



Analysis of Vertical Farming Business Model

- Swegreen Case Study

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Abstract

The world's population is projected to increase to 9 billion by 2050 according to the Food and Agriculture Organization, FAO (2020), and this growth in the earth's population is anticipated to put great pressure on the existing natural resources. It will increase food demand which would intensify agricultural production. Vertical farming (VF) is a new method to grow crops by artificially growing plants vertically on stacked layers. It provides opportunities for sustainable crop growth by minimizing water use, increasing productivity per unit area, and reducing fertilizer/pesticide use which leads to maintaining the ecosystem's health and to protect the crops from climate-related disasters. More than 80% of the fruits and vegetables consumed are imported to Sweden, which is associated with devastating climate side effects such as transportation, keeping and cooling. VF can fulfil the everyday demands of consumers in Sweden for fresh nutrients and is an aspect of flexible feeding methods - particularly in and near densely populated regions.

VF currently produces a limited range of vegetables and plants that are more expensive than conventional agricultural products, and although it has many environmental and social benefits in terms of sustainability, it also needs to improve economic profitability. The purpose of this thesis is to examine how this industry can be economically viable. To achieve this goal, reviewing the literature on the Business Model Canvas (BMC), SWOT analysis of the company and its business model, and three dimensions of sustainability are used to create a theoretical framework. To gain an in-depth understanding of the business model, a case study was conducted with a vertical farming company in Sweden called Swegreen, and data on business model analysis and SWOT analysis were collected through an interview. Based on the findings, the company changed its business model from B2C to B2B based on past experiences to stay consistent in the economic sector and reduce costs. According to SWOT analysis of the BMC, the company almost has equal strengths and weaknesses in implementing the nine building blocks, but the opportunities ahead outweigh their threats, which indicates that the industry is still young and has a bright future ahead.

Keywords: vertical farming(VF), business model canvas, business model, SWOT analysis hydroponic agriculture, urban agriculture, in-store farming

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Abbreviations

BMC	Business Model Canvas
B2C	Business to Customer
B2B	Business to Business
CIO	Chief Innovation Officer
CS	Customer Success
CO ₂	Carbon Dioxide
EUFI	The European Food Information Council
FAO	Food and Agriculture Organization
FaaS	Farming as a Service
GHG	Green House Gas emissions
ISGS	In-Store Growth System
LEDs	Light-Emitting Diode
NGO	Non-Governmental Organization
R&D	Research and Development
SWOT	Strength, Weakness, Opportunities, Threats
SRI	Stanford Research Institute
SDGs	Sustainable Development Goals
UN	United Nations
VF	Vertical Farming
WCED	World Commission an Environment & Development

1. Introduction

The aim of this thesis is to comprehend the most suitable strategy and business model for Vertical Farming start-ups. This chapter begins with a general background that functions as a basis for expressing the problem statement. Based on the problem, the purpose and question of the research were formulated, and it will end with the delimitations of the study.

1.1 Background

Climate change and related global warming are the major issues that all countries in the world are facing nowadays. Global warming is supposed to be limited to less than 2 degrees Celsius under the Paris climate agreement (Paris Agreement 2015; Rogelj *et al.* 2016). Decarbonization is one of the three main targets assigned by the European Commission to be achieved by 2030 to step towards reducing 40 % greenhouse gas emissions relative to emissions in 1990 (European Commission 2014). According to the Food and Agriculture Organization (FAO), greenhouse gas emissions in the agricultural industry account for 17% of total world emissions (FAO 2020).

On the other side, this organization predicted that the world population will reach to 9 billion by 2050, which is 34% more than the current population. This means that urbanization will continue at a rapid pace. The fast growth of urbanization involves more food production, which is causing global warming, soil degradation, biodiversity loss, and widespread use of fertilizers and pesticides affecting our food supply chain (FAO 2009).

However, conventional agriculture is extremely hanging on environmental conditions that make it quite risky in some ways. About seven out of ten per cent of freshwater consumption is related to the agricultural sector (Khokhar 2017). To understand the importance of this issue, we can refer to the United Nations (UN) water development report in 2018, which states that more than 2 billion people worldwide do not have access to sanitary drinking water (Water UN 2018). Moreover, just in the last 25 years, agriculture has been eradicated about 1 million square kilometres of woodlands on earth (Nunez 2019). To address this, we can consider total population growth and rising standards of living, which both tend to

increase demand for agricultural products, which in turn is likely to lead to more land use and deforestation (Moghimi 2021). The use of pesticides results in the loss of 30% of agricultural products annually (Popp *et al.* 2013). Furthermore, the level of satisfactory production of farmers is usually a function of favourable weather conditions and other factors. Without any doubt, using pesticides and weather uncertainties, such as severe climate change or changing rainfall patterns, are going to be worsened by climate change (Moghimi 2021)

During the last decade, an innovative method has emerged, commonly referred to as vertical agriculture, and has become an important part of the movement toward sustainable urban farming (Cobb 2011; Nordahl 2009; Despommier 2007, 2009, 2010). This method is promising as an effective tool to help increase food production, provide food security and reinforce sustainable urban farming. The concept of vertical farms is not new. The idea of planting crops in large multi-storey buildings was first explained by American geologist Gilbert Ellis Bailey (1915), as represented by his pioneering but lesser-known book titled: *Vertical farming* (Besthorn 2013). Decades before the recent environmental concern and food security crisis had become part of the global agenda, Bailey realised that the only way to prevent the unavoidable future crisis of food scarcity was to develop farming practices. Bailey (2011, p. 3) pointed out in the language of his time that Vertical Farming (VF):

Enables the farmer to farm deeper, to go down to increase area, and secure larger crops. Instead of spreading out over more land he concentrates on less land and becomes an intensive rather than an agriculturist, and so learns that it is more profitable to double the depth of his fertile land than to double the area.

1.2 Problem statement

Everything that has been said so far about VF is a great advantage, but the main criticism of vertical farming is the large amount of energy required to produce crops (EUFIC 2018). That is why VF can also be very expensive because it requires a lot of energy and labour. For example, one of the factors that makes a vertical farm more expensive is manufactured light, since, a vertical farm does not use natural light, and it needs artificial light (Specht *et al.* 2014). In order to succeed in the market, it must compete with industrial agriculture on a large and highly efficient scale which puts the financial outlook for VF in a precarious position at best. With the current issues in mind, vertical agriculture appears to be a promising method from a macro perspective. However, when it comes to business economics, these benefits often seem irrelevant. Because; a business is expected to ultimately make a profit in a competitive market. In this case, the main influencing factor is the amount of energy required. A vertical farm fundamentally uses high energy to grow faster with the minimum risk and water usage and with better quality in a smaller

place. An important question to ask for growth with VF is whether it is worth spending extra energy to get better quality, higher production efficiency, and so on. Certainly, the promises of VF to help solve the problem of water scarcity in the world or to minimize deforestation by producing expensive lettuce and premium vegetables are not being fulfilled. However, the future may be very bright for VF (Moghimi & Asiabanpour 2021)

VF, which is rather a new concept in Sweden, has not been profitable for most companies, especially on the commercial scale. In business, success begins with the finance department, which ultimately drives sales and marketing. A business must learn how to maximize its profits in order to succeed. Additionally, innovative firms face many obstacles that hinder their growth and even threaten their survival. There are several barriers that can be attributed to both internal and external business forces influencing the firm's decision making to different degrees. There are some factors that many innovative businesses will definitely face one of them can be competition. Therefore, they must adopt a precise strategy that will lead to a sustainable business model in the future, which is necessary to overcome obstacles and cannot be achieved without a clear plan (Austin 2020).

A business model can be defined as a story about how firms work (Magretta 2002). The key to a good business model is to answer Peter Drucker's age-old question: Who are we selling to? What is important to them? Moreover, it answers the fundamental question every manager should ask: What are the business's profitability prospects? How can we deliver value to our customers at an appropriate cost? What is the underlying economic logic behind this? Business models are driven by value. Furthermore, it is important to know what value is provided to which customers (Drucker 2011). The business model canvas as an analytic tool can help the company to have a clear picture of where the organization is today and where it can be tomorrow and also how it will reach there (Hemmer 2016). As well as this, many organizations do not achieve their goals in a given period due to their inability to refine their business strategies and alignments. Organizations are usually unable to properly implement SWOT analysis models in businesses (Culp *et al* 2016). Unsuitable performance and failure to analyze SWOT data can disrupt the results of the organization's execution of the analysis (Gurl 2017).

1.3 Aim

The purpose of this study is to investigate a viable future business model of vertical agriculture through strategic marketing concepts as well as identify the requirements for the successful performance of VF in Sweden. In today's competitive business world, companies and organizations that wish to innovate and make a profit can use business models (Maurya 2012). The BMC method will be used in this research and according to Osterwalder & Pigneur (2010), the BMC is

designed to provide value and enhance performance. This method will be employed to assess present strategies at the same time define future strategies to strengthen competitiveness in the face of existing markets and coming opportunities. In addition to using the BMC method, this study is also combined with SWOT analysis. This analysis is performed to identify the strengths and weaknesses of the business and its ability to seize opportunities and meet existing threats (Kalpande *et al.* 2010). Through a SWOT analysis, it is possible to further formulate the company's strategy, because it can be seen what occurred inside the company and in the external environment (Arslan & Er 2008). Thus, the Research question is going to be:

“How can a sustainable business model for vertical farming as the future of agriculture be developed?”

The reason for choosing this topic is that a large part of fruits and vegetables are imported to Sweden (Antonissen 2020), and the need for a new style in the production of agricultural products that are profitable, sustainable and environmentally friendly is strongly required. For that reason, many entrepreneurs and start-ups in the agricultural sector have turned to VF but have not yet reached profitability and large-scale production. Additionally, since vertical farms are a new field in Sweden and little research has been conducted regarding economic sustainability and profitability, especially through integrating SWOT analysis and the BMC. Thus, these methods were used in developing this research in order to better understand how sustainable business models for farms are designed.

1.4 Delimitations

This study is conducted in the field of business administration with a single case study approach. The main focus will be on a company named “Swegreen” located in Stockholm that undertakes VF. The study is based on the business model applied and SWOT analysis of the company, so the unit of analysis is a vertical farm company business model and the unit of observation is Swegreen. It should be noted that the thesis is confined to Hydroponic VF systems despite other methods, such as Aeroponics and Aquaponics are working in Sweden. The reason is that most major players in Sweden have executed hydroponic systems which means that there is more available data compared to other alternatives.

The data on the business model and SWOT analysis were collected only from one of the top managers of the company, meaning that as a result, the findings cannot be generalized to all the vertical companies in Sweden. However, the credibility of this study is high because the author has conducted an interview with the chief innovation officer, who is also one of the company's co-founders, and the analysis is based on the existing literature. There are some limitations when

conducting a SWOT analysis such as undermining internal forces and underestimating external threats. It can also be risky when we ignore the changing circumstances and hide one strength or factor of a company's strategy. The author planned to include more than one company in the study to draw conclusions based on the analysis and comparison of business models of several VF companies in Sweden and to have more interviews, but only the Swegreen company agreed to cooperate and conducted the interview.

2. Theoretical framework

This chapter begins with a review of the literature that defines VF, the BMC and its functions, and describes the implementation and concept of SWOT analysis. Lastly, a section on strategy discusses combination of SWOT analysis and BMC and sustainability concepts.

2.1 Vertical farming

VF is a technique of cultivating plants without the need for soil and sunlight in an environment where all conditions are under control and are stacked in vertical layers, hence it is called "vertical farming" (Dos Santos 2013). Today, some of the most common crops grown by VF methods are lettuce, tomatoes, basil, cucumbers and flowers. Products are usually farmed in environments such as shipping containers or large warehouses (Aero Farms 2021). Moreover, three methods are commonly adopted in VF classifications: 1) Hydroponics, 2) Aeroponics, and 3) Aquaponics (Farah, 2013).

In the Hydroponics system, plants grow in soilless nutrient solutions where the roots are immersed in the solution and the plants grow in the nutrient solution in the growth tray (Epicgardening, 2017) (Figure 1).

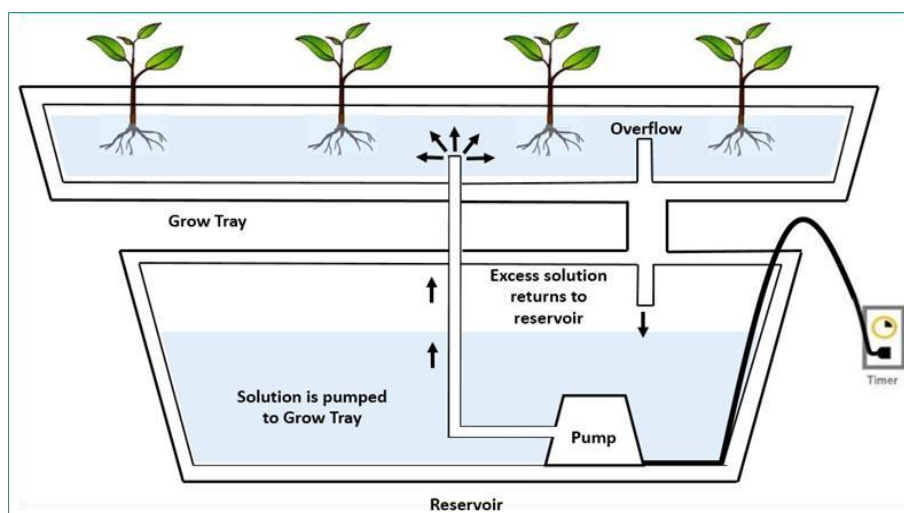


Figure 1: Diagram of a hydroponic system (Gupta & Ganapuram 2019, P.4)

In an Aeroponic system, the roots of plants are suspended in the air therefore, by spraying the root areas with a nutrient solution, the roots are continuously fed with a good sprayer to ensure that the roots receive sufficient oxygen (Agrihouse, 2011) (Figure 2).

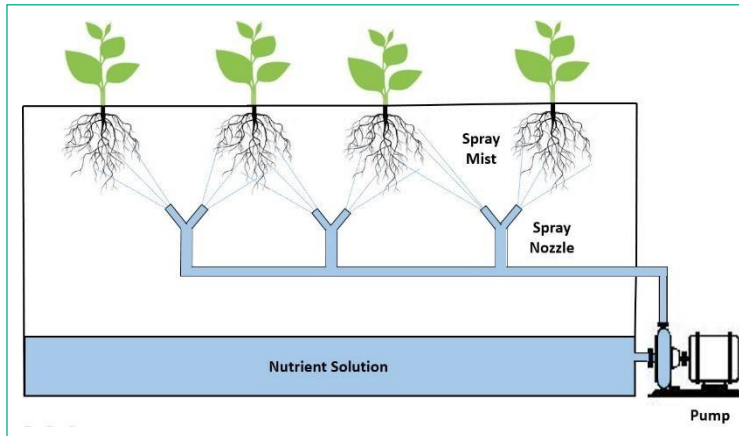


Figure 2: Diagram of an aeroponic system (Gupta & Ganapuram 2019,P.5)

Aquaponics: This procedure, is a combination of aquaculture and hydroponics in one ecosystem. Waste produced from fish farming in fish tanks has a high nutrient content and is used as a source of nutrients for plants to grow in the growth tray. This water is recycled to the fish tank when all the waste is decomposed and used by plants as nutrients (Ellingsen & Despommier, 2008) (Figure 3). Compared to other methods, hydroponics is one of the most common planting processes used on vertical farms. The use of this method is predominant in Sweden, so the focus of this study is on VF with the hydroponics systems.

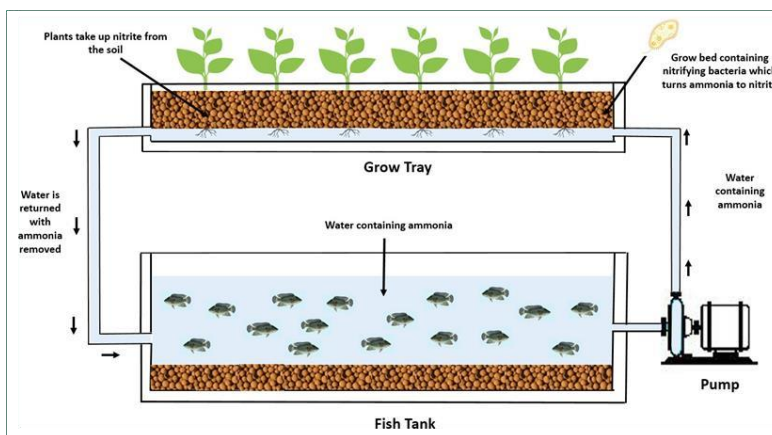


Figure 3: Diagram of an aquaponics system (Gupta & Ganapuram 2019,P.6)

Since the focus of this research is on the business model and VF strategy, it is necessary to first understand the difference between urban farming and VF. Urban agriculture is known as indoor agriculture, is highly soil dependent and is located within the city boundaries (FAO 2011). While vertical agriculture does not require the use of soil because, as mentioned above, it grows in a solution so it can reduce the amount of land needed to produce food. Furthermore, this method produces much higher yields per area than other forms of urban agriculture while consuming fewer resources which is another benefit of VF (Kamprad 2022). A vertical farm can be built anywhere, such as in urban or rural areas, regardless of outdoor conditions, and the only basic requirement is the availability of water and energy (Despommier 2009).

2.2 Business model

The phrase “business model” was first stated in an academic paper in 1957 (Bellman *et al.* 1957). The business model can be defined as a structural framework that describes the financial and organizational model of the company (Cheesbrough & Rosenblum, 2002). It can also be described as the way companies deliver value to customers, encourage customers to pay for value and turn those payments into profits (Teece 2010). According to Osterwalder and Pigneur (2010, p.18-19):

A business model describes the rationale of how an organization creates, delivers, and captures value.

This process is divided into 9 building blocks by Osterwalder and Pigneur (2010) known as the Business Model Canvas (BMC), which is described in more detail in the next section. Zott and Amit (2008) believe that the business model as a unique and practical tool provides analysis and management, particularly in research and practice. Although a business model has not been clearly defined in the literature (Trimi & Berbegal-Mirabent 2012). But in reviewing the literature, we can obviously see four important factors that include value proposition, customer relationships, infrastructure and revenue model (see Table 1) (Johson, 2010; Osterwalder, 2004; Osterwalder and Pigneur, 2009; Stähler, 2001; Wirtz *et al.* 2010; Wüstenhagen *et al.* 2008).

Table 1: The business model conceptualization (Osterwalder, 2004; Osterwalder & Pigneur, 2010)

Business model pillar	Description
Value proposition	It is a set of products and services that create value for the customer and allows the firm to make a profit.
Customer relationships	It consists of consumer interface, customer segments, and distribution channels that include the overall relations with the customer.
Infrastructure	It includes assets, technical knowledge and partnerships and describes the company's value creation framework.
Revenue Model	Shows the relationship between the cost of creating the value proposition and the revenue generated.

Before studying the details of the business model and how it works, it is important to understand the difference between a business strategy and a business model, because there is a confusion between the use of the term business strategy and the business model (Chesbrough & Rosenbloom 2002). Business strategy determines how the business should be done to achieve the desired goals. It is a set of competitive plans and actions that a business uses to attract customers, succeed in competition, strengthen performance and achieve organizational goals (Heubel 2021), Whereas, the business model is much broader than the business strategy, which shows how companies can potentially create value and seize opportunities (Morris *et al.* 2005). Business models are often necessary, especially in technological innovations that create both the need to provide market exploration and the opportunity to meet the unwanted needs of customers (Teece 2010).

2.2.1 The function of the business model

Business models can play a key role in describing company performance (Zott *et al.* 2011). Afuah and Tucci (2003) believed that the business model is a unified structure for defining competitive advantage and company performance and they propose it as the way a company builds its resources and uses them to provide better value to its customers and thus make money. Afuah (2004) had more focus on corporate profitability and a strategic framework where the business model is conceptualized using a set of elements that match the determinants of corporate profitability. According to other researchers, for example in a technology-driven company the main function of the business model is to commercialize the technology in a way that allows the company to acquire the highest potential value from that technology (Chesbrough & Rosenbloom 2002; Chesbrough 2007, 2010; Teece 2010; George & Bock 2011; Zott *et al.* 2011). In this regard, evidence provided by other studies shows a positive relationship between applied business models and firm performance (Demil & Lecocq 2010). But due to misinterpretation and misuse of the business model phrase, it cannot be assumed as a comprehensive

solution for the success of the company, because it does not cover some strategically important aspects such as, fundamental opportunities and threats, and strengths and weaknesses (Ghezzi 2014). Hence, it is recommended to combine the use of the business model with other strategic and analytical planning tools to ensure success (ibid).

2.2.2 The Business Model Canvas (BMC)

The Business Model Canvas (BMC) first was created by Alexander Osterwalder in 2008. This business model is formed by nine elements that demonstrate an overview of key business drivers (see Figure 4) (Osterwalder & Pigneur, 2010). BMC is an appropriate strategic management model that, as a useful tool, can depict value creation, relationships, and elements of success on urban farms (Pölling *et al.* 2017).

BMC is an instrument that gives useful insights from companies to highlight key success elements, identify barriers, compare competitors, and develop business ideas and innovations. It is commonly used by entrepreneurs to evaluate their business model. According to Henriksen and his colleagues (2012, p. 34)

Although the Canvas has a simple structure, it forms a complex system of interdependencies between the different elements.

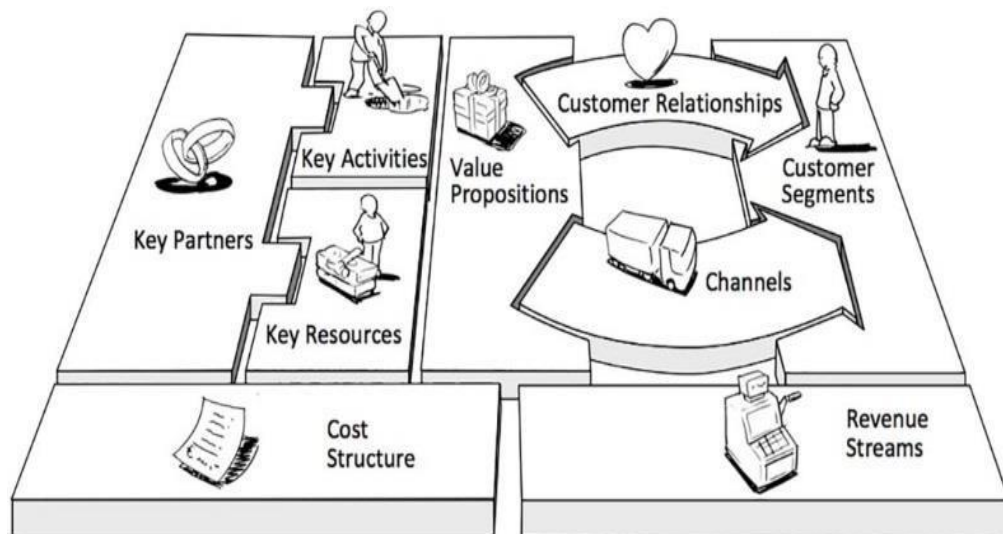











Figure 4: Business Model of Canvas; Osterwalder and Pigneur , 2010(page18-19)

The principles of business are defined by Osterwalder and Pigneur (2010) as 9 building blocks, each BMC block is briefly described below:

1.  **Customer segment:** The building block outlines the different groups of individuals or organizations that a company intend to attain and serve.
2.  **Value proposition:** The value proposition creates value for a customer segment through a set of products and services that meet the needs of that segment.
3.  **Channels:** The channels building block describes how the value proposition is communicated and delivered to customer segments.
4.  **Customer relationship:** Defines the type of customer relationship that a company establishes with each particular customer segment.
5.  **Revenue streams:** Represents how a company generates revenue
6.  **Key resources:** This block outlines the most important assets required to operate a business model
7.  **Key activities:** Describes the most important things a company must do to make the business model work.
8.  **Key partners:** Describes a network with people outside the organization, such as suppliers and partners that makes the business model work.
9.  **Cost structure:** The most important costs associated while operating under a business model

2.3 SWOT Analysis

The SWOT framework is credited to Albert Humphrey, who developed the approach at the Stanford Research Institute (SRI) back in the 1960s and early 1970s (Wikipedia n.d). SWOT analysis is a simple but widely used tool to assess the internal and institutional environment of a technology or business proposition (Downey 2007). For the strategic planning process, SWOT analysis is an initial but important "first step" in business planning that identifies potential market opportunities (Banerjee & Adenaeyer 2014). A SWOT analysis can be used to analyze the internal and external environment of the organization and can also be a support tool for decision making (Yüksel & Dagdeviren 2007).

2.3.1 Components of SWOT analysis

SWOT analysis is an analytic framework for strategic planning and strategic management approach that is employed to help organizations identify strengths, weaknesses, opportunities, and threats associated with the business competition or project planning. It is sometimes also called the SWOT matrix, which is used for situational assessment or analysis (Weihrich 1982). The word SWOT consists of the first letters of four components.

- **Strengths:** Features of a business or project that make it superior to others.
- **Weaknesses:** Features that put a business or project at a disadvantage compared to others.
- **Opportunities:** Factors in the environment that a business or project can use as its benefits.
- **Threats:** Factors in the surroundings that can cause problems for a business or project.

Evaluation outcomes can be given in the form of a matrix or as a paragraph (Ansoff, 1980) (see Table 2).

Table 2: SWOT analysis (Leigh 2009; p.115-140)

Internal	Strengths	Weaknesses
	a. b. c.	a. b. c.
External	Opportunities	Threats
	a. b. c.	a. b. c.
	Enhancer	Inhibitor

2.3.2 Internal and external factors

Strengths and weaknesses are often assumed to be internal factors, whereas opportunities and threats are often considered to be external factors (Minsky and Aron 2021). The notion of strategic fit is defined by the degree to which the firm's internal strengths match external opportunities (Andrews 1971; Mintzberg *et al.* 1998). Internal factors are considered as strengths or weaknesses depending on their impact on the goals of the organization. Some factors that may indicate strengths in one goal may be weaknesses in another which these factors may include personnel, financial and production capabilities. External elements such as macroeconomics, technological change, socio-cultural change, government rules and regulations as well as market changes, which a number of authors prioritize external factor assessment over internal factors (Minsky & Aaron 2021; Watkins 2007).

2.4 Strategy

The essence of strategy is defined as activities to provide a unique combination of value - the choice to do different activities than competitors or to do activities differently (von Rosing *et al.* 2015). Max McKeown's (2011) disputes that strategy is about shaping the future and using existing tools to achieve desirable goals, he agrees that strategy is about human endeavor and shaping the future (McKeown 2011). Henry Mintzberg (1978) of McGill University defined strategy as a model in the decision-making process as opposed to a view of strategy as planning. Strategy is very important to achieve goals due to the limited resources available.

It usually affects setting goals and preferences, setting activities to achieve goals, and mobilizing resources to implement the steps (Freedman 2015). A strategy describes how the future (goals) is achieved by tools (resources) (Simeone 2020). It can be considered or it can appear as a pattern of activity because the organization adapts to its environment or competes (Freedman 2015).

2.4.1 Combination of SWOT analysis & BMC

SWOT analysis is a tool that most business owners, managers and marketers are familiar with. It is a simple marketing tool and an attractive business strategy, but because of its simplicity it can have vague results, as SWOT lacks any framework for defining which aspect of a business should be analysed (Leahy,2021). SWOT analysis is considered as a starting point for discussion and by itself cannot guide managers how to achieve a competitive advantage, especially in a rapidly changing environment (Dess *et al.* 2012). This does not mean that SWOT should be eliminated, but it does mean that there is a way to use it in a more structured way, along with modern strategy tools. So that it can shape the business and marketing strategy with more communication and chances of success (Leahy, 2021).

A BMC is a tool that simply allows managers to define their businesses by using 9 fundamental building blocks. Its simplicity means they can quickly chart their current business (Van den Broeck, 2017). Most importantly, it provides a framework that SWOT analysis lacks, as well as defines the important dimensions of the business in a structured and standardized way. SWOT asks four important broad questions. In the first two cases, what are the strengths/weaknesses of business? - which are about the internal evaluation of the organization. The second two cases, - what opportunities exist in business and what possible threats it may face - evaluate the situation of the business in the outer environment. An appraisal of internal and external aspects remains essential for designing marketing strategy. In addition, considering both the "beneficial" and the "harmful" aspects will guide decision-makers in determining beneficial business protections or limitations that they must overcome (Banerjee & Adenaeuer 2014). On the other hand, one of the fundamental advantages of a BMC is that it can be used to design, challenge and test new business models - where is business going, and where the business will go in the future? what changes can managers make? - And then leaders in organizations can use this acquired knowledge to shape business and marketing strategy. It is therefore important to consider the Canvas analysis as a whole, and with the SWOT analysis, consider the overall strengths and weaknesses of the existing business model, and how opportunities and threats can be directed to new business opportunities (Leahy, 2021).

2.4.2 Sustainability

To better understand whether VF can compete with conventional farming in terms of sustainability, it is best to review the definition of sustainability. According to the report of the World Commission on Environment and Development (WCED 1987, p. 43), also known as the Brundtland Report, sustainable development is described as follows.

Meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

Sustainability bases the development debate on a global framework in which the ultimate goal is to meet human needs (Brundtland, 1987). Savitz and Weber (2007 p. 17-28) suggested that the discussion of business interests and the environment and society interests intersect in the operation of each company, and they called that “sustainability sweet spot”, which is the overlap between the company's goals of increasing market share and profits and its environmental goals of tackling climate change and public health. When transmitting this idea to the business, the sustainability of the company can be defined as meeting the needs of direct and indirect stakeholders of a company (such as staffers, customers and shareholders) without compromising the ability to meet the stakeholder's demands in the future. According to the concept of sustainability from orthodox management theory, economic sustainability alone is not a sufficient condition for the overall stability of a company (Gladwin *et al.* 1995a). A one-sided emphasis on economic sustainability can be successful in the short term. However, in the long term, sustainability requires all three dimensions of economic, environmental and social simultaneously (see Figure 5).

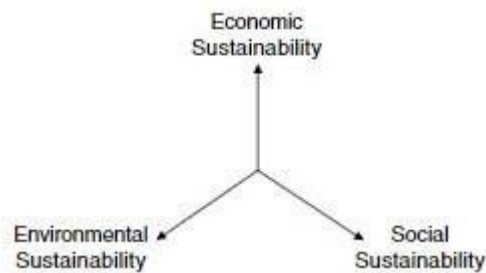


Figure 5: Three dimension of sustainability;(Dyllick & Hockerts ,p.130-141)

In the year 2015, the United Nations (UN) published 17 global goals for environmental, economic and social sustainability that are named the Sustainable Development Goals (SDGs) (Figure 6). These goals are set to be achieved by 2030. This is an urgent call for action by all countries - developed and developing - in a global partnership (United Nations, 2015).



SUSTAINABLE DEVELOPMENT GOALS



Figure 6: 17 Sustainable Development Goals (SDGs) by United Nations, 2015.



Zero Hunger (Goal 2), noted boosting agricultural productivity and sustainable food production with the help of maintaining ecosystems and improving land and soil quality to eradicate the threats of hunger. To achieve this goal, enterprises must keep and grow their economic, social and environmental capital. From this definition, three key components of corporate sustainability can be recognized (Dyllick & Hockerts 2002). Therefore, if VF can boost the achievement of these goals, it can also be considered a sustainable business by following the corporate sustainability guidelines. In the continuance of this report, definitions of sustainable development will be considered as prerequisites for the performance of vertical agriculture.

2.4.3 Environmental sustainability

It is very easy to start moving towards environmental sustainability: When everyone recognizes the limitations of ecosystems and natural resources, the design of economic decisions can be in such a way that the end products of those economic measures are environmentally sustainable (Sharma *et al.* 2010). The relationship between trade and environmental concerns is more related to the perspective of predicting environmental sustainability. In other words, the idea of environmental priorities makes sense for businesses (Gladwin *et al.* 1995b, Hawken, 1993, Costanza *et al.* 1991). Many approaches are based on this fundamental principle of

sustainability. One of the most common approaches that focus on business is to argue that environmental sustainability can contribute to economic profitability as well as a competitive advantage. Moreover, Hart (1997) has stated convincingly that environmental sustainability matches well with business profits motives, because it leads to excellent financial function, environmental sustainability may be best conducted by corporations. According to Dyllick and Hockert (2002, p.133) definition for environmental sustainability is:

Ecologically sustainable companies use only natural resources that are consumed at a rate below the natural reproduction, or at a rate below the development of substitutes. They do not cause emissions that accumulate in the environment at a rate beyond the capacity of the natural system to absorb and assimilate these emissions. Finally, they do not engage in activity that degrades ecosystem services.

2.4.4 Economics sustainability

Economic sustainability is when firms feel stable. For a business to be sustainable, it must be profitable. However, profit cannot overcome the other two factors of sustainability like, social and environmental. Especially, maximizing profits at any cost is by no means what the economic factor has to do with (Andrew 2021). Economic sustainability, in its easiest form, can be interpreted as, how enterprises remain in business (Doane & MacGillivray 2001). Sustainability of the economy requires a very broad understanding of the concept of capital, which is commonly used by economists (Dyllick & Hockerts 2002). Understanding that economic capital must be managed in a sustainable way is nothing new. Financial accounting, as well as managerial accounting, can provide managers with only an estimation of a company's economic capital. While in economic sustainable companies also need to have different types of economic capital such as financial capital (equity, debt) tangible capital (machinery) and intangible capital (technical knowledge). Accordingly, the definition of economic sustainability of companies can be as follows: Economically sustainable firms secure sufficient cash flow at any time to provide liquidity while making fixed returns above average for their shareholders (Dyllick & Hockerts 2002).

2.4.5 Social sustainability

For a company to be socially sustainable, it needs to internalize social costs and maintain and strengthen capital stocks (Gladwin *et al.* 1995b). One of the problems with this definition is that most companies fail to meet the expectations of all stakeholders at the same time because they are faced with the exchanges between the needs of different shareholders. One possible answer to this difficulty could be to define socially sustainable companies as companies that are fair and reliable to

all stakeholders (Zadek *et al.* 1997; Kaptein & Wempe, 2001). According to Dyllick and Hockert (2002, p.134), the definition for social sustainability is hence:

Socially sustainable companies add value to the communities within which they operate by increasing the human capital of individual partners as well as furthering the social capital of these communities. They manage social capital in such a way that stakeholders can understand its motivations and can broadly agree with the company's value system.

The concept of social capital is basically the value of social relationships and networks, which contribute to the growth of an organization's economic capital (Economic Times website 2022). From this perspective, a company can be considered as social capital management in a sustainable way when its stakeholders understand and broadly agree with the way a company is doing something (Dyllick & Hockert 2002).

3. Method

This chapter presents the method that is used in this study to achieve the study aim and answer the research question. The chapter includes the following headings: research approach, literature review, case study, semi-structured interview, data analysis.

3.1 Research approach

There are two options for researchers to conduct a business study, a quantitative or qualitative research strategy (Bryman & Bell, 2011). In this study, a qualitative research method has been used because according to Lakshman (*et al.* 2000), when there are no obvious variables to produce the result, qualitative research is appropriate. Moreover, Robson (2011) states that the qualitative method helps to achieve a deep understanding of phenomena in their real-world environment by focusing on social structures and man-made definitions. One of the reasons that a qualitative method has been chosen for this study is because this thesis deals with a detailed description of the situation that is under study (Bryman *et al.* 2015). Edmonson and McManus (2017), argued that insignificant maturity in a theoretical context indicates a greater likelihood of using qualitative research. According to Creswell and Poth (2016) where presenting the complexity of a situation is significant, qualitative design is preferred to discover the meanings that individuals or groups attribute to a phenomenon. In addition, Robson (2011) states that flexible research is an unformed "do it yourself" plan, and the researcher's job is to find a study strategy that helps the accomplishment of the project goal.

Start-up companies face many obstacles in the first steps that hinder their growth and even threaten their survival. These obstacles can be the effect of internal and external business forces that directly or indirectly impact the organization's decisions to varying degrees (Radomska & Kozyra 2020). The aim of the business model analysis is to gain a deeper understanding and expand the knowledge about the basic elements of a business model, which is important in strengthening and implementing the economy of business models as well as learning and creating a competitive advantage (Slávik 2011). In addition, this study employed Robson's

(2011) flexible method, as it allows the research design to evolve, the framework and tools utilized to be reviewed while continuing the research.

This study employs the BMC strategy suggested by Osterwalder and Pigneur (2010). After the researcher specifies 9 features in the BMC, the researcher conducts the SWOT analysis. The link between a SWOT analysis and the BMC in this study is that SWOT can support identifying the strengths, weaknesses, opportunities and threats that are faced by companies in the implementation process of the 9 components of BMC. This combination allows for centralized assessment based on evaluating of the company's capabilities and opportunities development in the future.

Thus, the study in this dissertation uses these steps, beginning with a research question that arises from the analysis of literature review and identifying a research gap (Robson & McCartan 2016). Research questions not only determine the purpose of the research but also guide the theoretical framework and method of data collection and analysis (Robson & McCartan 2016).

3.2 Literature review

The research was initiated by reviewing the literature to gain a better understanding of definitions and to compare various perspectives, as well as to identify gaps in academic knowledge, followed by reviewing recent empirical studies. The concept of the literature review is to gain an understanding of what is already known about a subject, what theories and concepts are utilized, what approaches are selected, and how they are applied. In this way, researchers can gain a better understanding of the issue and see if there is a knowledge gap in that area that can be fulfilled (Bell, Bryman & Harley 2018). In addition, as Yin (2009) stated that the literature review, and what has already been done and documented in relation to the research project, to achieve accuracy in formulating enlightening questions on the subject under study in preparation for the research, is central.

Secondary data used during the thesis project is to review the literature of peer-reviewed journal papers to give the research reliability and high quality. The review of previous literature was conducted in the databases such as; Google Scholar and the Web of Science. To find relevant articles, books, and reports keywords such as “Urban agriculture,” “Urban farming,” “Vertical farming,” “SWOT analysis” “Business model,” “Business model Canvas” were used. After that, reading the abstracts and sorting of the articles have done in order to find the most relevant ones to the topic to ensure the trustworthiness of the study, peer-reviewed and well-cited papers were picked. There was no time frame for searching to avoid restrictions. Recent research, however, has taken priority. The literature review made it possible to identify additional articles and key books related to the subject under study. In addition, dissertations and data generated outside of academic publication "Gray

Literature", such as websites, sustainability reports, and company documents were included in the project.

3.3 Case study

In this thesis, a case study design was chosen, in order to achieve the purpose of the study and gain a background understanding of the phenomenon. Because, according to Bryman and Bell (2015), a case study gives a chance to the researcher to discover a particular area through one or more items within the system, it also allows the researcher to find the opportunity to clarify the complexity of a phenomenon. The nature of the case study, or in other words, the main tendency among the types of case studies, is to try to clarify a decision or set of decisions: why they were made, how they were implemented and with what result (Schramm, 1971). This study considers the chosen aim, research questions, and the unit of analysis to investigate the case of the "Swegreen" vertical farm as a single case study. In order to analyse its business model strengths and weaknesses, to develop an understanding of how the company has planned its business model to respond to the threats and opportunities to be faced in the future. Another reason for choosing the case study was that start-ups active in this field have almost the same situation because these companies in Sweden are still young and dependent on financial flows. Therefore, the researcher thought that by choosing an in-depth study on one of them, the result could be beneficial to the others. However, attempts to make contact with another active companies in this area failed and only Swegreen agreed to dedicate time for the interview.

3.4 Semi-structured interview

There are two main types of qualitative interviews which according to Bryman (*et al.* 2015) are called structured and semi-structured. The main difference between the two types is that structured interviews often offer a fixed range of questions to the interviewee, while in semi-structured interviews, the interviewer has more flexibility in the range of questions. In order to get a better understanding of the phenomena in this study, empirical data will be collected through a semi-structured interviewee. A semi-structured interview is a good method to provide the respondent with the ability to drive the discussion toward what he or she thinks is important which provides the researcher with a deep perception of the situation (Bryman *et al.* 2015). Robson (2011) states that a semi-structured interview offers the interviewer flexibility and space, but it is recommended to have an introductory interview guide, which helps as a useful tool for covering specific themes. In order to collect insights about the firm's business model analysis, the researcher did a

semi-structured interview with, Mr Sepehr Mousavi, The Head of Innovation and Chief Sustainability Officer (see appendix 1 for the interview guide).

The interview questions were prepared before the interview and sent to the interviewee. The interviewee is defined as an assistant and a key informant in this approach, and an important element for the success of the case study (Yin 2009). A distance between the interviewer and applicant forced the interview to take place online. Although the first language of both the interviewee and interviewer was Persian, the interview was conducted in English to avoid translation and misunderstanding.

3.5 Data analysis

After interviewing, collected data such as all the notes and the voice recording of the interview was transcribed by the researcher in a document. Then data, related to the purpose and research questions, were highlighted for use in the coding process. The second stage of organizing in this project involves coding the theme proposed by Robson (2011). With the help of theories and tools shown in the theoretical framework the collected data was analyzed. By applying the BMC and SWOT analysis the external and internal factors affecting the company were investigated.

To evaluate whether VF can compete with conventional farming in terms of sustainability, the benefits and challenges of sustainability were identified, explained and analyzed. The BMC was applied to analyse the data for the results part with the use of the 9 identified building blocks. Conducting a SWOT analysis after identifying 9 building blocks in the BMC and sustainability analysis led to a better understanding of how to plan a sustainable business model for the future of the VF industry.

3.6 Ethical considerations

The researcher may encounter ethical issues during the research process; therefore, openness and honesty should be considered (Bryman & Bell 2015). In accordance with the principles of research ethics, participants in a study provided with the necessary information to be able to make an informed decision about whether or not to participate in the study (Bryman 2012). Participants also provided with a consent form explaining what the study involves. It is important to demonstrate to them that they understand the research, their role and its implications when obtaining their consent (Robson 2011). Accordingly, an informed consent document has been prepared for the interviewee to clarify what information is collected and how it will be used for the thesis project (the document is kept). Moreover, the interviewee agreed to be interviewed and recorded for the

study. Interviewee's contact information was retained with his consent, in order to verify the quality and transparency of the interview.

3.6.1 Quality assurance

Researcher, according to Robson (2011), is an instrument used in conducting flexible research. Therefore, the results of the study are highly dependent on the researcher's prior knowledge and skills and require a rigorous approach to data collection, analysis, and report writing in order to verify the accuracy, reliability, and validity of the findings (ibid). A traditional positivist research paradigm is used in this study to evaluate the quality of this study in terms of its validity, reliability, and objectivity (Bryman & Bell 2015).

3.6.2 Credibility

Bryman and Bell (2015) state that members of the social world have different views of reality. Therefore, the existence of credibility in research is crucial in order to assure that the data sources, the data analysis methods or any relevant information that was excluded from the study, as well as the conclusions of the author, are accepted by others (Bryman & Bell 2015). In order to meet this criterion, the research sources must agree or have trust in the researchers' interpretations or reevaluations of the findings (Gill *et al.* 2018). The credibility of the data was ensured by pattern matching when analysing multiple sources of data. The theories and models introduced in the theoretical chapter have also been used to analyse the findings. By making the research process transparently, credibility is enhanced.

3.6.3 Transferability

The transferability of research determines whether or not the findings can be applied in other contexts (Bryman & Bell 2015). To accomplish this, an accurate and continuous explanation of the social reality under investigation is expected. In order to provide accurate and detailed answers, this was taken into account when collecting the semi-structured interview. In Cziko's view transferability allows for "temporary understanding." Transferability acknowledges the fact that there are no absolute solutions to given situations; Instead, it is better for every individual to determine their own best practices. Nevertheless, it is important for readers to know that results are not always transferable. Readers should be aware that the outcome of this study, which took place under these circumstances, will not necessarily occur even under the same circumstances. Therefore, it is important to consider the differences between the situations and to refine the research process accordingly (Cziko 1992, p.10-27).

4. Results

This chapter describes the findings for Swegreen and the business model of the company under study that this information provided is essential for the analysis. Another purpose of this chapter is to present the relationship between the analysis of empirical data and the conceptual framework for providing an answer to the research question.

4.1 Swegreen

The research question to address the purpose of this study is “How can a sustainable business model for vertical farming as the future of agriculture be developed?”. In order to answer the research question, the Swegreen company was chosen as a case study. The goal is to have an in-depth study of VF business model at the Swegreen Company.

Swegreen is an agtech company in Sweden and the location of this VF innovation venture is in Stockholm. According to Mr. Sepehr Mosavi, Swegreen's chief innovation officer, the company started back in 2019 around a competent team that has somewhat twenty years of experience altogether in the VF industry. The company's business model is to produce food as close as possible to consumers like supermarkets and restaurants and shopping malls. They grow plants by using the hydroponic growing system and according to their website, “we are offering the world's most efficient and automated In-Store farming solution and the most hyper-local and climate-smart greens grown in our sustainable, circular, futuristic and controlled-environment systems”(Swegreen Website 2022).

Swegreen is a leading provider of urban agriculture in a service model powered by artificial intelligence farm management, cloud-based monitoring, and highly automated hardware platforms - which they call Farming as a Service (FaaS). Their In-Store Growth System(ISGS) secures the production of quality leafy vegetables and herbs for the customers with perfect flavour and minimum resources required (ibid). The first ISGS were launched back in 2020 and now they have about six, seven different units actually around Sweden in different cities and are planned to scale up from here and base on the solid proper concept. Swegreen tries to commercialize the VF technology and knowledge by having different units that can be installed at the customer's place, such as retail stores or restaurants, etc., in which

case the company team can take control of production remotely at the customer's place (ibid).

4.2 Business Model Canvas

The BMC acts as a link in creating value for customers, for companies, and helping companies explore external and internal environments (Ahokangas & Myllykoski 2014; Lynch, 2013), determining the key to a sustainable business, is mainly in the business model, i.e. how revenue is generated, how goods and services are produced, and how customers use the company's goods or services. The BMC of Swegreen's conditions was based on an interview with the Chief Innovation Officer(CIO), who then provided detailed information on the nine elements of Swegreen's BMC. The source person is considered to have the capacity to provide accurate information about the data needed to identify the 9 building blocks for the latest image of the current business model of the Swegreen company.

4.3 The 9 Building blocks in Swegreen

The following section is a brief description of each 9 building blocks in Swegreen's BMC as described by its CIO:



Customer segment: Swegreen's business model is to produce food as close to consumers as supermarkets and restaurants and shopping malls. So retailers are one of the most important customers for Swegreen, basically, there are different types of retailers in Sweden some of them are like ICA, Coop, Lidl, and City gross. As Mousavi said, "ICA is the biggest one and has been by far our most important customer because these are like businessmen and women who are quite agile". They also have restaurant customers like Fotografiska, the museum of photography in Stockholm, which is also another type of customer that they have in smaller units.



Value proposition: Swegreen's value proposition is a service offer that is called farming as a service. In that offer, customers can go and subscribe to a certain provision number of plants per day. In this method, the customer does not need to take any risk of buying a greenhouse and putting it inside the store. This is more likely to be offered to larger supermarkets because there is a need for some areas to put the greenhouse, and this is taken into account in the margins they receive after the sale of the plants. So it is very close to the end consumer and therefore there is no need for transportation. The product has a premier advantage in taste and quality compared to other ones that they buy in bulk or import on getting from others like actors in Sweden. It is also economically viable and comparable

and it is kind of prices that could actually go and compete with the conventional products.



Channels: Channels in Swegreen are much like a business relationship where they have to meet with their customers to tell them about the product. As a young business, they also need to convince customers to explore new opportunities, so they rely on customer-based relationships as a reference. For example, ICA is very important to them and they believe that if they could satisfy them they can get more contracts with other ICAs since they are connected to each other and the number of ICAs in (whole) Sweden is around eighty which can be a good market for them. According to Mr. Mousavi, having centralized systems, which is very important for a well-established brand, should have the same communication through different media, and all this can help you to have a stronger brand and contract with consumers. They also have a department called Customer Success (CS), and it has a variety of functions, from technical services to support, such as farm operators. Therefore, all technical components have been automated and digitized to take care of applications as well as customer planning.



Customer relationships: To stay in touch with their customers, they want to do whatever they promise. Swegreen has two different engagements with their customers and there are in two different senses, the first is people who should work as farm operators for their customers on the in-store farms, then Swegreen educates them with all the technical parts. Another area that is very important for Swegreen's customers is helping them to offer and sell products, they help their customers in marketing, positioning, campaigns, in-store displays and of course help them to have a very steady flow.



Revenue streams: As an innovative company, the generated revenue comes from production and operation, the more units they sell, the more margins and revenue are generated, but part of it also comes from their intellectual property and technology that is like a subscription model or “a vertical farming Netflix fee” as they named it.



Key resources: The most important key resources in Swegreen are advanced technology and pairing it with a good operating model, technical support as well as good customer support so that they can maintain their business and also be able to develop it.



Key activities: A key activity in Swegreen is how to turn a vision into (a) reality by creating a strategy. The technology sector is one of the important key activities that require heavy research and development to achieve in-depth technology. Production, sales and customer service are the other key activities in Swegreen and describe the most important things a company must do to make the business model work.












Key partners: As an innovative company, investors are among the most important partners that ensure the success of Swegreen business model. Despite the fact that some items are needed for technology to work, such as sensors and different tools, LEDs, as well as inputs such as seeds and different nutritional elements, all of these items can be obtained from different suppliers. Therefore, they are not so dependent on specific suppliers.



Cost structure: Creating the farm, constructing the infrastructure, and building the hardware are the most costly parts of their business model. Research and development, as well as human resource management, is also a very important and costly component. (see Table3)

Table 3: Business model canvas of the selected company

<p>Key Partners </p> <p>Investors, Inputs supplier, Retailers,</p>	<p>Key Activities </p> <p>Production Sales Customer Service</p>	<p>Value Proposition </p> <p>Provide farming as a service, The superior advantage in taste and product quality, Economically viable products High tech provision</p>	<p>Customer Relationships </p> <p>Educating customer's staff, Helping customers with selling, marketing, positioning, doing campaigns and demo in-store</p>	<p>Customer Segments </p> <p>Supermarkets Restaurants, shopping malls Retailers, Fotografiska ICA Coop City gross</p>
<p>Cost Structure </p> <p>Creating farm, Infrastructure, Consumable inputs, Staff</p>	<p>Key Resources </p> <p>Financial resources Supervising technology, Advanced technology, Customer support, Human resources, R&D, Production tools</p>	<p>Revenue Streams </p> <p>Monthly subscription fee, Units sale</p>	<p>Channels </p> <p>Communication through various media e.g. website and meetings Customer Success department</p>	

4.4 SWOT analysis

In this section, the SWOT analysis is presented as an overview of the CIO's descriptions of Swegreen's strengths, weaknesses, opportunities and threats.

Opportunities: After long experience working in this field managers thought that logistics was so heavy to run farms and sell or have a business to customer or B2C businesses (B2C stands for Business to Consumer. This refers to a time when a business sells products and services directly to the end consumer). So heavy operations experience for B2C turned them exactly toward a Business to Business or (B2B), that is a transaction or trade that takes place between one

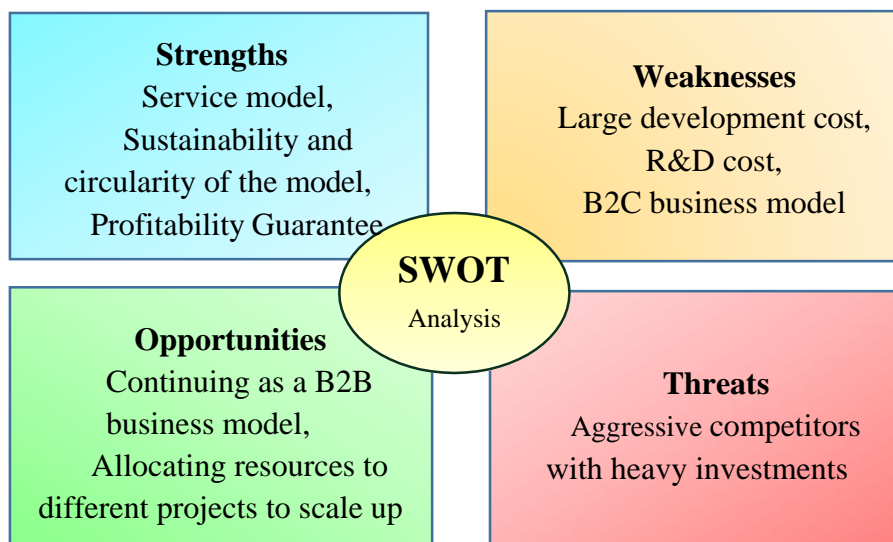
business and another business, such as a wholesaler and retailer. So they found it a great opportunity to continue as a B2B business. This reason led them to look at the modular farm in different cases and build a data system so that they could look at the intellectual property on the basis of intelligence. According to the Innovation Officer: “it is very important to allocate your resources to different projects so the priority of a good strategy and good vision is very important for a business to be able to scale up”.

Threats: If we look at the threats facing these small innovative companies we can easily identify their biggest threats. According to the chief innovation officer, there are some more aggressive players who are looking to dominate the market even if look at their financial statements, they are losing money on those businesses but they do it to take over the whole market share and suffocate their competitors. According to CIO “Thus, we need to have some heavy investment behind you if we want to compete with bigger brands, especially the ones that are more aggressive of course are difficult”.

Weaknesses: They have a significant weakness - having a greater number of costs than revenues. "We have large development costs behind us. It is quite common for tech companies to have red numbers in the first years with regard to research and development costs", says Sepehr Mousavi at Swegreen. Recently, they have changed their business model and move into the grocery stores to reduce the need for logistics because they believe that having individual customers or B2C businesses was one of the weaknesses in their business model.

Strengths: Among their strengths, there are two main ones, the first one is the service model, where customers do not need to take any risks which is super important for them. It is a business based on a guarantee, i.e., if customers are not satisfied with the profit or anything else, they can get their money or space back. The other strong point is much more focused on the sustainability and circularity of its model which the customers could actually rely on that. (see Table 4)

Table 4: SWOT analysis of the selected company



4.5 Combination of SWOT analysis & BMC

Since the purpose of this thesis is to analyse the business model of the company, in order to have a deeper look at the implementation of the business model components and analyse the impact of internal and external factors on it, the information in this section has been collected by the author and has been obtained through interview analysis.

The combination of SWOT analysis and 9 elements of Swegreen's BMC is shown in Table 5, which is to determine the strengths, weaknesses, opportunities and threats through the implementation of each element of the BMC.

Table 5: Combination of SWOT analysis & BMC (own processing)

Element	Strengths	Weaknesses	Opportunities	Threats
Customer segment	Big retailers e.g. ICAs	The most difficult type of customer	Extensive branches throughout the country	Market conquest by competitors
Value proposition	Farming as a service	Expensive infrastructure	Scaling up and running easier	N/A
Channels	Face to face communication	Need to convince	Customers act as a reference	Failure to fulfil commitments, loss of the entire network
Customer relationship	Educate and support customers	Customer relationship budget	New business opportunities and access to more retailers	Capture the market by competitors
Revenue stream	Monthly subscription fee, Units sale	Not sustainable revenue yet	Scaling up and diversifying the sectors	Different types of actors in the same sector
Key resources	Human resources, R&D	Expensive	Be able to scale up	Bigger competitors
Key activities	Production	Manual operation	Use technology for more automation	N/A
Key partner	Investors, Not dependent on suppliers, Big retailers	Difficult to work with retailers that are used to a very logistics steady system	Expanding retailers, achieve more investors support	Decrease customer trust level
Cost structure	Funding source from investors	Infrastructure is the most expensive	Achieve more fund and make money	N/A

4.6 Sustainability

Environmental sustainability: The company's main focus is on the sustainability of its products, in many different areas, including not using soil, space creation, water-saving, CO₂ emission savings, CO₂ capture and carbon capture with air from stores, and energy consumption reduction. Based on getting CO₂ from the air, and recycling excess heat from LEDs, many of these are the points they made, because they use precision agriculture for resource efficiency to prevent nutrient waste and water waste.

Economic sustainability: Swegreen is looking for scaling up and diversifying the sectors but as a young starter, it is difficult to say if they are looking at a very sustainable revenue stream because they are technology-driven and their profitability and income are very much dependent on development and technology.

Social sustainability: In terms of production, they produce high quality healthy and nutritious products for the consumer. Optimal controllable growing conditions promote proper growth, maximize nutritional value, and harvest at the peak of the growth cycle. Moreover, their organization has been very diverse in terms of the background of all employees. They like to work with different types of people with different backgrounds or genders. But, as Mr. Mousavi believed, as a Non-Governmental Organization (NGO) in the early stages, they still need to work a little more on social sustainability.

4.7 Sustainability analysis

Considering the sustainable dimension of VF and in order to analyse the key advantages of sustainability, the following (Figure 7) depicts the environmental and social benefits followed by economic benefits identified through an interview and secondary data in the VF industry.

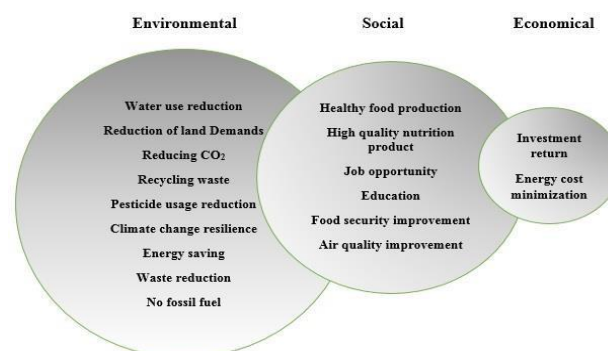


Figure 7: Key elements of sustainability in vertical farming(own prossesing)

5. Discussion

This chapter discusses the findings and how they relate to existing literature. The starting point for the discussion is research questions: How can a sustainable business model for vertical farming as the future of agriculture be developed?

5.1 Vertical farming

The aim of this research is to understand how VF can have a sustainable business plan. As highlighted in previous chapters, Swegreen brought agricultural products to retailer stores closer to the end customer, which reduce transportation and the disposal of agricultural products, and is very important for food security. So it shows that VF not only responds primarily to agricultural concerns related to climate change but also responds to long-term food security and availability for the growing population, which is according to one of the 17 Sustainable Development Goals set by the United Nations in 2015 "zero hunger" goal or in official wording is: "End hunger, achieve food security and improved nutrition and promote sustainable agriculture"(UN 2015).

Over the last years, agriculture has witnessed significant innovations and advances to bring food production systems closer to consumers due to growing interest in urban farming systems and alternative food systems with a focus on shorter supply chains. (Klerkx & Rose, 2020; Eigenbrod & Gruda, 2015; Benke & Tomkins, 2017; Pulighe & Lupia, 2020). Therefore, VF has been recognized as a promising solution to provide food resources and reduce pressure on agricultural land. In recent years, VF has witnessed widespread expansion, technical innovation, effective growth and promotion around the world. Although urban farming has many examples and methods, VF and hydroponics have been more popular options in urban environments around the world (Kozai, 2013; Kozai & Niu, 2016; Weidner *et al.* 2019; Specht *et al.* 2014; Armanda *et al.* 2019; Appolloni *et al.* 2020). The popularity of ISGS is also increasing in relation to residential, commercial and retail spaces (Bustamante 2020; Butturini & Marcelis, 2020). These new farming systems use new business models to ensure customers are provided with fresh plants and they have received several systems of widespread investment and expansion around the world (Jürkenbeck *et al.* 2019; Butturini & Marcelis, 2020).

As the result highlighted, in order to succeed and achieve a sustainable business model, Swegreen changed its strategy by innovating its business model, from selling products to customers to selling to businesses, which has led to lower corporate costs in the business model. Therefore, in-store growing service system examples can be considered sustainable business models that can help providers with approaches to transition to a circular economy and differentiate themselves from competitors (Amaya *et al.* 2014; Michelini *et al.* 2017).

5.2 Swegreen's BMC

According to the findings, the business model for the company can be divided into four main components that are the backbone of the nine main blocks of BMC in Swegreen, which are customers, value proposition, infrastructure and financial viability (Johnson, 2010; Osterwalder, 2004; Osterwalder & Pigneur, 2009; Stähler, 2001; Wirtz *et al.* 2010; Wüstenhagen & Boehnke, 2008). The results show that the value proposition is defined as a service offer in Swegreen, and they rely on advanced technology, which is a key asset in Swegreen, to achieve and create value. To maintain the business and scale up they require more automation and artificial intelligence, and they invest heavily in R&D as a technology-driven organization. As discussed by Chesbrough and Rosenbloom (2002), and Zott (*et al.* 2011) one of the most important tasks in a technology-based company's business model is to enable the company to obtain the highest possible value by commercializing the technology. In addition, as it is consistent with the results of the company, Swegreen's business model is based on developing economic value from the technology available in the vertical farming sector.

From a B2B business model outlook, creating value involves delivering new and local products but is also steered by intangible assets such as technology, innovation, intellectual property and consumer relations. Economically it is more difficult to quantify these factors, particularly in a retail environment where area for modules is restricted and usually costly. Thus, although value is created, the economic value, especially the profitability of systems for companies and the revenue generated for users of growing service systems, is not clear at this stage, and indicates novelty of the systems (Martin & Bustamante, 2021)

Swegreen, like all other companies, uses an operating model based on the integration of hardware and software to provide value. This is usually achieved through a platform for digital interaction between providers and system users that requires a set of people, procedures, and technology to deliver value, which according to Martin and Bustamante (2021), it derives from the principle of "Growth as a Service" model. This model is a kind of integration that involves participating in a large farm, where retailers or real estate owners invest in a

modular farm and the company takes care of their growth. There are many surveys, interviews and secondary sources that provide an understanding of the revenue models of these systems, while at this stage there is a combination of strategies and it is not yet clear whether modular systems provide a sustainable profit model over time (ibid).

5.3 Combination of SWOT analysis & BMC

To get a more objective view of the current position of the company in the field of business, a SWOT analysis is provided by comparing specific internal and external factors. The function of the SWOT analysis was employed to obtain information from situational analysis and to divide it into internal issues such as strengths and weaknesses and external issues such as opportunities and threats (Ferrel & Harline 2005). According to the results of Table 5, the data shows that although the strengths and the weaknesses in implementing 9 building blocks are still relatively equal, the opportunities outweigh the threats.

After analyzing the internal and external aspects of the company, it emerged that the company has very good knowledge about its biggest threats, there are some competitors who, although losing money in the financial statements, intend to take over the entire market. So this means that the company should start to realize opportunities and do some activities like an extension of the customer segment and channels that can have a significant benefit for the company. In addition to increasing profits, they need to invest heavily in further developing the company's technology. Because precision farming technology has a very high production efficiency, which makes their business very strong and inimitable.

Weakness is an internal negative aspect that can impair the firm's ability to achieve its mission, goals and objectives (Mustaniroh *et al* 2020). Unstable revenues, expensive infrastructure, and heavy reliance on technology are examples of weaknesses that the company may still face in the future. Their biggest strength can be the guarantee-based service model that satisfied risk-averse customers. According to Doganova and Eyquem-Renault (2009) the Growing Service System (GSS) providers are able to analyze the market and expand a network; Which is recognized as a tool for technology entrepreneurs and the key performance of business models.

5.4 Sustainability

In terms of environmental benefits findings highlighted that Swegreen use renewable energy sources for energy recovery and water recovery. As an urban

agricultural company, they preserve biodiversity, reduce waste and energy used to produce and supply food to the public (Ankri, 2010; Perez, 2014; Thomaier *et al.* 2015). However, according to Despommier (2010), VF is not a solution to all environmental problems, but it can be a significant help by providing solutions to existing problems. It has the potential to be a better alternative for conventional agriculture by minimizing the damage caused by agriculture and can replace industrial agriculture.

More than half of the world's fruit and vegetable products never reach the consumer due to storage and transportation or arrive when they cannot be consumed (FAO (2011)). Vertical agriculture, with its location in urban centres, has led to local production, which is an important part of the transition to transform the food industry. In a sustainable society, local production is a key step in reducing transportation and reducing food waste due to unused or unsold vegetables. In addition, indoor agriculture creates new jobs for growers, engineers and researchers in urban areas. Furthermore, because of the novelty of this industry, there is a need for training and education.

VF, depending on the growth and height of the field, can increase crop yield by up to 100 times compared to conventional farming (Kalantari *et al.* 2018). This means that not only does it reduce the need to find more farmland, but also can allow the natural ecosystem to recover. Moreover, plant growth in a controlled environment eliminates external hazards such as climate issues, natural disasters and internal issues such as germs and pests that damage the crop, which indicates the need to not use pesticides on vertical farms.

Eventually, VF has economic benefits by eliminating costly parts of the food supply chain, increasing efficiency in the region, and minimizing waste. However, the costs of creating farms, R&D, business development and marketing still outweigh the economic benefits. In (Figure 8), the comparison of dimensions of sustainability in Swegreen shows that economic sustainability is still insignificant compared to social and environmental sustainability. Therefore, more time in the market is required to assess if VF can be profitable sustainably.

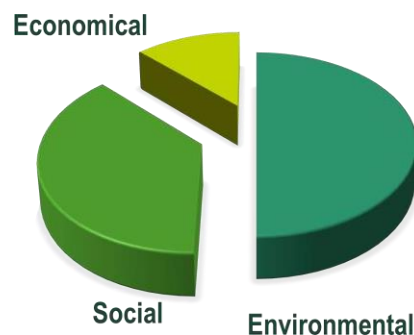


Figure 8: Comparison of three dimension of sustainability of selected company

6. Conclusion

The conclusion of this thesis is included in this section, which is based upon the findings of the chosen company, and at the end of this chapter, the author mentions future research that could be undertaken.

This study was initiated to investigate how economic sustainability can be developed in the VF industry as a future of agriculture in Sweden. VF has unique competitive advantages over conventional farming methods, including the ability to produce sustainable quality and quantity products very close to end customers throughout the year. It is a fledgling industry and still faces many challenges and opportunities and we have to consider that it is at a promising stage, but it is still too early to compare it with conventional agriculture economically.

A comparison of the findings in the sustainability section concludes that all of these benefits suggest that business models can be socially and environmentally sustainable, but when it comes to economic sustainability over time, there are still some uncertainties.

Using SWOT analysis, all aspects of the model business, such as strengths and weaknesses, opportunities and threats, were studied. According to the findings, managers of the company based on their experiences in this field, in order to achieve profitability and reduce costs in this industry have changed their business models. To stay in the market, they moved from B2C to B2B business model. This method has enabled them to significantly reduce costs such as location and energy costs, by creating small farms in large stores such as ICA or Coop. The subscription revenue model indicates company relies heavily on technology and as a technology-driven organization most of the investment is allocated to R&D.

It cannot be said that vertical agriculture is the solution to all the problems related to the food industry. It is rather an alternative of imported vegetables and herbs. If vertical farms companies want to last must turn a profit or at least reach a breakeven point. In an ideal world, in the existing condition of technology, vertical farms can meet the total demand for vegetables and plants in Sweden, leading to a reduction in imported alternatives.

The results of this study also highlighted a novel method employed by this firm is the development of technology and software systems in VF, as a new business

model. They used this approach as an exclusive way to improve their marketing strategies.

The generated value by these types of systems strongly depends on intangible products such as fresher yields, local production and automatic control over growing elements. To deliver this value, the company was designing a combination of hardware and software programs that offer a number of automated services to achieve the desired outcome. It was found that value capture strategies for these types of companies differ between B2C and B2B business models. Modular monetization units are often equipped with a subscription service for B2B contexts. There are key reasons for using these types of business models, including comfortability, local production advantages, improved product quality and greater flexibility in local food systems. Moreover, increasing transparency and awareness of VF methods and products are other benefits of these modular systems that are useful in marketing. Furthermore, it highlights that improving business models can lead to greater economic efficiency, reduce costs, revenue system improvements, and increased automation in a limited space. The results and knowledge generated through the empirical evidence from the business model of the Swegreen Company in vertical agriculture, which is referred to as "farming as a service" according to its CIO, can show a change in the attitude and performance of these businesses towards greater sustainability, and it can also be considered in the emerging literature as a sustainable business model in urban vertical farming.

The results of this study can be useful for "farming as a service" companies as well as retailers and modular VF systems for further development in various fields.

6.1 Further research

In this thesis, using a case study, an attempt has been made to examine the company's business model in-depth to understand how business models can affect new production technology in the Swedish agricultural food sector. The opinion of the author and the interviewed company is that in the current market situation, the success of VF in Sweden depends more on profitability. For further research, the focus should be on understanding the concepts in comparison to their larger-centralized counterparts and analysing their business models even in different countries, especially those that are profitable. In addition, more research is needed to study the role of technology on profitability and adopt these approaches to increase understanding of the opportunities and challenges of using sustainable business models. Therefore, more time, experience and research are needed to decide which alternative business model is more optimal for the profitability of VF.

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Personal messages

Mr. Sepehr Mousavi, The Head of Innovation and Chief Sustainability Officer in Swegreen, Google Meet interview, 22-April-08.

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Bahareh Maleki

Appendix 1: Interview questions

Introduction

- What is your position at the company? and can you briefly explain the background of the company? How many people do you have in your team? Where is the current location of company?

Business

- What value or benefits do you create for your customers? And what products and services do you offer to do this? And do you think your value proposition is well aligned with the customer's needs?
- What customer segments do you mostly serve? And who are your most important customers?
- What kind of relationship do each of your customers expect you to establish and maintain with them?
 - What motivation does the company have to maintain the relationships?
- Through which Channels can you reach your Customer Segments?
 - Which ones work better?
 - Which ones are most cost-efficient?
 - How do you raise awareness about your company's products and services?
 - How do you provide after-sales customer support?
- is production your main activity to generate revenue? if your answer is no, what is your other activity
- which one can you consider as your company's most important key resource to create a value proposition?
 - Human Resources?
 - production equipment?
 - Localization?
 - supervision technology?
 - Financial capital?
 - Are your key resources difficult for competitors to imitate?
 - Can you deploy key resources in the right amount at the right time?
- Who are the most important partner/supplier that makes your business model works?
- What are the most important cost inherent in your business model?
 - which key resources are most expensive?
 - Which key activities are most expensive?
 - Is your business model cost-driven (focus on minimizing cost wherever possible like using low price value proposition or maximum automation)

or value-driven (less concentrated on the cost and instead focus on value creation)?

- What a customer is willing to pay for?
- Are your revenue streams diversified and sustainable?

SWOT analysis

What kind of threats or opportunities in the vertical farming business has forced you to change anything in your business model?

If you will be asked to consider one weakness and one strength of your business model what it would be?

Sustainability

What are the environmental and social sustainability measures in your company?
Or do you have any sustainability reporting (a way of checking if organizations or companies are sustainable)?

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