primarily consumed in urban areas (FAO 2011). Vertical farming is a way of transforming traditional agricultural food production from a rural field-based state into new urban areas by growing plants without soil, in a closed environment, using a mineral nutrient solution (Pandey *et al.* 2009). This farming method allows for year-round production based on controlled growing conditions. These farms are situated close to, or beyond, urban areas, yet the vertical farm may be established anywhere, such as urban or rural areas, irrespective of outdoor conditions. The major requirement is water and energy availability (Despommier 2013; Benis & Ferrão 2017).

3.3.1 Vertical Farming challenges and opportunities

Vertical farming became an important theme in the 2000s literature in which scholars discussed the positive and negative aspects of this system and the feasibility to transform it into business opportunities (Despommier 2013; Cox 2016; Graamans *et al.* 2018; Pinstrup-Andersen 2018; Romeo *et al.* 2018). Many authors high-light the negative aspects of conventional agricultural in terms of resource use and pollution in order to present vertical farming as an opportunity to respond to these specific challenges (Benis & Ferrão 2017; Graamans *et al.* 2018; Pinstrup-Andersen 2018).

Benis and Ferrão (2017) report that agriculture occupies approximately 40% of arable land worldwide, creating a large part of the water pollution, and generating a huge amount of greenhouse gas emissions into the environment (Benis & Ferrão 2017). The same point was also stated by Cederberg et al. (2019) highlighting how the continuous expansion of agricultural land lead to increases in biodiversity loss and the pollution of water and air because of the extensive use for fertilizers and other chemicals to enhance production (Cederberg *et al.* 2019). In addition, the food supply chain is long, since food production takes place in the rural areas and the consumption is mainly in the urban areas, which leads to more food waste and long transportation channels for the goods and thus more emissions (Benis & Ferrão 2017). Vertical farming responds perfectly to these challenges as discussed by a number of authors (Benis & Ferrão 2017; Pinstrup-Andersen 2018; Romeo *et al.* 2018; Weidner *et al.* 2019). Solutions such as moving production closer to cities so consumers can access locally grown food on the one hand yet will alleviate significantly the burden on soil and water on the other hand (Benis & Ferrão 2017; Pinstrup-Andersen 2018). Moreover, that will shorten the supply chain, and cities will obtain a certain level of self-sufficiency by reducing the need for the transported food (Benis & Ferrão 2017; Weidner *et al.* 2019). This can add value to vertical farming since it will be a good source for local food with less impact on the environment (Romeo *et al.* 2018).

Despite all the benefits of vertical farming, many scholars discussed the challenges associated with indoor food production. One important challenge, that was highly discussed in the literature, is the high demand for energy required for lighting and regulating the heat temperature (Ehrenberg 2008; Al-Chalabi 2015; Cox 2016; Chance *et al.* 2018; Graamans *et al.* 2018; Pinstrup-Andersen 2018; Romeo *et al.* 2018). In its defense, many authors highlight that the energy efficiency in vertical farms is generally higher than the greenhouse production systems (Graamans *et al.* 2018). In addition, advanced technology and the use of renewable energy sources might increase the energy efficiency. Therefore, vertical farming will have

better environmental performance, be more competitive and present new opportunities in the future (Al-Chalabi 2015; Pinstrup-Andersen 2018; Romeo *et al.* 2018). Noticeably, indoor farming will always depend on electricity and support from the industry (Cox 2016).

Another limitation of vertical farming is the typology of plants it permits to cultivate as discussed in Cox (2016), Chance *et al.* (2018) and Pinstrup-Andersen (2018). Whereas, vertical farming focus on leafy greens or herbs due to improve profitability, since the most of the plant's weight may be marketed and consumed, while certain other plants have stalks, leaves or roots that are inedible, which creates a loss in some of the resources that has been used to grow the plant; hence this situation limits the range of crop species suitable for vertical farming (Cox 2016) see also Pinstrup-Andersen (2018) and Chance et al. (2018). This challenge illustrates the significance of combining traditional and indoor farming, as certain crops are not suitable for cultivation within urban areas or indoors.

Another obstacle is high competition between the different sectors such as agriculture, industrial, and residential on the required resources, especially land, energy, and water, which makes it difficult for food production in urban areas (Ehrenberg 2008; Mok *et al.* 2014).

An important challenge that has been discussed in the literature is the price premium required to make the production in vertical farming profitable which might narrow the customers' segment to the elite market and deprive low-income customers of the benefits of fresh and local food (Cox 2016; Pinstrup-Andersen 2018).

The consumer perception of vertical farming and its products is another obstacle facing its commercialization (Pandey *et al.* 2009; Al-Chalabi 2015; Pinstrup-Andersen 2018). This was discussed by Al-Chalabi (2015) who noted the lack of knowledge of vertical farming. Customers consider the product as not natural and believe that chemicals are used to grow plants in such a system. While the method is to grow plants without soil, using mineral nutrients and water without chemicals (Pandey *et al.* 2009). On the other hand, when customers measured the similarities between the lettuce produced in the open field, the greenhouse, and the vertical farm, they were unable to discern the variations, but they remained doubtful regarding the naturality of the vertical farm’s lettuce (Pinstrup-Andersen 2018).

Despite the previously mentioned challenges regarding vertical farming, there is an agreement to investigate further in this system in order to evaluate its viability. (Ehrenberg 2008; Al-Chalabi 2015; Pinstrup-Andersen 2018). Similarly, Pinstrup-Andersen (2018) argued for the need to gather further data to assess the viability of vertical farming and claimed that its maximum potential could be discovered by detailed research. Furthermore, the author claimed that it would be unfair to neglect its advantages, although, on the other side, it is too early to draw any conclusions regarding its importance in addressing micronutrient shortages in urban populations.

Finally, many scholars agreed on the potential benefits of vertical farming to lower costs and the possibility to get a big market potential, although the initial fixed costs of establishing the system on an industrial scale are large and hard to quantify (Banerjee & Adenaeuer 2014). However, it is clear there is a need to expand the research in this field in order to access accurately the economic and environmental implications (Pinstrup-Andersen 2018; Sanjuan-Delmás *et al.* 2018).

3.3.2 Business Model Innovation and Vertical Farming

Several producers struggle to make profit due to the high capital investment required, high level of knowledge, consistency and reliability of input and the willingness from customers to pay higher prices for the products related to the high production cost (Kalantari *et al.* 2018). Therefore, a suitable business model innovation that response to the challenges and the opportunities that arise from presenting the new production technology, is needed for the vertical farming sector to commercialize the technology and improve vertical farming position in the market. Figure 5 below is to summarize the main findings from the literature about vertical farming challenges and opportunities.

Figure 5:Vertical farming challenges and opportunities. (own processing)

3.4 Conceptual framework

The Conceptual framework in figure 6 is established based on the literature reviewed to enable addressing the aim of the study and answering the research questions by linking the concepts of business model and business model innovation to the unit of analysis. The concept of business model will be used to determine the necessary resources in the firm to produce the value proposition and value channel by analysing the business model elements, type of value proposition, customers' segment, value receiving in return, and value channels.

The previous elements of the business model, challenges and opportunities arise from introducing new technology, will be the core to establish an understanding of how the firms use business model innovation to response to the challenges and opportunities by applying the needed developments on its standard business model, which can give a competitive advantage to the firm in return.

This framework will be applied on the vertical farm "Swegreen" which is the case study in this paper to gain a deeper understanding of how the concepts are applied on a real firm.

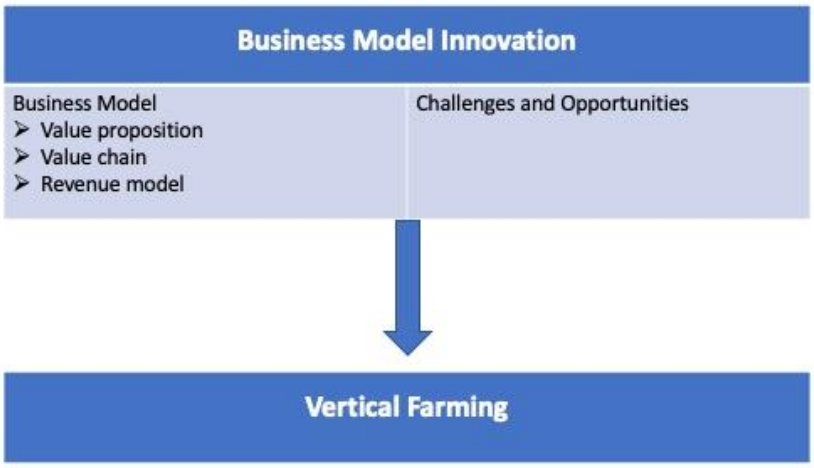

Figure 6: Conceptual framework (own processing)

4 Empirical background

This chapter presents the empirical background and answers obtained from the interview about the company itself, challenges and opportunities, the studied company's business model and business model innovation; therefore, this chapter provides essential information for the next chapter, before the empirical findings are addressed.

4.1 Introduction of Swegreen

The case study used in this thesis is the company named Swegreen. Swegreen is an urban vertical farm that primarily grows leafy greens by using the hydroponic growing system. The hydroponic system is a method of farming where plants grow in the absence of soil, and the roots of the plants lie in the water with dissolved nutrients instead (Despommier 2013). The Head of Innovation and Chief Sustainability Officer, Mr. Sepehr Mousavi, considers Swegreen as an active company working with vertical farming as a solution, where the company is trying to build up a new model for local food production with sustainable resource management. Swegreen was established as a startup in 2019, and the management team in the company have experience of over six years in vertical farming with different Swedish companies. Moreover, with these competencies, the team is trying to build a proof of concept farm to develop a service based on proof of concept, which will make farming as a service the new area for Swegreen business activities.

The farm is located in Stockholm, Sweden, thus the proximity to the point of sale is very short. This factor enables the Company to provide people with affordable, sustainable, local and fresh leafy greens all-year long. This notion is propelled specifically by the fact that in Sweden, the import of vegetable is extensive (Cederberg et al. 2019). Swegreen is trying to commercialize the technology and knowledge of vertical farming by having different units that could be installed at the customer's site, such as retail stores or restaurants and so on, where the company team can remotely control the production at the customer's place. In getting this remote service from the company, the customer doesn't need to do anything or have any knowledge about growing, to start with the farming business.

4.2 Challenges and opportunities

According to Mousavi, vertical farming is an innovative way of thinking and is a kind of upgrade for regular traditional farming. Even though the capital invested in building the first farm is considered to be high, Mousavi finds this high investment as an opportunity rather than a challenge. Furthermore, Swegreen considers the other vertical farms in the business environment as co-market creators, not as competitors. Rather, the company find the competition coming from the unsustainable greenhouse products which have lower sustainability standards. Nevertheless, the traditional farming products are different in terms of the product typology combined with the Swegreen product; hence there is no competition with other vertical farms.

Another challenge to vertical farming is the typology of plants; at Swegreen they mainly produce leafy greens. There are many reasons behind this choice according to Mousavi. Firstly, the amount of biomass that is sellable and edible with leafy greens is hundred per cent, which is more profitable to the company and all the resources used to grow the plant are

utilized with little waste. The second reason is from an economic and environmental sustainability aspect; as vertical farming is energy-intensive, so the optimal products in the current resource situation are the leafy greens, whereas for fruits there are many parts that are not edible and are considered as waste. The third reason is the concept of local food production: it is important that the food that needs to be consumed fresh is produced near to the retail outlet and thus the customer. This applies to these types of products because the quality of the product will be affected by storing it in the fridge for days. Furthermore, other types of plants can be grown in vertical farming systems, but the main principle driving this innovation is the cost of resources compared to the return and compared to other types, which in the meantime is sub-optimal.

Mousavi explained the role of local food producers, such as vertical farms, in term of food self-sufficiency for the country with the increased pressure on the global supply chain during the situation caused by the COVID-19 pandemic. This situation is considered as an opportunity to vertical farming and other local producers. However, vertical farming depends on the new technological innovations that need a global collaboration and freedom in mobilizing, therefore this situation might not be the best on the long run.

Another big challenge to vertical farming is the high cost of energy use. The system uses light-emitting diode LED lights for mimicking the sunlight indoors. Recently, LED technology has been shown to be less efficient with all the developments. The efficiency of the lights cause dissatisfaction for producers in terms of the wasted surplus heat from the LEDs, costs and they are deemed unsustainable. Therefore, to address this, Swegreen is using a type of integrated facility connected to other urban infrastructure- an innovation called water-cooled LEDs. In this process the company cool down their LEDs with cold water coming to the facility and thus turn this into hot water. This can then be sold to their host facility, the tower that Swegreen is located in. And that was their solution. But obviously, if there are LEDs that don't have that much of surplus heat released as energy that is deemed more sustainable.

The high price for products from vertical farming compared to the same products produced by other cheaper methods of farming (in particular imported produce) is yet another challenge for vertical farming. However, Swegreen endeavours to sell at a competitive price compared to the same products in the Stockholm market. Also, since the supply chain is shorter than the traditional supply chain, whereby imported products will pass through a number of distribution channels (mid- actors) before reaching the final customer. This gives a competitive advantage to the local product in this case. The price difference doesn’t limit the customers’ segment in the market since, according to Mousavi, the price offered by the company is competitive in the Stockholm market.

However, these days customers’ preference tends to be for purchasing and consuming certified products such as organic and ecologic products, while other customers prefer locally produced products. Ttherefore, from a business perspective it is crucial to improve the customers' awareness about vertical farming products and ultimately be able to certify such products with suitable certifications, since vertical farming cannot be certified as organic produce because the system doesn’t use any soil.

4.3 A New Production Technology

Swegreen considers vertical farming as any new production technology and it needs time for the customers to accept it. However, they find it essential to communicate with customers

when determining final product development decisions and less important when making decisions related to the infrastructure. Mousavi finds the development of advanced technology for farming, and the proof of concept for farming as a key area of service development for the future of Swegreen. In order to achieve that, Swegreen needs more “early adopter” customers to come on board to inform the development of the product(s) and /service(s). This coupled with having a better level of investment for research and development to complete the task of technology development and proof of concept, with less dependability on external parties will enable Swegreen to ensure its own sustainability in vertical farming.

4.4 Swegreen’s Business model

Swegreen’s business model is based on two value propositions. The first proposition addresses the availability of local, sustainable and fresh leafy greens in the Stockholm market where the company operates. The second is to make vertical farming technology available as a service to their customers in different locations in the country and provide them with all the necessary support for production and to enable them to meet the needs and demands of their consumers. In this latter way, the company commercializes the technology.

The company therefore has two revenue channels; produce sales and service provided by the company. Swegreen team makes sure to get feedback from their customers in order to adjust the production in a way that meets the consumption i.e. which reduces the food waste and the resources used to produce. Swegreen focuses on monitoring the demand from the customers' side on the one hand, and on the other hand, the scalability and viability of the technology to achieve the best results. The decision for the business model design in Swegreen comes from a variety of business “actors” such as the Board of Directors, company investors and those in the management team. The company undertook a few changes to the business model at the beginning of 2020.

The most crucial change was including the farming technology as a service to broaden their customers’ segment. So far, the management team is satisfied with this business model and they do not find any difficulties in developing it further when needed. However, it is highly dependent on the financial circumstances of the company.

4.5 Business model innovation

The decision for the company to innovate in the business model, according to Mousavi, includes many considerations such as the company structure, the financial situation for the company, and the market situation. However, when such a decision is made, the innovative business model has to be validated before implemented into the company structure.

Swegreen business model is not unique to the market, but its strength lies in the quality of the service provided by the company coupled with taking advantage of the high-tech development of this technology, which according to Mousavi competitors cannot imitate. Therefore, if Swegreen has to innovate in the business model, the focus will be more on the value proposition and expansion of the the offering into the global marketplace while enhancing the small-scale business service offering. This will, it is anticipated by Mousavi, lead to greater attraction for potential investors. Thus, the innovation in the business model will therefore be a mix of the value proposition and value capturing.

In the above context, Mousavi suggests that the primary source of innovation might come from the corporate culture that keeps innovation as an accepted tool for its growth, with focus

on having new blood in the company to keep new/fresh insights available all the time. However, not all of innovative ideas are practical or feasible relative to the situation of the company, maturity, readiness of the market and acceptance by company's decision-makers. Meanwhile it is worth keeping in mind that business model innovation is like a double-sided sword, on the one side it is necessary to achieve more success, yet on the other side it needs to be used carefully since there are always innovative ideas, but not always destined for success. Therefore, it is advised to thoroughly test the business model before presenting it to the market.

5 Analysis

This chapter presents analyses of the empirical data in relation to the conceptual framework with the emphasis on presenting the findings of the analysis. Thus, the aim of this thesis is addressed, and the research questions answered. This chapter aims to provide analysis which helps to answer the research questions That were formulated in chapter 1.3 as follows:

1. *What is the business model of a vertical farming venture?*
2. *How has the firm innovated its business model in response to challenges and opportunities arising from the vertical farming technology?*

5.1 Business Model

The first research question was developed to address the aim of this study namely, "what is the business model for a vertical farming venture?" by using the single case study of Swegreen. In order to analyze Swegreen's business model it will be important to determine the key resources and opportunities available in the market and also the available internal resources in the company.

Swegreen's main internal resources utilized to generate value can be construed by three elements. These are i) the farm where the company operates its activities and produces the final products to be sold later, ii) the human resources in the company which include the management team experienced in vertical farming, and iii) the investors which provide the financial needs to run the business. There are also some external resources that need to be in place for the value generating aspects of the company's business. For example, the customers in the company's market including retailers, end users and restaurants; the technology suppliers who play an essential role in providing and developing the vertical farming technology, to be utilized and commercialized into the business model, in order to generate the value out of it.

5.2 Analysing The Company's Business Model

Through analysis of previous key resources for Swegreen, the business model for the company can be analyzed according to the components that consist it which are the three main building blocks. Firstly, value proposition which describes how the firm designs its value offering to the chosen customers' segment; secondly, value chain which focuses on the partners, customers, suppliers and other actors in the value chain to determine the best channels for delivering the value created by the offering; and thirdly the revenue model, which focuses on how the business model makes explicit how the firm gains its revenue from the given value proposition and value chain by estimating the cost structure and potential profit.

An analysis of the empirical data from the in-depth interview with the company's Head of Innovation and Chief Sustainability Officer, establishes that the value proposition can affect the value chain and the revenue model according to the target customers' segment and the offering type. In this context Swegreen has three types of value proposition.

The first one is the leafy green products offered to the local retail outlets in Stockholm city, whereas the targeted customers are the grocery stores near to the company location and the

product is sold to the local consumers, and the company receives revenue from the sales of the products. This proposition requires a strong communication channel with retailers in order to understand how the products are consumed in different seasons, so that production can be adjusted to meet the needs as identified by the retailers in their feedback. This has the advantage of reduces food waste.

The second value proposition is the vertical farming service, identified in the empirical data. This results in providing the customer with fully controlled facility by the company and the customer just needs to produce and consume or sale. The targeted customers are retail stores, restaurants, distributors and so on. The revenue comes from renting this service to the customers. This proposition needs close interaction with the customer and works on a peer to peer basis in order to ensure the quality of the service.

The third value proposition is the services provided to the facility, where the company is operating, by providing the infrastructure (building) whereby the excess energy form the LED system used in the production phase is harnessed to heat water and thus results in a by-product of hot water which can be used by the facility. The revenue is generated from the sale of the hot water to the building proprietors. This value proposition requires creative thinking in utilizing the new technologies to problem solve i.e. the use of water-cooling LEDs require water for cooling and this water in turn is heated by the energy given off by the LEDs which transform the cold water to hot water. Then this requires communicating the environmental benefits behind such an offering. The first finding from the analysis is visualized in Figure 7 below, to understand the business model for Swegreen and its main components.

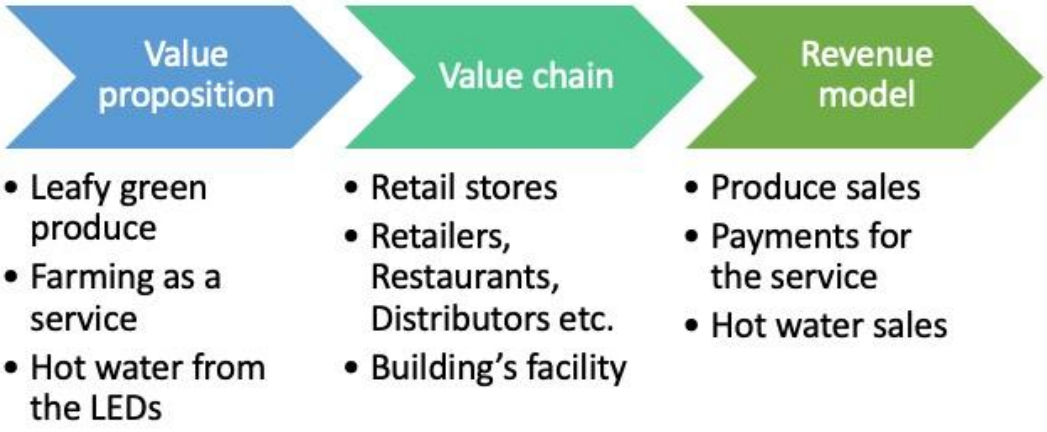

Figure 7: Swegreen's Business Model. (own processing)

5.3 Response to Challenges and Opportunities

The second research question focused on the challenges and opportunities related to vertical farming technology and how the company innovated in its business model to response to the

challenges, Specifically it askes “How has the firm innovated its business model in response to challenges and opportunities arising from the vertical farming technology?”

There are many challenges that were considered in Swegreen business model and some of these challenges were turned into opportunities. An analysis of the empirical data establishes these. For example, the amount of leafy greens produced which create sustainability problems in terms of food and resources waste is a challenge. This challenge was addressed by adjusting production according to consumption levels through enhancing communication (feedback) along the value chain. This resulted in greater efficiency.

Another challenge, which is related to vertical farming production technology, is the energy intensive production. This weakness has been seen by the company as a challenge and turned into a business opportunity by using the by-product heat to in turn heat water, and this hot water is sold to the building facility.

One further challenge is around customers awareness of the benefits of products of vertical farming is reportedly low. The company is working on this by creating communication channels with the customers and attracts their attention to the social and environmental benefits that can be gained by consuming local products from a sustainable source, such as vertical farm.

The final challenge from the analysis is the high investment needed to establish a vertical farm. This challenge inspired the company to build its proof of concept about farming as a service and innovate its business model to generate value from this concept by providing the whole system for the customer and the last one only needs to focuses on marketing activities, and the company will be paid for the service. Moreover, that will increase the segment of customers and add more revenue to the company in the long run. Table 2 below summarizes the challenges stated in the previous paragraph and the way that the company innovated its business model as a response.

Table 2: Challenges that found from the analysis. (own processing)

Type of challenge	Reason	Soulition	How addressed in the Business model
➢ Plants typology	Optimal product for such systems	Maximum use of the available resources	Adjust the offering type of produce with the local preferences
➢ Energy intensive	The need to mimic the sunlight indoor to grow the plants	Use the heat surplus created by the lights to heat the water and sell it as hot water	New way of offering value to different customer segments
➢ Customer awareness	New technology and new systems to the market	Communication channels	From feedback from the customers and include it in the value channel
➢ Food waste	Amount produced higher than the amount consumed	Adjust the production according to the customers consumption	Ensure the fit between the offering and the demand by getting feedback from customers
➢ High investment	The system and the technology are considered as expensive to implement for the first time	Turn this challenge into opportunity by offering the whole system as a service	Implement this solution in the business model as a value proposition

5.4 Business model innovation

By examining Swegreen business model, it is notable that the company innovated in the business model by adding new value propositions to fulfill the determined gap in the costumers' demand, which in turn generates more value for the company by targeting different customer segments within the same resources' capacity. This value generating concept was developed through creative thinking by the company to utilize the available resources in an efficient way and commercialize the new production technology through its business model.

There are many drivers behind this innovative way of thinking, both internal and external. The internal factors include the company culture of adopting innovative solutions, the wide experience of the management that helps to generate and evaluate new ideas to be applied in the optimal manner, the available resources in the company such as advanced technology, human resources and financial resources. While the external drivers include the business environment, policies and regulations, investors, customer preferences and good communication channels with their customers.

The opportunities to innovate in the company's business model are unlimited, yet so are the challenges. However, the innovated business model can be imitated in the short or the long term but the key behind differentiation is more about the company applying this business model and the human resource competences that enable optimal results from the implemented business model. Table 3 below illustrates the innovation made by the company in its business model.

Table 3: Business Model Innovation in the company. (own processing)

Drivers behind innovation		Change in the BM	Area of innovation	Type of innovation	Aim	Source of innovation
Internal	Exernal					
• Financial resources • Human resources • Company culture	• Business environment • policies and regulations • Investors • Customer preferences	Farming as a service	Customer demand	incremental	New revenue source	Company's business model
		Farming as a service	Customer segment	incremental	New revenue source	Company's business model
		Hot water	Customer segment	incremental	New revenue source, Environmental sustainability	New technology (water-cooled LEDs)

6 Discussion

This chapter provides a discussion of the findings and how they are related to existing literature. The starting point for the discussion is the tow research questions: 1) What is the business model of a vertical farming venture? 2) How has the firm innovated its business model in response to challenges and opportunities arising from the vertical farming technology?

6.1 Business model

The business model is defined in the literature in different ways such as a structural template (Amit & Zott 2001; Teece 2010; Deshler & Smith 2011; George & Bock 2011), a system (Morris *et al.* 2005; Chesbrough 2007; Zott & Amit 2010; Sorescu *et al.* 2011), a description (Demil & Lecocq 2010; Berglund & Sandström 2013), a framework (Chesbrough & Rosenbloom 2002; Doz & Kosonen 2010) or a conceptual tool (Osterwalder *et al.* 2005). However, in the findings, the company's business model can be described more as a mix of structural template, a framework and a system more than a description or a conceptual tool. Where a Vertical farm business model can be defined as a system of interdependent activities that creates and delivers value to the customers, and then convert the payments to profits, the business model also provides methods of how to set the boundaries to the firm and how to organize the firm's internal structure and governance.

Nonetheless, the company's business model is consistent with the activity system perspective by Zott & Amit (2010), since the design of the business model is projecting the company as a whole unit to get the overall design right. The fit between the value proposition and the customer demand to create a sustainable competitive advantage for the company, presented by Chesbrough (2007), Demil & Lecocq (2010) and Teece (2010), is noticed in the findings from the company's business model.

The main task of the business model is to commercialize the technology in a way that allows the firm to capture the highest possible value from this technology as discussed by Chesbrough & Rosenbloom (2002), Chesbrough (2007, 2010), Teece (2010), George & Bock (2011), and Zott *et al.* (2011). Which match with the findings from the studied company, hence the business model is based on creating economic value out of the available technology in the vertical farming sector.

In contrast to the evidence about the positive relationship between the applied business model and the company performance provided by Demil & Lecocq (2010), this relationship was not clearly found in the data collected. However, it was mentioned in the empirical data, that an acceptable business model by the company staff might improve the employees' performance to make it work in a successful way.

As it was discussed by Ghezzi (2014), that business model could not be considered as a holistic solution for the firm success since it does not cover certain important strategic aspects such as "industry's structural attractiveness", "contextual opportunities and threats", "competitors' strengths and weaknesses". This idea match with the findings since the business

model might face challenges to implement it according to many strategic circumstances which differ from a firm to another.

The three main building blocks comprise the business model components framework presented by Doganova and Eyquem-Renault (2009), which are value proposition, value chain and revenue model were found as a clear and straightforward way of understanding the business model for the studied company, as well as an excellent way to communicate the company's business model with the stakeholders.

The combination between the static and the dynamic view of the business model presented in the literature by Demil & Lecocq (2010) and Sorescu et al. (2011), is found in the empirical and it gives the company the flexibility to innovate in the business model to response to the challenges and opportunities when needed. Moreover, in the findings the way of differentiating the company's business model was by operating it according to high quality standards not only the business model uniqueness since any business model can be imitated, in contrast to Teece (2010), who drew the attention on the necessity for further development of the business model as it can be imitated by competitors over time. Table 4 below includes a comparison between the findings about business model from the literature and the analysis.

Table 4: Business Model in Literature and Findings from the Analysis. (own processing)

Literature	Findings
Business model definition as structural template, a system, a description, a framework or a conceptual tool	Mix of structural template, a framework and a system
The activity system perspective by projecting the company as a whole unit to get the design of the business model	The company is applying this perspective when designing the business model
The fit between value proposition and customeres' demand	Consistent with the literature
The aim of the company's business model is to commercialize the technology	Commercializing vertical farming technology in the company's business model
The positive relationship between the applied business model and the company performance	The relationship was more about the acceptance of the employees in the company of the business model, might improve their performance
Business model is not a holistic solution for company's success	The business model might face challenges to implement it according to many strategic circumstances.
Value Proposition, Value Chain And Revenue Model	Found in the company's business model
The combination between the static and the dynamic view of the business model, and the need for innovating in the business model	This kind of combination gives the company more flexibility to innovate in the business model
Differentiating the company's business model by making it difficult to be imitated by competitors	Differentiatition in the company's business model by by operating it according to high quality standards not only the business model uniqueness

6.2 Vertical farming challenges and opportunities

According to the study findings, all the benefits mentioned in the literature of the vertical farming were addressed in the business model such as closer production to the consumers, reducing burdens on water and soil, and reducing the food waste.

The high demand for energy required for lighting and regulating the heat temperature is one of the important challenges facing vertical farming (Ehrenberg 2008; Al-Chalabi 2015; Cox 2016; Chance *et al.* 2018; Graamans *et al.* 2018; Pinstrup-Andersen 2018; Romeo *et al.* 2018). This challenge is addressed in the company business model in which the company

finds a way to deal with this energy-intensive, by using the water-cooled LEDs innovation. This challenge is mentioned in the literature as one of the most critical challenges for vertical farming. However, with more technology development, this challenge can be tackled as per the findings.

The typology of plants is considered as an opportunity according to the findings since the leafy greens products were considered as the optimal product for such a system under the current circumstances. In contrast to what discussed in Cox (2016), Chance *et al.* (2018) and Pinstrup-Andersen (2018) where this plants typology is considered as a challenge.

In the findings, the competition on resources such as land, water and so on, was not mentioned while in Ehrenberg (2008) and Mok *et al.* (2014) this was considered as a challenge.

The price premium required to make the production in vertical farming profitable which might narrow the customers' segment to the elite market and deprive low-income customers of the benefits of fresh and local food (Cox 2016; Pinstrup-Andersen 2018). This price premium is considered as a big challenge. However, the findings match with the literature on this point.

The consumers' perception as a challenge was discussed by Al-Chalabi (2015) who noted the lack of knowledge of vertical farming. Customers consider the product as not natural and believe that chemicals are used to grow plants in such a system. To enhance the customers' knowledge about vertical farming, a proper communication channel with the consumers is needed, to increase their awareness about the products that come from vertical farming. This was stated in the literature as well.

Furthermore, the importance of the business model to improve the competitive position in the market, further evaluation of such systems viability is noticed in the findings and it match with what stated in the literature. Table 5 includes a summary of what came in the literature and the study findings about vertical farming challenges and opportunities.

Table 5: Vertical farming Challenges in literature and findings. (own processing)

Literature	Findings
Energy intensive	It is a challenge and the solution was through the new lighting technology
Typology of plants	Considered as an opportunity more than a challenge
The competition on resources such as land, water and so on with other sectors	Was not mentioned as a challenge
Price premium	Considered as a challenge but, with less dependence on the imported produce can be solved
Customer awareness	An important challenge and will need good communication channels with the customers to address and overcome it

6.3 Business model innovation

The study finds that there are internal factors standing behind the business model innovation in the firms such as the company culture of adopting innovative solutions, the vast experience of the management that helps to generate and evaluate new ideas to be applied in an optimal manner, the available resources in the company such as advanced technology, human resources and financial resources. Furthermore, the study finds that innovating in the business model is a continues process according to the constraints and enabling change factors in the internal and external environment. While the external factors include the business environment, policies and regulations, investors, customer preferences and proper communication channels with their customers.

The study finds that the business model innovation plays an essential role to link between the technology and the economic goals in the company, and enable the company to response to the challenges and opportunities, which is matching with the argument by Chesbrough and Rosenbloom (2002), who describe business model innovation as an essential tool that connects between technical and economic domains in the firm when commercializing new technology.

This study confirms the three ways of demonstrating sources to the innovation in the business model suggested by Trimi and Berbegal-Mirabent (2012), whereas, the company's business model itself can be the source of innovation, by modifying one or more of the elements and capturing higher value without changing the main product or service. Nevertheless, newly presented technology to the firm might cause a change in the business model in order to integrate the technology in the firm's business model and enhance the value capture of the technology. Furthermore, the change in the customers' demand might initiate modification in the business model to meet these changes (Trimi & Berbegal-Mirabent 2012). Table 6 includes what came in the literature as well as the findings about business model innovation.

Table 6: Business Model Innovation in literature and findings from analysis. (own processing)

Literature	Findings
The business model is related to the constraining and enabling change factors in the external environment	External factors
The capability of the firms to modify their business models according to the changes in the environment in terms of customer, technology, competition, and macroeconomic trends, leads to the success of the business model innovation	Enternal factors
Innovating in the business model is a continues process	Consistent with the findings
Business model innovation is an essential tool that connects between technical and economic domains in the firm when commercialising new technology.	Business model innovation plays an essential role in linking the technology and the economic goals of the company
Sources to the business model innovation	The company's business model, new technology, change in customer demand

7 Conclusions

This study aims to develop understanding of how Business Model Innovation is used with the introduction of a new production technology in the Swedish agri-food sector focusing on the vertical farming. A single case study interview analysis has enabled the research aim to be addressed, whereas a conceptual framework was developed as an analytical approach to determine the challenges and opportunities in the agri-food sector from the relevant literature, and how firms response by innovating in their business model to deal with the challenges and exploit the opportunities to achieve success. However, the business model and business model innovation have some limitations as a holistic factor for the company's success, whereas many important strategic aspects are not included in the business model design. Therefore, the business model and the strategy should be developed in parallel to achieve the best results for the company.

Innovating and changing in the company's business model under certain circumstances and in a specific period of time might yield different results if the same changes are made in other time and under different circumstances. Therefore, it might be better to analyze the company's business model in different periods of time to have transferability and explore patterns that might be applied in different contexts.

Vertical farming is considered as a new sector, where there is a great opportunity to innovate in its business model to ensure the best results from this kind of business. However, business model innovation for vertical farming involves a side of risk-taking on the internal and external level to implement it. Therefore, evaluating the new business models before implementing them to the market in a way that reduces the risk, might give better results for the company.

It is also worth noting the role of the human factor when operating a new business model, which can make a big difference because the quality of the operations in applying the same business model might differentiate a company from other. Whereas, the individuals who are responsible for the operations can play a significant role in the success or failure of the company's business model.

Innovation in the business model can be applied to one or more of the business model components. However, that does not mean that business model is considered as a static, but it can be looked at as a general frame for the company's image, whereas some changes in the details might create differentiation to one company over another one.

Moreover, the company's business model is influencing and get influenced by the external environment. Therefore, the policies and regulations applied to a certain industry have an important influence on the business model. For example, supporting policies to local production can create more opportunities to innovate in the business model and enhance the local companies' competitive advantage. Nevertheless, there is a significant role for the customers in the business model innovation process, through understanding the customers' needs, know how to satisfy these needs and communicate the offering via an acceptable business model for the customers, would increase the success chances.

Finally, the findings in this study show that business success is not only about technology, but it is more about adopting an innovative business model that commercializes the technology

and response to the challenges by turning them into opportunities in order to maintain the competitive advantage for the firm.

7.1 Future research

This thesis uses a single case study to understand how Business Model Innovation is used with the introduction of a new production technology in the Swedish agri-food sector focusing on the vertical farming. For future research, more case studies are needed to enrich the findings and enhance transferability, with more focuses on analysing different companies' business models to gain a better understanding on how the business model innovation can improve the competitive advantage for vertical farming sector

7.2 Limitations

This thesis involves a single case study, which can be considered as a limitation in terms of the generalizability of the findings. The author attempted to have more interviews and more than one company to include in the study, however, because of the current situation of the COVID-19 that was not possible. Yet, credibility in this study is high because the author did the interview and the member checking, and the analysis are based on the literature.

Bibliography

Literature and publications

Ackoff, R.L. (1994). Systems thinking and thinking systems. *System Dynamics Review (Wiley)*, vol. 10 (2/3), pp. 175–188 John Wiley & Sons, Inc. DOI: https://doi.org/10.1002/sdr.4260100206

Al-Chalabi, M. (2015). Vertical farming: Skyscraper sustainability? *Sustainable Cities and Society*, vol. 18, pp. 74–77. DOI: https://doi.org/10.1016/j.scs.2015.06.003

Amit, R. & Zott, C. (2001). Value creation in E-business. *Strategic Management Journal*, vol. 22 (6–7), pp. 493–520. DOI: https://doi.org/10.1002/smj.187

Baden-Fuller, C. & Morgan, M.S. (2010). Business Models as Models. *Long Range Planning*, vol. 43 (2–3), pp. 156–171. DOI: https://doi.org/10.1016/j.lrp.2010.02.005

Banerjee, C. & Adenaeuer, L. (2014). Up, Up and Away! The Economics of Vertical Farming. *Journal of Agricultural Studies*, vol. 2 (1), pp. 40–60. DOI: https://doi.org/10.5296/jas.v2i1.4526

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, vol. 17 (1), pp. 99–120 SAGE Publications Inc. DOI: https://doi.org/10.1177/014920639101700108

Behnke, I. & Kibbel, F. (2017). The Business Model Innovation Process in High-Tech Start-ups: When, What and Why Changes in a Business Model occur., 2017.

Benis, K. & Ferrão, P. (2017). Potential mitigation of the environmental impacts of food systems through urban and peri-urban agriculture (UPA) – a life cycle assessment approach. *Journal of Cleaner Production*, vol. 140, pp. 784–795. DOI: https://doi.org/10.1016/j.jclepro.2016.05.176

Benke, K. & Tomkins, B. (2017). Future food-production systems: vertical farming and controlled-environment agriculture. *Sustainability: Science, Practice and Policy*, vol. 13 (1), pp. 13–26. DOI: https://doi.org/10.1080/15487733.2017.1394054

Berglund, H. & Sandström, C. (2013). Business model innovation from an open systems perspective: structural challenges and managerial solutions. *International Journal of Product Development*, vol. 18 (3/4), p. 274. DOI: https://doi.org/10.1504/IJPD.2013.055011

Bocken, N.M.P., Short, S.W., Rana, P. & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, vol. 65, pp. 42–56. DOI: https://doi.org/10.1016/j.jclepro.2013.11.039

Bryman, A. & Bell, E. (2015). *Business research methods*. 4. ed. Oxford: Oxford Univ. Press.

Carter, S.M. & Little, M. (2007). Justifying Knowledge, Justifying Method, Taking Action: Epistemologies, Methodologies, and Methods in Qualitative Research. *Qualitative Health Research*, vol. 17 (10), pp. 1316–1328 SAGE Publications Inc. DOI: https://doi.org/10.1177/1049732307306927

Cederberg, C., Persson, U.M., Schmidt, S., Hedenus, F. & Wood, R. (2019). Beyond the borders – burdens of Swedish food consumption due to agrochemicals, greenhouse gases and land-use change. *Journal of Cleaner Production*, vol. 214, pp. 644–652. DOI: https://doi.org/10.1016/j.jclepro.2018.12.313

Chance, E., Ashton, W., Pereira, J., Mulrow, J., Norberto, J., Derrible, S. & Guilbert, S. (2018). The Plant-An experiment in urban food sustainability. *Environmental Progress & Sustainable Energy*, vol. 37 (1), pp. 82–90. DOI: https://doi.org/10.1002/ep.12712

Chesbrough, H. (2007). Business model innovation: it's not just about technology anymore. *Strategy & Leadership*, vol. 35 (6), pp. 12–17 Emerald Group Publishing Limited. DOI: https://doi.org/10.1108/10878570710833714

Chesbrough, H. (2010). Business Model Innovation: Opportunities and Barriers. Long Range Planning, vol. 43 (2–3), pp. 354–363. DOI: https://doi.org/10.1016/j.lrp.2009.07.010
Chesbrough, H. & Rosenbloom, R.S. (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. Industrial & Corporate Change, vol. 11 (3), pp. 529–555 Oxford University Press / USA. DOI: https://doi.org/10.1093/icc/11.3.529
Creswell, J.W. (2013). Research design: qualitative, quantitative, and mixed methods approaches. 4th. ed
Demil, B. & Lecocq, X. (2010). Business Model Evolution: In Search of Dynamic Consistency. Long Range Planning, vol. 43 (2–3), pp. 227–246. DOI: https://doi.org/10.1016/j.lrp.2010.02.004
Deshler, R. & Smith, K. (2011). Making Business Model Innovation Stick. People & Strategy, vol. 34 (4), pp. 18–23 HR People & Strategy. Available at: https://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=70939187&site=ehost-live [2020-04-06]
Despommier, D. (2013). Farming up the city: the rise of urban vertical farms. Trends in Biotechnology, vol. 31 (7), pp. 388–389. DOI: https://doi.org/10.1016/j.tibtech.2013.03.008
Doganova, L. & Eyquem-Renault, M. (2009). What do business models do? Research Policy, vol. 38 (10), pp. 1559–1570. DOI: https://doi.org/10.1016/j.respol.2009.08.002
Doz, Y.L. & Kosonen, M. (2010). Embedding Strategic Agility. Long Range Planning, vol. 43 (2–3), pp. 370–382. DOI: https://doi.org/10.1016/j.lrp.2009.07.006
Ehrenberg, R. (2008). Let's get vertical: City buildings offer opportunities for farms to grow up instead of out. *Science News*, vol. 174 (8), pp. 16–20. DOI: https://doi.org/10.1002/scin.2008.5591740818
FAO (2011). *Challenges of food and nutrition security, agriculture and ecosystem management in an urbanizing world*. (25)
George, G. & Bock, A.J. (2011). The Business Model in Practice and its Implications for Entrepreneurship Research. *Entrepreneurship Theory and Practice*, vol. 35 (1), pp. 83–111 SAGE Publications Inc. DOI: https://doi.org/10.1111/j.1540-6520.2010.00424.x
Ghezzi, A. (2014). The dark side of business models: the risks of strategizing through business models alone. *Strategic Direction*, vol. 30 (6), pp. 1–4 Emerald Group Publishing Limited. DOI: https://doi.org/10.1108/SD-03-2014-0036
Gill, M.J., Gill, D.J. & Roulet, T.J. (2018). Constructing Trustworthy Historical Narratives: Criteria, Principles and Techniques. *British Journal of Management*, vol. 29 (1), pp. 191–205. DOI: https://doi.org/10.1111/1467-8551.12262
Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, vol. 8 (4), pp. 597–606. Available at: https://nsuworks.nova.edu/tqr/vol8/iss4/6
Goyal, S., Kapoor, A., Esposito, M. & Sergi, B.S. (2017). Understanding business model - literature review of concept and trends. *International Journal of Competitiveness*, vol. 1 (2), p. 99. DOI: https://doi.org/10.1504/IJC.2017.084715
Graamans, L., Baeza, E., van den Dobbelsteen, A., Tsafaras, I. & Stanghellini, C. (2018). Plant factories versus greenhouses: Comparison of resource use efficiency. *Agricultural Systems*, vol. 160, pp. 31–43. DOI: https://doi.org/10.1016/j.agsy.2017.11.003
Hedman, J. & Kalling, T. (2003). The business model concept: theoretical underpinnings and empirical illustrations. *European Journal of Information Systems*, vol. 12 (1), pp. 49–59. DOI: https://doi.org/10.1057/palgrave.ejis.3000446

Hwang, J. & Christensen, C.M. (2008). Disruptive Innovation In Health Care Delivery: A Framework For Business-Model Innovation. *Health Affairs; Chevy Chase*, vol. 27 (5), pp. 1329–35 Chevy Chase, United States, Chevy Chase: The People to People Health Foundation, Inc., Project HOPE. DOI: http://dx.doi.org.ezproxy.its.uu.se/10.1377/hlthaff.27.5.1329

Kalantari, F., Tahir, O.M., Joni, R.A. & Fatemi, E. (2018). Opportunities and Challenges in Sustainability of Vertical Farming: A Review. *Journal of Landscape Ecology*, vol. 11 (1), pp. 35–60 Sciendo. DOI: https://doi.org/10.1515/jlecol-2017-0016

Khanagha, S., Volberda, H. & Oshri, I. (2014). Business model renewal and ambidexterity: structural alteration and strategy formation process during transition to a Cloud business model. *R&D Management*, vol. 44 (3), pp. 322–340 Wiley-Blackwell. DOI: https://doi.org/10.1111/radm.12070

Lambert, S.C. & Davidson, R.A. (2013). Applications of the business model in studies of enterprise success, innovation and classification: An analysis of empirical research from 1996 to 2010. *European Management Journal*, vol. 31 (6), pp. 668–681. DOI: https://doi.org/10.1016/j.emj.2012.07.007

Magretta, J. (2002). Why Business Models Matter. *Harvard Business School*, p. 8

Mahadevan, B. (2000). Business Models for Internet-Based E-Commerce: AN ANATOMY. *California Management Review*, vol. 42 (4), pp. 55–69 California Management Review. DOI: https://doi.org/10.2307/41166053

Markides, C. (1997). Strategic innovation. *Sloan management review*, (38)

Markides, C. (2006). Disruptive Innovation: In Need of Better Theory*. *Journal of Product Innovation Management*, vol. 23 (1), pp. 19–25. DOI: https://doi.org/10.1111/j.1540-5885.2005.00177.x

McGrath, R.G. (2010). Business Models: A Discovery Driven Approach. *Long Range Planning*, vol. 43 (2–3), pp. 247–261. DOI: https://doi.org/10.1016/j.lrp.2009.07.005

Mitchell, D.W. & Bruckner, C.C. (2004). Business model innovation breakthrough moves. *Journal of Business Strategy*, vol. 25 (1), pp. 16–26 Emerald Group Publishing Limited. DOI: https://doi.org/10.1108/02756660410515976

Mok, H.-F., Williamson, V.G., Grove, J.R., Burry, K., Barker, S.F. & Hamilton, A.J. (2014). Strawberry fields forever? Urban agriculture in developed countries: a review. *Agronomy for Sustainable Development*, vol. 34 (1), pp. 21–43. DOI: https://doi.org/10.1007/s13593-013-0156-7

Morris, L. (2009). Business Model Innovation The Strategy of Business Breakthroughs. *International Journal of Innovation Science*, vol. 1 (4), pp. 191–204. DOI: https://doi.org/10.1260/1757-2223.1.4.191

Morris, M., Schindehutte, M. & Allen, J. (2005). The entrepreneur's business model: toward a unified perspective. *Journal of Business Research*, vol. 58 (6), pp. 726–735. DOI: https://doi.org/10.1016/j.jbusres.2003.11.001

Nandakumar, M.K., Ghobadian, A. & O'Regan, N. (2010). Business-level strategy and performance: The moderating effects of environment and structure. *Management Decision*, vol. 48 (6), pp. 907–939 Emerald Group Publishing Limited. DOI: https://doi.org/10.1108/00251741011053460

Osterwalder, A., Pigneur, Y. & Tucci, C.L. (2005). Clarifying Business Models: Origins, Present, and Future of the Concept. *Communications of the Association for Information Systems*, vol. 16. DOI: https://doi.org/10.17705/1CAIS.01601

Pandey, R., Jain, V. & Singh, K.P. (2009). Hydroponics Agriculture: Its Status, Scope and Limitations. p. 11

Pinstrup-Andersen, P. (2018). Is it time to take vertical indoor farming seriously? *Global Food Security*, vol. 17, pp. 233–235. DOI: https://doi.org/10.1016/j.gfs.2017.09.002

Prahalad, C.K. & Mashelkar, R.A. (2010). Innovation's Holy Grail. *Harvard Business Review*, vol. 88 (7/8), pp. 132–141 Harvard Business School Publication Corp. Available at: https://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=51604137&site=ehost-live [2020-04-06]

Pynnönen, M., Hallikas, J. & Ritala, P. (2012). MANAGING CUSTOMER-DRIVEN BUSINESS MODEL INNOVATION. *International Journal of Innovation Management*, vol. 16 (04), p. 1250022. DOI: https://doi.org/10.1142/S1363919612003836

Robson, C. (2011). Real world research a resource for users of social research methods in applied settings. Chichester, West Sussex Wiley-Blackwell. Available at: https://trove.nla.gov.au/version/266502847 [2020-04-11]

Robson, C. & McCartan, K. (2016). *Real World Research*. John Wiley & Sons.

Romeo, D., Vea, E.B. & Thomsen, M. (2018). *Environmental Impacts of Urban Hydroponics in Europe: A Case Study in Lyon | Elsevier Enhanced Reader*. DOI: https://doi.org/10.1016/j.procir.2017.11.048

Sanjuan-Delmás, D., Llorach-Massana, P., Nadal, A., Ercilla-Montserrat, M., Muñoz, P., Montero, J.I., Josa, A., Gabarrell, X. & Rieradevall, J. (2018). Environmental assessment of an integrated rooftop greenhouse for food production in cities. *Journal of Cleaner Production*, vol. 177, pp. 326–337. DOI: https://doi.org/10.1016/j.jclepro.2017.12.147

Saunders, M.N.K., Lewis, P. & Thornhill, A. (2009). *Research methods for business students*. 5th ed. New York: Prentice Hall.

Schneider, S. & Spieth, P. (2013). BUSINESS MODEL INNOVATION: TOWARDS AN INTEGRATED FUTURE RESEARCH AGENDA. *International Journal of Innovation Management*, vol. 17 (01), p. 1340001. DOI: https://doi.org/10.1142/S136391961340001X

Seelos, C. & Mair, J. (2007). Profitable Business Models and Market Creation in the Context of Deep Poverty: A Strategic View. *Academy of Management Perspectives*, vol. 21 (4), pp. 49–63 Academy of Management. Available at: https://www.jstor.org/stable/27747411 [2020-04-06]

Shafer, S.M., Smith, H.J. & Linder, J.C. (2005). The power of business models. *Business Horizons*, vol. 48 (3), pp. 199–207. DOI: https://doi.org/10.1016/j.bushor.2004.10.014

Sorescu, A., Frambach, R.T., Singh, J., Rangaswamy, A. & Bridges, C. (2011). Innovations in Retail Business Models. *Journal of Retailing*, vol. 87, pp. S3–S16. DOI: https://doi.org/10.1016/j.jretai.2011.04.005

Stringer, R. (2000). How To Manage Radical Innovation. *California Management Review*, vol. 42 (4), pp. 70–88 California Management Review. DOI: https://doi.org/10.2307/41166054

Teece, D.J. (2010). Business Models, Business Strategy and Innovation. *Long Range Planning*, vol. 43 (2), pp. 172–194. DOI: https://doi.org/10.1016/j.lrp.2009.07.003

Tell, J., Hoveskog, M., Ulvenblad, P., Ulvenblad, P.-O., Barth, H. & Ståhl, J. (2016). Business Model Innovation in the Agri-food Sector. *International Journal of Social Ecology and Sustainable Development (IJSESD),*. DOI: https://doi.org/10.4018/IJSESD.2016040101

Timmers, P. (1998). Business Models for Electronic Markets. *Electronic Markets*, vol. 8 (2), pp. 3–8. DOI: https://doi.org/10.1080/10196789800000016

Trimi, S. & Berbegal-Mirabent, J. (2012). Business model innovation in entrepreneurship. *International Entrepreneurship and Management Journal*, vol. 8 (4), pp. 449–465. DOI: https://doi.org/10.1007/s11365-012-0234-3

Ulvenblad, P., Barth, H., Björklund, J.C., Hoveskog, M., Ulvenblad, P.-O. & Ståhl, J. (2018). Barriers to business model innovation in the agri-food industry: A systematic literature review. *Outlook on Agriculture*, vol. 47 (4), pp. 308–314. DOI: https://doi.org/10.1177/0030727018811785

Voelpel †, S.C., Leibold, M. & Tekie, E.B. (2004). The wheel of business model reinvention: how to reshape your business model to leapfrog competitors. *Journal of Change Management*, vol. 4 (3), pp. 259–276. DOI: https://doi.org/10.1080/1469701042000212669

Voelpel, S., Leibold, M., Tekie, E. & von Krogh, G. (2005). Escaping the Red Queen Effect in Competitive Strategy: *European Management Journal*, vol. 23 (1), pp. 37–49. DOI: https://doi.org/10.1016/j.emj.2004.12.008

Weidner, T., Yang, A. & Hamm, M.W. (2019). Consolidating the current knowledge on urban agriculture in productive urban food systems: Learnings, gaps and outlook. *Journal of Cleaner Production*, vol. 209, pp. 1637–1655. DOI: https://doi.org/10.1016/j.jclepro.2018.11.004

Weill, P. & Vitale, M. (2001). *Place to Space: Migrating to Ebusiness Models*. Harvard Business Press.

Yin, R.K. (2013). Validity and generalization in future case study evaluations. *Evaluation*, vol. 19 (3), pp. 321–332 SAGE Publications Ltd. DOI: https://doi.org/10.1177/1356389013497081

Zott, C. & Amit, R. (2010). Business Model Design: An Activity System Perspective. *Long Range Planning*, vol. 43 (2–3), pp. 216–226. DOI: https://doi.org/10.1016/j.lrp.2009.07.004

Zott, C., Amit, R. & Massa, L. (2011). The Business Model: Recent Developments and Future Research. *Journal of Management*, vol. 37 (4), pp. 1019–1042. DOI: https://doi.org/10.1177/0149206311406265

Internet

Cox, S. (2016-02-17). *Enough with the vertical farming fantasies: There are still too many unanswered questions about the trendy practice*. *Salon*. Available at: https://www.salon.com/2016/02/17/enough_with_the_vertical_farming_partner/ [2020-04-10]

EUFIC (2015-02-07). *Food production: A sustainable food supply: (EUFIC)*. Available at: https://www.eufic.org/en/food-production/article/food-production-3-3-a-sustainable-food-supply [2020-03-09]

EUFIC (2018-05-28). *Vertical Farming – what's the deal anyway?: (EUFIC)*. Available at: https://www.eufic.org/en/food-production/article/vertical-farming-whats-the-deal-anyway [2020-03-09]

United Nations Population Division | Department of Economic and Social Affairs. Available at: https://www.un.org/en/development/desa/population/publications/urbanization/population-distribution.asp [2020-04-11]

Personal messages

The Head of Innovation and Chief Sustainability Officer in Swegreen, Mr. Sepehr Mousavi, Skype interview, 20-05-05.

Appendix 1: Interview guide

- **Introduction**

Your name and title
Can you summarize the background of the company? (example; history, operations, revenue)

- **Production**

1- Establishing a vertical farm needs a kind of big investment. Is the big investment considered as a challenge for the company to make a higher profit or an opportunity that reduces the new entrances to the market?
2- What are the challenges facing Swegreen regarding the competition in getting land, energy, and water for the farm in Stockholm?
3- Swegreen mainly produces leafy greens. What factors can allow the company to produce more variety of products?
4- What is your position in the value chain, and how does it differ from the conventional value chain in the agri-food sector?
5- In the current situation of the COVID-19, what is your role in the food self-sufficiency?
6- The high demand of energy cost in vertical farming is generally highlighted as an important challenge. What is the proportion of energy used in the production costs, and how can that be improved? What impact on the production can it have?
7- Whom do you consider as main competitors (vertical farms or conventional agriculture)?
8- What is the price difference between your product and the conventional product? Does that limit your customer segment?
9- How do customers see/perceive your product? Why do they buy it or do not buy it?
10- How can Swegreen be more competitive and profitable?

- **Business Model and Business model challenges**

1- How do you define your business model in relation to vertical farming technology?
2- What are the main components of your business model?
3- How do you set your value proposition? What makes it different from competitors?
4- Have you made any changes to your business model so far? Why?
5- What are you monitoring most when running your business?
6- Who decides the business model for Swegreen?
7- What kind of challenges or opportunities has the COVID-19 situation created on the business and did you need to change anything in your business model

- **Business Model Innovation**

1- As a manager in the company, do you consider the current business model is giving the best results to the company? Or changing something in the business model might yield better results? If yes, what can it be?
2- When do you think it is an excellent time to develop the business model? What are the drivers that can lead to this development? If you are to take the decision, what components in the business model will you develop, and why?
3- What is unique about Swegreen's business model?
4- How difficult is Swegreen's business model to be imitated or adopted by competitors?
5- What do you consider as the main sources to innovate in the company business model? And how often do you think that the company should make development on the business model?

6- In case you innovate a new business model, how will you integrate it into the company structure?