



The Uptake of Vertical Farming Practices

- A case study on Tatton Agriculture Park in Kenya

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Abstract

This thesis provides insights into the opportunities and barriers surrounding the uptake of vertical farming practices in Kenya, specifically in the context of Tatton Agriculture Park. The findings contribute with existing knowledge on vertical farming and highlight the importance of addressing financial constraints and raising awareness to promote further uptake. The study emphasizes on the significance of entrepreneurial opportunities and value mapping in shaping the decision-making process of farmers and underscores the potential of vertical farming for sustainable agricultural practices, food security, and economic growth in Kenya. Although the FAO and EU Team could provide support for the development of new farming practices such as vertical farming, they do not explicitly target this method. Thus, making farmers the key decision-makers for its uptake in practice. To comprehend the opportunities and barriers associated with this practice, a case study was conducted in Kenya with data collected from various source. The findings of this research can inform policymakers, researchers, and practitioners in formulating strategies, policies, and interventions to support the development and uptake of vertical farming practices in Kenya and similar contexts.

Keywords: Vertical Farming (VF), Entrepreneurial Opportunity Theory (EOT), Value Mapping Theory (VMT)

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Abbreviations

CEA	Controllable Environment Agriculture
EOT	Entrepreneurial Opportunity Theory
EU	European Union
FAO	Food Authority Organisation
GDP	Gross Domestic Product
NFT	Nutrient Film Technique
US	The United States of America
VF	Vertical Farming
VMT	Value Mapping Tool

1. Introduction

This chapter will introduce the agricultural situation in the global north and global south regions. It will further discuss the empirical and theoretical problem that exists in Kenya while also identifying the knowledge gap for the research. The aim, the research questions and the delimitation of the research will also be presented in this chapter.

1.1. Theoretical Background

According to UN estimates, the world's population will reach 9.8 billion by 2050 (FAO, 2020), pointing out that greenhouse gas emissions from humans must be reduced to prevent adverse climate change (Smith et al., 2008). Agriculture is faced with a special challenge to not only develop agricultural methods that produce food with low greenhouse gas emissions, but also ensure consistency and productivity in food supply from an economical perspective (Garnett et al., 2013). Although agricultural output has increased along with population growth, yields have stalled in recent years leading for some to wonder if the productivity ceiling has been reached (Mueller & Binder, 2015). Considering the rising demand for food and the increasing population, the need for innovative and sustainable agricultural practices has become more pressing for farming as a business (Garnett et al., 2013). This situation has captured the attention of policy makers at both the national and regional level to push the development of agricultural practices that could potentially solve the problem (EC 2022). In the perspective of entrepreneurs, this situation can be considered as a business opportunity in the agricultural sector that could benefit involved parties such as food producers who could potentially gain an economic advantage (Shane & Venkataraman, 2000). For entrepreneurs to take advantage of this situation, they need to redefine their view of opportunities that aligns with the purpose of the business and this process involves changes like uptake of new technologies (Shane & Venkataraman, 2000). While vertical farming has gained attention as a potential solution for food security, there have been debates regarding its feasibility and effectiveness in addressing the challenges faced by agriculture globally (Yan et al., 2022). The phenomenon of vertical farming was first introduced by Gilbert Elis Bailey in 1915 and further developed by William Fredrick Gerick at the University of California at Barkley in 1930. In the 1980s, Swedish ecological farmer Ake Olsson created a spiral rail system for vertical farming, suggesting it as a way to cultivate vegetables in cities (Despommier, 2019). The idea behind the phenomenon of vertical farming is to grow plants in multiple stacks of vertical layers from the ground rather than growing flat on the fields, to maximize space efficiency and minimize environmental impact experienced in traditional farming methods (Despommier, 2019). Nowadays, vertical farming embraces the principles of soilless farming which includes methods like hydroponics – a modern farming technique that involves cultivating plants without soil using a nutrient-rich water solution to deliver essential nutrients directly to the plant roots (Despommier, 2019). This method allows precise control over nutrient levels and water distribution, optimizing plant growth and yields (Despommier, 2019); Aeroponics – a method where plants are grown in an air or mist environment without the use of soil or traditional hydroponic media (ibid.). Nutrient-rich mist is periodically sprayed directly onto the plant roots, promoting efficient nutrient absorption and rapid growth (Despommier, 2019); and Aquaponics – is a unique integrated system that combines hydroponics with aquaculture which can also be referred to as fish

farming (Despommier, 2019). In aquaponics, fish are raised in a tank, and their waste provides nutrients for the plants grown hydroponically. The plants, in turn act as a natural filter, cleaning the water that is then returned to the fish tank (Despommier, 2019), with the aim of maximizing the use of available land and space, both urban and rural, to produce as much food as possible (ibid.). To achieve this goal, modern ideas of vertical farming use indoor farming techniques and controlled environment agriculture (CEA) technology, in which all environmental conditions such as light, humidity, and temperature can be regulated (Nimaan & Sezgin, 2021). Thus, CEA can be viewed more like a collective term for any form of agriculture practiced within an artificial surrounding for the plants grown, which can be controlled in the aspect of either temperature, humidity, air, water, and or lighting (Despommier, 2019). Nimaan and Sezgin (2021), describe vertical farming as a farming technique that involves hydroponics to cultivate plants in nutrient-enriched water, either with or without mechanical support provided by an inert medium such as sand or gravel. This approach to plant growth eliminates the use of soil, and instead, the plant is supported by an inert growing medium, such as cocopeat, while being nourished through a nutrient-rich water solution (Nimaan & Sezgin, 2021). Hydroponics is known to use up to 95% less water compared to traditional farming (ibid.). Hydroponics offers several advantages, such as rapid plant growth, a decrease in soil-related cultivation issues for both biotic and abiotic, and reduced use of fertilizers and pesticides, as well as lower water and nutrient usage by approximately 50% (Nimaan & Sezgin, 2021). However, it is labour-intensive and requires careful management of the nutrient solution to maintain plant health and growth (Nath, Sharma, & Singh, 2019).

Vertical farming has continuously been an emerging trend in the global North region, particularly in countries like the United States, Japan, and the Netherlands (Despommier, 2019; Kozai, Niu, & Takagaki, 2019). In the US, vertical farming is gaining popularity as a means of producing fresh produce in urban areas, where access to locally grown produce is limited (Graamans et al., 2021). There are several large-scale commercial vertical farms in operation in the US, such as AeroFarms and Plenty, which use hydroponic and aeroponic systems to grow leafy greens and other crops (Brin, Fesquet, Bromfield, Murayama, Landau, & Kalva, 2016). Similarly, in Japan, vertical farming is being explored as a means of addressing food security challenges, particularly in the wake of natural disasters such as earthquakes and typhoons (Kozai et al., 2019). The Netherlands is also emerging as a hub for vertical farming, with companies like Philips and PlantLab leading the way in developing innovative technologies for vertical farming (Despommier, 2019). While vertical farming is still regarded to as a relatively new and evolving field, its potential for sustainable food production and reducing the carbon footprint of agriculture is gaining attention and investment from both the public and private sectors (Yan, Liu, Liu, & Zhang, 2022).

In the global south region, the growth of vertical farming has not been relatively as rapid as the global north region, despite the agricultural sector is a key contributor to the economy of developing and developed countries within the region (Paucek, Durante, Pennisi, Quaini, Gianquinto & Orsini, 2023). Some of the countries that have already up taken vertical farming are South Africa, Morocco, Egypt and Kenya (Nimaan & Sezgin, 2021). However, Kenya is also one of the countries that will face considerable challenges in its agriculture development

and food systems (Paucek et al., 2023). With a rapidly growing population, it is expected that Kenya will face increasing demand for food in the coming years (FAO, 2020). This, combined with the effects of climate change, threatens the country's agriculture sector which accounts for over 30% of the country's Gross Domestic Product (GDP) that employs more than 60% of the workforce by putting food security at risk (Kimani-Murage, Schofield, Wekesah, Mohamed, Mberu, Ettarh, Egond, Kyobutungi, & Ezeh, 2014; FAO, 2020).

Therefore, according to Garnett et al., (2013), agricultural sector in developing countries such as Kenya faces several difficulties that need to be continuously addressed. To potentially tackle these issues, there is urgent need to develop the current farming practices and whereby entrepreneur like farmers and food producers can use this opportunity to grow their businesses and increase their profit margins. The phenomenon of vertical farming will be essential in enhancing development of farming practices to promote sustainable growth and progress of the agricultural sector according to the author of this paper.

1.2. Empirical background

Improving agricultural productivity is key to reducing poverty and stimulating economic growth in Kenya (FAO, 2020). In this context, vertical farming has emerged as a potential solution for addressing some of the challenges faced by the Kenyan agriculture sector such as scarcity of arable land, soil acidity due to excessive use of chemical fertilizers, fungicides, pesticides and herbicides, scarcity of water, and harsh climatic conditions (Despommier, 2019). Vertical farming is being implemented in Kenya; however, its uptake has mostly been slow despite the profitability aspect of such farming practices (Nimaan & Sezgin, 2021). The implementation of vertical farming would require significant investment in infrastructure, technology, and skilled labour (Liu, Chen & Liu, 2004; Nimaan & Sezgin, 2021). Moreover, the feasibility of vertical farming depends on the availability of resources such as energy and water, as well as the presence of supportive policies (Despommier, 2019). According to Nimaan & Sezgin (2021) the total number of vertical farms that exist in Kenya are not known but there are few vertical farms implemented. There is a gap in knowledge regarding the process of implementing vertical farming practice in this national context. One of the knowledge gaps identified concerning the development of vertical farming in Kenya is lack of effective implementation strategies to maximize the value of business opportunities when they present themselves (Paucek et al., 2023). This would include identifying the appropriate infrastructure requirements, such as farm structures, irrigation systems, and lighting technologies, that are suitable for the local conditions (Despommier, 2019). It would also involve exploring different business models and factors surrounding operational practices such as resource management, skilled labour and policies or regulations that can maximize the profitability and sustainability of vertical farming in the given context. According to Shane & Venkataraman (2000), such factors can be referred to as opportunities. Opportunities come with challenges of their own which are context based (Yan, Liu, Liu, & Zhang, 2022), In the case of developing vertical farming, farmers may experience certain barriers that may hinder or slow down the process of adopting vertical farming (Yan, Liu, Liu, & Zhang, 2022). It is important for farmers to understand the barriers they face with the uptake of vertical farming since it creates the value for their businesses (ibid.). Therefore, by understanding the

opportunities and barriers that farmers face will help them in making decisions on the implementation strategies for vertical farming in Kenya.

By addressing this knowledge gap, policymakers, researchers, and practitioners can gain a comprehensive understanding of the specific barriers and opportunities associated with implementing vertical farming in Kenya. This knowledge can inform evidence-based decision-making, policy formulation, and the development of strategies that promote sustainable agricultural practices, enhance food security, and stimulate economic growth in the country. Therefore, there is a need for empirical research to understand the motivations and barriers to the uptake of vertical farming, as well as its financial impact of food production in Kenya (Paucek et al., 2023).

1.3. Research Aim and Questions

This research aimed to contribute with a better understanding on the development and uptake of vertical farming in Kenya. This study focused on the uptake of vertical farming at the level of the farm by conducting qualitative research using a single case study on Tatton Agriculture Park in Kenya. The questions this study addressed to fulfil the aim of this research are:

- What opportunities are conceived by Tatton Agriculture Park farmers to uptake vertical farming practices?
- What barriers are conceived by Tatton Agriculture Park farmers to uptake vertical farming practices?

1.4. Scope and Delimitation

The author of this study was exposed to some limiting factors while conducting the research. Some of these delimitations were: First, the study focused specifically on the field of business administration which was conducted using a single case study approach. Second, the study was limited to the specific geographic location of Kenya and did not consider the uptake of vertical farming in other countries or regions. Third, the study focused primarily on the perspective of farmers and did not consider the perspectives of other stakeholders, such as consumers, government regulators, or investors. Fourth, the study focused on qualitative data using a single case study to conduct the research which restricts the breadth of data available for analysis. While qualitative methods provide rich and detailed insights, the findings may not capture the full range of perspectives and experiences that could emerge from studying multiple cases. This limitation might hinder a comprehensive understanding of the research topic. Lastly, the scope of the study was fitted to a specific time frame of twenty weeks and did not investigate long-term trends or changes in the uptake of vertical farming as a farming practice. Additionally, due to budget constraints, the author conducted interviews online due to insufficient travel funds and time constraints. These delimitations helped to provide a clear focus for the study to ensure that the research questions were feasible and answerable within the scope of the research.

Unit of Analysis

The unit of analysis for this research was “Tatton Agriculture Park”. The analysis was focused on the practices of the farmers in Tatton Agriculture Park.

1.5 Outline

Figure 1 below represents the outline of this research to aid in the planning, organisation and execution of the research by contributing to the quality and effectiveness of the study. Chapter 1 serves as the foundation of the research, introducing the reader to the overarching context, problem statement, objectives, significance, and limitations of the study. Chapter 2 conducts an in-depth review of relevant theoretical frameworks in past literature to provide a comprehensive understanding of the subject matter of the research to formulate a conceptual framework that is viable to the research. Chapter 3 details the research methods used to gather data and analyse it effectively. Data quality and validity assurance processes are also outlined, including steps taken to maintain data integrity and ensure the reliability of findings. These processes involve anonymizing personal data, secure storage, and rigorous data analysis techniques. Chapter 4 presents the empirical findings of the research based on the data collected through semi-structured interviews with farmers at Tatton Agriculture Park. Chapter 5 takes the findings from Chapter 4 and subjects them to a rigorous analysis based on the conceptual framework developed from the theoretical framework in the literature review. Chapter 6 engages in a comprehensive discussion of the research findings. It connects the data analysis to the existing literature reviewed in Chapter 2, drawing upon relevant studies to support and contextualize the findings. Chapter 7 serves as the culmination of the research journey. It revisits the research problem, objectives, and significance, summarizing the key findings and insights obtained throughout the study providing recommendations for the research.

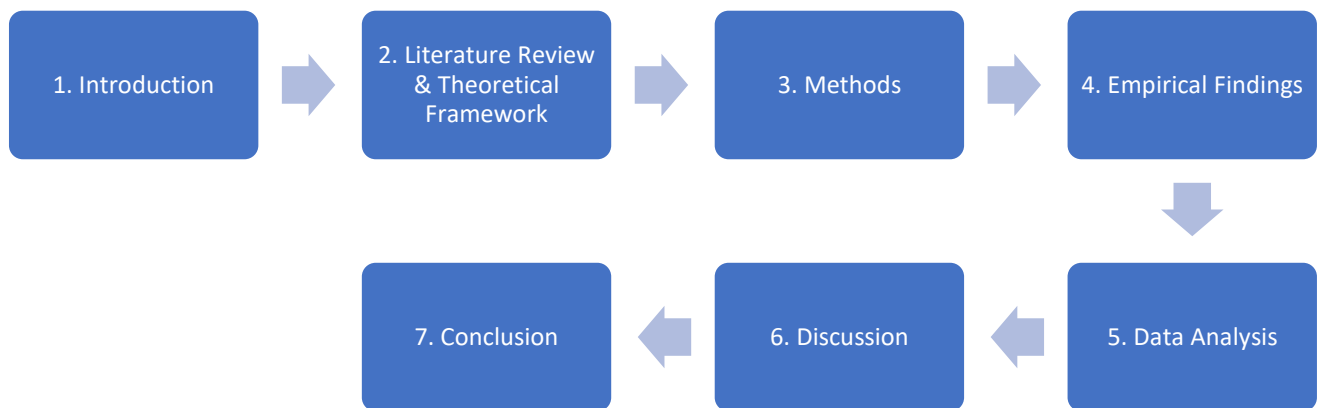


Figure 1. Outline of the research (Author's processing)

2. Literature Review and Theoretical Framework

This section of the paper starts with a detailed examination of the literature on vertical farming and the theoretical framework applied for the research i.e., Entrepreneurial Opportunity Theory (EOT) and Value Mapping Theory. It also describes how these theories can be used to analyse opportunities and barriers for the uptake of new technologies. Thereafter, a conceptual framework is used to provide an analytical approach for this study.

2.1 Entrepreneurial Opportunity Theory:

Entrepreneurial Opportunity Theory, developed by Shane and Venkataraman (2000), is a theoretical framework that seeks to explain how entrepreneurs identify and exploit opportunities for new ventures. The theory suggests that entrepreneurship is fundamentally driven by the identification and exploitation of opportunities in the external environment outside the organization (Ardichvili, Cardozo & Ray, 2003). In a nutshell, according to Shane and Venkataraman (2000), entrepreneurial opportunities can be defined as situations in which new goods, services, or business models can be introduced, and value can be created and captured by entrepreneurs.

Entrepreneurial Opportunity Theory argues that opportunities arise from changes or discrepancies in the external environment of the organisation, such as technological advancements, market shifts, regulatory changes, or social and cultural trends (Shane & Venkataraman, 2000). These changes create gaps or unmet needs in the market, and entrepreneurs are seen as individuals who are uniquely capable of identifying these gaps and exploiting them to create innovative and value-adding solutions (ibid.). The theory highlights the cognitive abilities, prior knowledge, social networks, and entrepreneurial skills of individuals as key factors that influence their ability to identify and exploit opportunities (Shane & Venkataraman, 2000).

Entrepreneurial Opportunity Theory also emphasizes the dynamic nature of opportunities (Stevenson, Roberts, & Grousbeck, 1999). Opportunities are not fixed entities, but rather subjective and context-dependent perceptions of possibilities for action (Stevenson et al., 1999). Entrepreneurs interpret and evaluate opportunities based on their subjective perceptions, and their decisions to pursue or exploit opportunities are influenced by their cognitive processes, motivations, and capabilities (ibid.). Entrepreneurial Opportunity Theory suggests that entrepreneurs engage in a process of opportunity identification, evaluation, and exploitation, which involves a continuous cycle of sensing, seizing, and reconfiguring opportunities based on the changing external and internal conditions (Ardichvili et al., 2003). This process is displayed in figure 2.

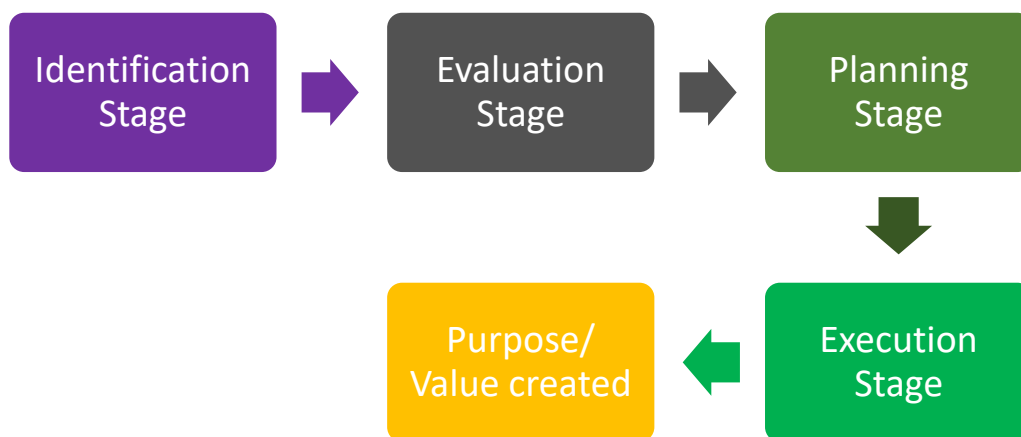


Figure 2. Process of Opportunity Identification (Author's processing) Source: Shane & Venkataraman, 2000

Furthermore, Entrepreneurial Opportunity Theory emphasizes that the process of opportunity identification and exploitation is influenced by the resources and capabilities of entrepreneurs and their ventures (Ardichvili et al., 2003). Entrepreneurs need to mobilize and leverage their resources, such as financial capital, human capital, social capital, and technological resources, to pursue opportunities and create value (ibid.). Additionally, entrepreneurial capabilities, such as creativity, opportunity recognition, strategic thinking, and risk management, are crucial in the process of identifying and exploiting opportunities (Shane & Venkataraman, 2000).

Entrepreneurial Opportunity Theory provides a framework for understanding how entrepreneurs identify and exploit opportunities in the environment to create and capture value. It highlights the dynamic and subjective nature of opportunities, the importance of resources and capabilities, and the role of entrepreneurial cognition and decision-making in the entrepreneurial process.

Therefore, the EOT developed by Shane and Venkataraman (2000), focuses on how entrepreneurs identify, evaluate, and exploit opportunities in the market. In the context of technology adaptation, this theory can be used to analyse how entrepreneurs identify and evaluate opportunities for up taking vertical farming, and how they exploit these opportunities to create value and generate profits. It can help understand the entrepreneurial mindset, skills, and actions that are required for successful technology adaptation, such as opportunity recognition, resource mobilization, risk-taking, and innovation. In recent years, EOT has been increasingly applied to analyse the adaptation of technology in various industries, including the agricultural sector (Oviatt & McDougall, 2005).

In the next chapter, the author will excavate into analysing the barriers associated with the context of vertical farming in Kenya by employing the value mapping theory approach. This will provide a more in-depth understanding of the barriers that farmers face in the uptake of vertical farming practices, and how these can potentially be overcome.

2.2 Value Mapping Theory:

The VMT is a framework for sustainable business modelling that aims to help companies align value creation for all stakeholders, including the environment and society, at all levels and through all activities of the business (Bocken et al., 2013).

According to Bocken et al., (2013), "value is the product or service the firm offers to its stakeholders".

The theory considers multiple forms of value: value captured, value missed, value destroyed, and new value opportunities (ibid.). It takes a multi-stakeholder perspective and explores both positive and negative forms of value creation to provide a systemic approach to the generation of new business model ideas for sustainability (Bocken et al., 2013). Ultimately, the value mapping theory seeks to identify and reduce conflicts and trade-offs between different stakeholder groups and assist in better aligning positive outcomes for all stakeholders (Bocken et al., 2015).

The framework has been used to create a tool which provides a systemic approach for generating new business model ideas for sustainability that considers both positive and negative forms of value creation and uses a multi-stakeholder perspective (Bocken, Rana & Short, 2015). The tool aims to help businesses align value creation for all stakeholders, including the environment and society (Bocken et al., 2013). The value mapping process involves four brainstorming sessions that focus on understanding the purpose of the business. These sessions involve: identifying positive and negative value created for stakeholders, identifying value missed or destroyed, and brainstorming new positive value opportunities (Bocken et al., 2015). The tool can be described figuratively in the figure 3 below (ibid.).



Figure 3. Value Mapping Tool (Author's processing) Source: Bocken et al., 2013

Entrepreneurs in the agricultural sector are always looking for ways to improve their yields, reduce costs, and increase profits (Bellwood, 2023). One promising technology that has gained significant attention in recent years that aligns with quality and quantity production of food is vertical farming (Yan, Liu, Liu, & Zhang, 2022; Despommier, 2019). However, the uptake of vertical farming has been slow due to various barriers, including high capital costs, lack of knowledge, and regulatory hurdles (Paucek et al., 2023). Given the functionality of the value mapping tool, farmers can utilize it to formulate strategies that will help them overcome barriers as entrepreneurs (Bocken et al., 2015). For instance, high capital costs are one of the main barriers to the uptake of vertical farming (Despommier, 2019). By mapping the value proposition of their business, farmers can identify the key costs associated with the technology, such as equipment, infrastructure, and energy costs (Bocken et al., 2015). They can also identify the potential savings that can be achieved by the uptake of vertical farming as a new technology, such as reduced labour costs, improved yields, and reduced transportation costs (Bocken et al., 2013).

Another important barrier that is common with the uptake of new technology is the lack of knowledge and expertise to utilize it effectively and efficiently (Bocken et al., 2015). According to Bocken et al., (2013) entrepreneurs can use the value mapping tool to identify the areas where they need to develop their knowledge and skills: in the case of vertical farming, these areas would be such as plant biology, lighting, and type of systems the vertical farm uses e.g., hydroponics. The participants can also identify the potential benefits of up taking this technology, such as increased yield and reduced environmental impact (Bocken et al., 2015).

Regulatory hurdles are another barrier to the uptake of new technology (Bocken et al., 2015). By mapping the value proposition of their business, entrepreneurs can identify the regulations and standards that they need to comply with to uptake this technology (ibid.). They can also identify the potential benefits of complying with these regulations, such as improved food safety in the context of vertical farming and reduced environmental impact (Bocken et al., 2015).

Once entrepreneurs have identified the different barriers associated with the uptake of a new technology – vertical farming in this case, they can use the value mapping tool to develop strategies to potentially overcome them (Bocken et al., 2013). For instance, they can identify potential partners, such as government agencies, research institutions, and investors, to provide support and resources that might help them potentially overcome these barriers (Bocken et al., 2015). They can also identify potential customers who are interested in sustainable and locally grown produce and tailor their marketing and sales efforts to appeal to them (Bocken et al., 2015).

Although primarily developed for new business model ideas, value mapping tool has potential for wider purposes of sustainable business thinking (Bocken et al., 2013). However, it has some limitations, including being mainly suited for qualitative assessment and for initial assessment of value, rather than in-depth analysis (Bocken et al., 2015). Ultimately, the value mapping tool offers a structured and comprehensive approach for businesses to consider sustainability across all levels and activities and align value creation for all stakeholders (Bocken et al., 2015).

2.3 Conceptual Framework

In this section, the paper will describe how the EOT and value mapping theory can be combined to achieve the aim of the study. This will be attained by utilising ideas others had in past literature to formulate an approach suitable for the study.

The purpose of the author's literature review is to critically examine how the existing research with such literature utilizes Entrepreneurial Opportunity Theory to analyse technology adaptation in various contexts. The author did this to learn about how others have applied this theoretical framework to his study to investigate uptake of vertical farming in Kenya with a focus on local farmers. This literature review will provide insights to understanding the dynamics of opportunities in technology adaptation in the context of vertical farming where farmers are entrepreneurs in this case. The value mapping theory is a useful framework for entrepreneurs, especially farmers, to analyse the different opportunities and barriers associated with the uptake of new technologies such as vertical farming. By mapping the value proposition of their business, entrepreneurs can identify the costs and benefits associated with the technology, the areas where they need to develop their knowledge and skills, and the regulations and standards that they need to comply with. They can also develop strategies to overcome these barriers by identifying potential partners and customers who are interested in sustainable and locally grown produce. By doing so, entrepreneurs can create a more efficient and profitable business model that benefits both their business and their customers.

This paper will use entrepreneurial opportunity theory to identify and analyse the opportunities that arise from the uptake of vertical farming at the farm level. The theory suggests that

entrepreneurs are constantly looking for new opportunities to create value and make a profit by identifying and exploiting gaps in the market (Shane & Venkataraman, 2000). It provides a framework for understanding how entrepreneurs identify and pursue opportunities (ibid.). According to Shane and Venkataraman (2000), when it comes to adopting new technologies such as vertical farming, entrepreneurs can use this theory to analyse the opportunities that the technology presents in the following stages:

1. Identification: Potential opportunities can be recognized using the EOT. For example, farmers may see a need to provide fresh produce to local markets or to meet the increasing demand for organic produce.
2. Evaluation: Once potential opportunities have been identified, entrepreneurs can use the theory to evaluate the potential for success. This includes assessing factors such as market demand, competition, and the resources needed to pursue the opportunity.
3. Planning: Entrepreneurs can use the theory to develop a plan for pursuing the opportunity. This includes determining the specific actions needed to take advantage of the opportunity, as well as the resources and capabilities needed to execute the plan.
4. Purpose development: Finally, entrepreneurs can use the theory to take action and pursue the opportunity. By continually assessing and adjusting their approach based on market feedback and other factors, they can maximize their chances of success. At this final stage, the purpose of the business is created.

This opportunity analysis process can be visually displayed in figure 4. The first three stages can be ideally viewed as a filtration process for the opportunity. Once the factors surrounding the success of the opportunity are clear, the purpose of the entrepreneur is identified and executed. From the final stage, the value mapping process can now begin given the purpose of the business is identified. This is how the entrepreneurship opportunity theory and value mapping theory can be utilized to analyse opportunities and barriers for up taking a new technology by entrepreneurs.

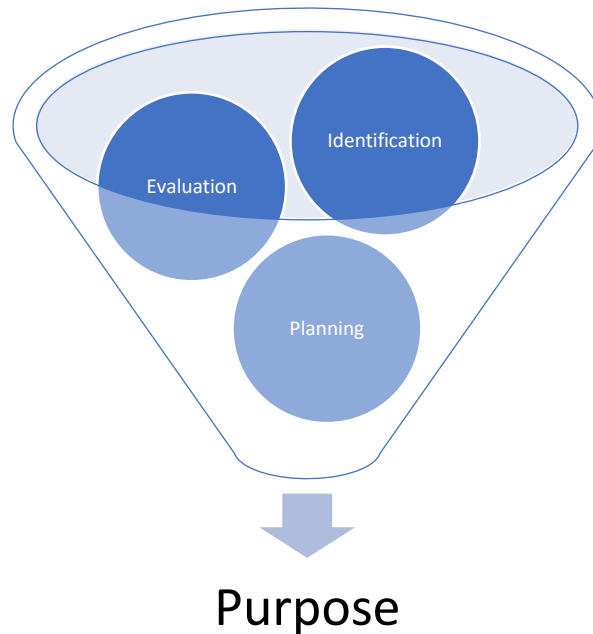


Figure 4. Opportunity analysis process from literature (Author's processing) Source: Shane & Venkataraman, 2000

Value mapping theory will be used to identify the barriers surrounding uptake of vertical farming from a farmer's perspective by analysing value created and destroyed. It emphasizes the importance of understanding the interests and needs of different stakeholders, including the farmer, suppliers, customers, and the wider community (Bocken et al., 2013). This analysis is important because vertical farming as a practice is tied to the value it creates for farmers or entrepreneurs and with that comes with barriers and opportunities that arise from it. Therefore, this approach can be helpful to analyse barriers that may come with the uptake of a new technology to create or add value (Bocken et al., 2015).

According to Bocken et al., (2013), the value mapping process can be broken down in the following steps to identify barriers surrounding the uptake of a new technology for entrepreneurs:

1. Identify stakeholders: The first step in using the value mapping theory is to identify all the stakeholders involved in the technology uptake process (Bocken et al., 2015). This includes not only the entrepreneurs themselves, but also suppliers, customers, regulators, and other parties who may be affected by the new technology (ibid.).
2. Assess value creation and destruction: The next step is to assess how the new technology creates value for each stakeholder, as well as any negative impacts it may have (Bocken et al., 2015). For example, vertical farming may create value for farmers by increasing crop yields, but it may also destroy value for traditional suppliers of agricultural products.
3. Identify barriers: Once you've assessed the value creation and destruction, you can start to identify any barriers that may be preventing the uptake of the new technology

(Bocken et al., 2015). These could include regulatory hurdles, lack of access to financing, or technical challenges (ibid.).

4. Brainstorm solutions: Finally, using the insights from the value mapping analysis, you can brainstorm potential solutions to the barriers identified. This could involve finding ways to mitigate negative impacts on certain stakeholders, or identifying new sources of value that the technology could create (Bocken et al., 2015).

By using the value mapping theory in this way, farmers can gain a deeper understanding of the challenges and opportunities associated with up taking new technologies and develop strategies to overcome barriers and create value for all stakeholders involved (Bocken et al., 2015).

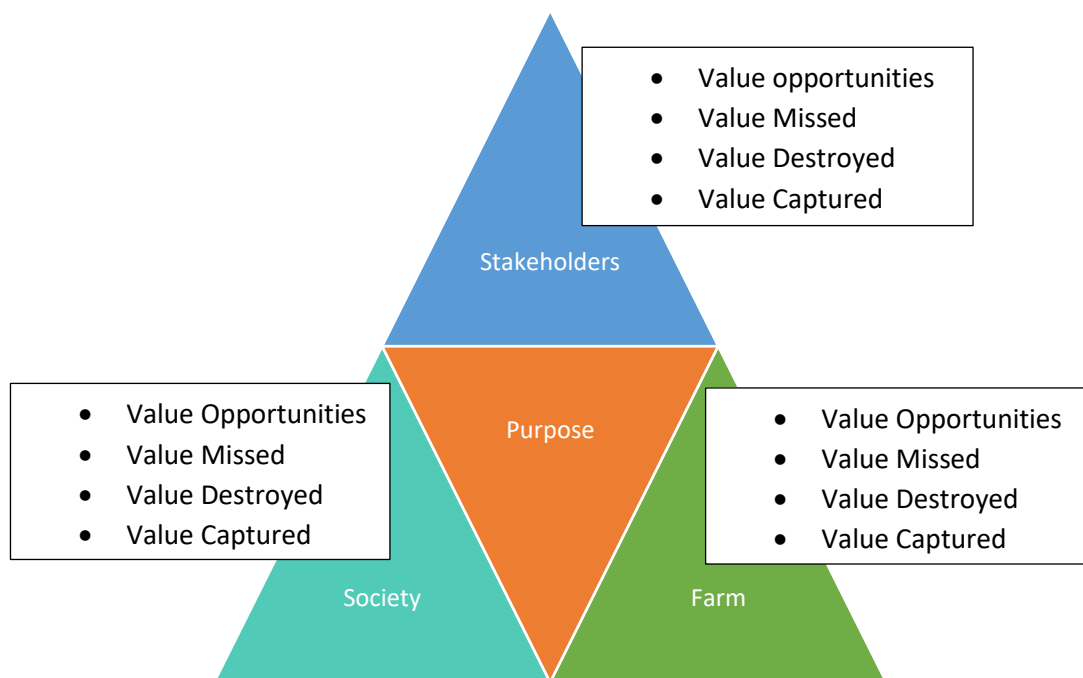


Figure 5. Value Mapping Process from literature (Author's processing) Source: Bocken et al., 2013

Figure 5 displays the final process of analysing the opportunities and barriers surrounding uptake of new technologies which combines the entrepreneurial opportunity theory and the value mapping theory to achieve the analysis. To ensure the sustainability of vertical farming, it is crucial to examine the impact vertical farming has on the environment and understand the opportunities and barriers associated with its uptake. This can be achieved by considering the farm, stakeholders, and society as key components. The farm encompasses the surrounding land where the vertical farm is located. Assessing the impact of vertical farming on the environment is essential for long-term sustainability. By studying the opportunities and barriers, we can gain valuable insights into how vertical farming practices can be optimized to minimize negative environmental effects. Stakeholders play a vital role in the success of up taking vertical farming. They include employees, managers, policymakers, suppliers of raw materials, and both external and internal investors. Understanding their perspectives and involvement in the uptake of vertical farming is crucial for fostering collaboration and ensuring

effective decision-making processes. The society, represented by the consumers of the farm's products, is another important aspect to consider. By studying the impact of up taking vertical farming on society, we can evaluate the value created and assess whether it aligns with societal needs and expectations from the perspective of farmers as entrepreneurs. This understanding helps to ensure that vertical farming practices are socially beneficial and contribute to the overall well-being of the community.

To comprehensively evaluate the sustainability of vertical farming, it is necessary to examine its impact from the perspectives of the farm, stakeholders, and society. By analysing the opportunities and barriers associated with its uptake, strategies to maximize the benefits while minimizing any negative consequences can be developed. This holistic approach would promote the uptake of sustainable vertical farming practices that are environmentally friendly, socially responsible, and economically viable.

The process of analysing the value of the business by using the value mapping theory is clearly described below on figure 5 which merges figure 1 and figure 4 together. The value needs to be identified at first using the value identification process which becomes the purpose of the business according to the EOT. Once the value is identified then the opportunities and barriers can be analysed at this point through the merging of the EOT and value mapping theory. This makes the analytical tool for the conceptual framework of this study. Figuratively, a combination of EOT and value mapping theory can be described below in figure 6.

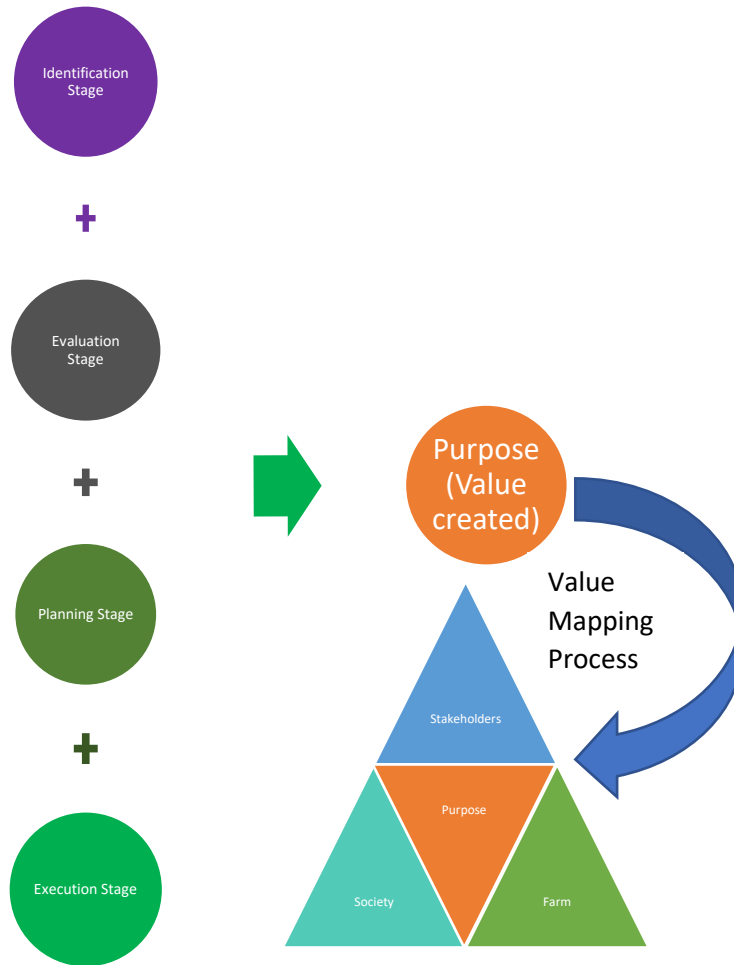


Figure 6. Analytical tool for the Conceptual Framework (Author's processing) Source: Bocken et al., 2013

The conceptual framework illustrated in figure 7 below is constructed by integrating the approach of the entrepreneurial opportunity theory and the value mapping theory as described in figure 6 to address the research questions and achieve the research objective. The entrepreneurial opportunity theory is applied in the analysis to create insights on the opportunities conceived by farmers that motivates them to uptake vertical farming. The notion of opportunity driven entrepreneurship will serve as a focal point to analyse the opportunities and barriers associated with the uptake of vertical farming. For sustainability purposes the value mapping theory will be applied to analyse opportunities and barriers at three analytical levels, namely the farm, society, and stakeholders that will represent the environment, society, and economy respectively. The conceptual framework will be implemented in a single case study of Tatton Agriculture Park, in Kenya, to gain a better understanding on the development and uptake of vertical farming from an empirical perspective.

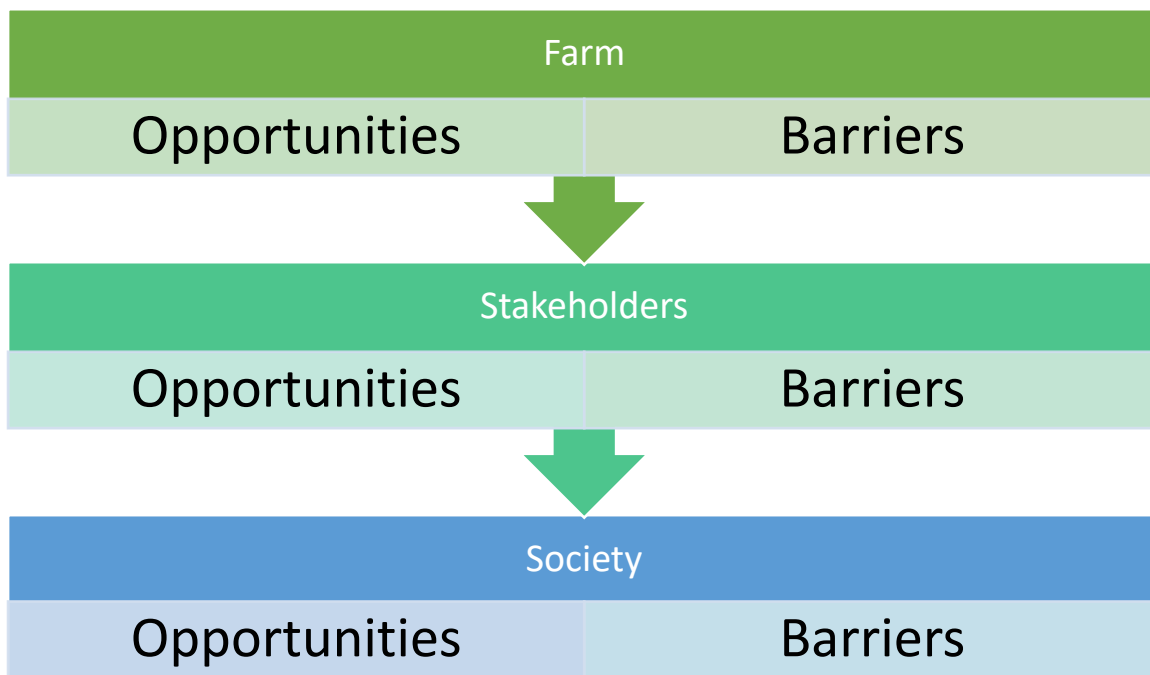


Figure 7. Conceptual Framework (Author's processing) Source: Bocken et al., 2013)

Figure 7 describes the conceptual framework which will be adopted by the methods chosen for the research to give a comprehensive perspective from a holistic lens on the uptake of vertical farming in a sustainable manner. The arrows in figure 7 represent the value created by the uptake of vertical farming, which is tied to the impact it has on the opportunities and barriers created on three levels namely, the farm, the stakeholders, and the society. It is important to study the value created by the uptake of vertical farming as a method of food production to understand the sustainability aspect of the practice. In the perspective of the farmers, vertical farming determines the existence value for the farm which conceive the opportunities and barriers associated with the practice. For stakeholders, the value created by the uptake of vertical farming creates opportunities and barriers as well which ought to be studied as well for stakeholders to understand how they can make better decisions to maximize opportunities and minimize barriers. Lastly, the value created by the uptake of vertical farming has a significant impact on the consumers who are represented by the society. This creates opportunities and barriers for the society which should be studied for better decisions to be made when promoting the uptake of vertical farming.

3. Methods

In this chapter, the methodology employed to accomplish the research objective and address the research questions is presented. The chapter comprises the following sections: 3.1. Research Design, 3.2. Literature Review, 3.3. Case Study, 3.4. Sampling strategy, 3.5. Data Collection, 3.6. Thematic Data Analysis, 3.7 Ethical Criteria, 3.8 Quality Assurance, 3.8.1. Credibility, 3.8.2 Transferability and 3.8.3. Dependability and Confirmability

3.1. Research Design

The author's research philosophy, which encompasses the overall decisions and actions taken throughout the research process, is a prominent aspect of this study (Bell, Bryman & Harley, 2022). The research philosophy is rooted in ontology, which refers to the researchers' assumptions about how they interpret reality, followed by epistemology, which concerns what the researchers know and how they acquired that knowledge. These two concepts are interconnected, and relativism theories underpin them (Bell, Bryman & Harley, 2022). The researcher adopts a constructivist ontology and an interpretivist epistemology in this study. Constructivism, as the ontological perspective, interprets social phenomena as continuously formed through social actors' interactions (Bell et al., 2022). Meanwhile, interpretivism, as the epistemological approach, emphasizes qualitative research and enables close engagement with respondents to gain insight into social behaviour. This ontological stance offers a specific version of social reality instead of a definitive version, as constructivism postulates that there are multiple subjective realities (ibid.). The study aims to understand the development and uptake of vertical farming, by understanding the opportunities and barriers associated with the uptake of vertical farming in a specific context. According to Bell et al., (2022), a constructivist ontology aligns with this objective as it recognizes that social phenomena, such as the adoption of new farming practices, are shaped by the interactions and interpretations of social actors. By adopting a constructivist perspective, the researcher acknowledges that the reality of vertical farming and its implications may vary among different stakeholders and contexts. This allows for a nuanced understanding of the complexities and diverse perspectives surrounding the phenomenon (Bell et al., 2022). An interpretivist epistemology is appropriate because the study seeks to gain in-depth insights into the experiences, motivations, and perceptions of farmers regarding vertical farming (ibid.). Interpretivism emphasizes qualitative research methods and values subjective interpretations of social behaviour (Bell et al., 2022; Schwandt, 1994). By closely engaging with respondents, the researcher can explore their perspectives, understand the meanings they attach to their experiences, and uncover the underlying factors that influence their decision-making processes (Schwandt, 1994). This approach enables a rich and nuanced understanding of the opportunities and barriers related to vertical farming in Kenya. Furthermore, the adoption of a constructivist ontology and interpretivist epistemology aligns with the nature of the research topic. Vertical farming is a complex and multifaceted phenomenon that is influenced by various social, economic, and environmental factors (Despommier, 2019). Such phenomena are best understood through an approach that recognizes the subjective interpretations and social constructions of reality (Bell et al., 2022). According to Schwandt (1994), by embracing a constructivist-interpretivist paradigm, the author can capture the diverse perspectives, explore the context-specific opportunities and

barriers, and generate knowledge that is situated within the specific social and cultural context of vertical farming in Kenya. Overall, the described research paradigm is most suitable for this study as it allows for a comprehensive and contextual understanding of the opportunities and barriers associated with the uptake of vertical farming. It acknowledges the multiplicity of subjective realities, emphasizes qualitative research methods, and enables close engagement with respondents to uncover meaningful insights about the phenomenon (Bell et al., 2022).

Academic research can be conducted using inductive, deductive, or abductive approaches (Bell et al., 2022). Inductive research refers to research that starts with the empirical investigation to establish a new theory. In contrast, the deductive approach is commonly associated with scientific inquiry. The researcher examines previous works, reads existing theories about the phenomenon under study, and then tests those theories. The abductive approach combines elements of both inductive and deductive approaches (ibid.). However, his research adopts an inductive approach as it combines the ideas of two theories to form a hypothesis which tries to establish a new theory from the integration of the EOT and the value mapping theory.

3.2. Literature Review

This paper discusses the approach used in a research project to achieve the study aim and answer the research question. The research began with a literature review, which aimed to gain a better understanding of definitions, compare various perspectives, identify gaps in academic knowledge, and review recent empirical studies. The purpose of a literature review is to understand what is already known about a subject, what theories and concepts are utilized, what approaches are selected, and how they are applied. This helps researchers gain a better understanding of the issue and identify knowledge gaps that can be filled. As Yin (2009) noted, a literature review is central to achieving accuracy in formulating insightful questions about the subject under study.

The literature review for this research project consisted of a review of peer-reviewed journal papers to ensure the research's reliability and high quality. Various databases, such as Google Scholar, Research Gate, SLU library, and Web of Science, were used to find relevant articles, books, and reports. Keywords such as "Urban agriculture," "Urban farming," "Vertical farming," "Controllable Environment Agriculture," "Entrepreneurial Opportunity Theory," and "Value Mapping Tool" were used to find relevant literature. After reading the abstracts and sorting the articles, the most relevant papers were chosen to ensure the study's trustworthiness. Peer-reviewed and well-cited papers were given priority, and there were no restrictions on the time frame for searching. Recent research was given priority, and the literature review helped identify additional articles and key books related to the subject under study. In addition to academic publications, the research also included data generated outside of academic publication, such as sustainability reports, websites, and company documents. The review of previous research provides a foundation for the research project, enabling researchers to ask insightful questions and design appropriate methodologies. The use of peer-reviewed and well-cited papers ensures the reliability and high quality of the research project. The inclusion of data generated outside of academic publication provides a broader understanding of the subject under study and allows researchers to consider a wider range of perspectives.

Historical development of agriculture shows that, human practices and technologies related to food production and cultivation evolves over time (Bellwood, 2023). Civilizations developed different techniques for growing crops, such as irrigation, crop rotation, the use of ploughs and other tools to enhance production with an objective of increasing profits (Klerkx et al., 2012). The industrial revolution in the 18th and 19th centuries brought about further innovations in agriculture, including the use of machines and chemical fertilizers to expand profit margins for farmers (Bellwood, 2023). Today, modern agricultural practices involve a combination of traditional methods and advanced technologies, with an increasing focus on sustainable and organic farming methods to minimize the negative impact on the environment amongst profitability goals (ibid.). Since the development of vertical farming is context dependent, it should be studied as such. This means that VF as a phenomenon cannot be separated from its area of uptake. Therefore, this paper will give a perspective of the uptake of vertical farming in the global north region and the global south region from what others have studied. This study was based on the global south region due to context of the area of focus the research was conducted, where different methods of vertical farming systems are practiced namely hydroponics, aeroponics and aquaponics.

3.3. Case Study

In addition to the literature review, this research project also utilized a case study and semi-structured interviews. A case study is a detailed examination of a particular subject, which helps researchers gain a comprehensive understanding of the issue under study (Bell, Bryman & Harley, 2022). Semi-structured interviews are a research method that allows researchers to ask open-ended questions and obtain detailed information from participants (Yin, 2009). These research methods provide researchers with a wealth of data that can be analysed to answer the research question (Bell et al., 2022). The study focused on the implementation of vertical farming in a specific national context, Kenya. By conducting a single case study, the researcher delved deep into the particularities of this context and gain a comprehensive understanding of the opportunities and barriers associated with vertical farming within the given setting. The case study approach allowed a detailed examination of the specific case, which provided rich and contextualized data that informed the research objectives.

Additionally, vertical farming is a relatively novel and emerging practice in Kenya (Nimaan & Sezgin, 2021). Conducting a single case study enabled the researcher to closely observe and analyse the process of implementation, uptake, and the associated opportunities and barriers faced by farmers. It allowed an in-depth exploration of the factors that influence the uptake of vertical farming within the unique context of Kenya. By focusing on a single case, the researcher could capture the complexities and intricacies of the phenomenon in a more nuanced manner (Flyvbjerg, 2011).

Furthermore, a single case study provided the opportunity for a holistic examination of the various dimensions and stakeholders involved in the implementation of vertical farming. The researcher could explore the perspectives and experiences of different stakeholders, including farmers, employees, managers, suppliers, and consumers, within the chosen case. This comprehensive understanding can inform evidence-based decision-making, policy

formulation, and the development of strategies that promote sustainable agricultural practices and stimulate economic growth.

Overall, the utilization of a single case study was most suitable for this research project as it allowed a detailed exploration of the implementation of vertical farming in a specific context. It provided rich and contextualized data, that enabled the examination of various dimensions of the farm, society and stakeholders, which offered a holistic understanding of the opportunities and barriers associated with vertical farming in Kenya.

3.4. Sampling Strategy

For this qualitative research using a case study approach, purposive or criterion-based sampling was used as the most fitting sampling strategy (Bell et al., 2022). Purposeful sampling is a non-random sampling technique where the researcher selects participants based on specific criteria that are relevant to the research questions. For example, the researcher could select farmers who have already up taken vertical farming, business owners who have implemented vertical farming as a business model, and policymakers who have implemented policies that promote vertical farming (Bell et al., 2022).

This type of sampling strategy was appropriate because the researcher was specifically looking to study a particular group or a specific case that was relevant to the aim of the study and the research questions. The researcher selected participants based on their experience with vertical farming in Kenya or their involvement in the implementation and promotion of vertical farming (Bell et al., 2022). This ensured that the data collected is relevant to the research questions and that the findings are representative of the population of interest. The researcher also used snowball sampling, where initial participants were asked to refer others who fit the criteria for the study (Bell et al., 2022). This approach was used to try increase the sample size and ensure a diverse range of perspectives and experiences are captured in the research.

3.5. Data Collection

The author of this paper did a qualitative research study that focused on Tatton Agriculture Park, an agribusiness entity that promotes vertical farming as a method of crop production in Kenya. According to Hennink et al., (2020), qualitative research was the most appropriate method for this study because it allowed an in-depth exploration of the phenomenon, facilitates understanding of the social and cultural context, offers flexibility and adaptability, prioritizes participant perspectives, and focused on contextual validity. These characteristics aligned well with the aim of understanding the opportunities and barriers associated with the implementation of vertical farming in Kenya. The study utilized a case study approach, which Bell et al., (2022) defined as an investigation of a particular topic using one or more instances that fall within the framework of the system. This research aims to understand how Tatton Agriculture Park handles the challenges and opportunities that come with the uptake of vertical farming.

To gather data, the author contacted Tatton Agriculture Park and conducted a semi-structured interviews with one of the directors and the company's clients who are local farmers and early adopters of vertical farming. The semi-structured interviews allowed flexibility and in-depth responses to the research questions. The author emailed a prepared interview guide (Appendix

1) to the interviewees before the interview, which provided a summary of the data respondents ought to answer to the predetermined research questions.

Once the interview was conducted, the author transcribed all notes and voice recordings into a word document. The data was carefully highlighted depending on its relevance to the study's goal and research questions, and the chosen data will be organized into three levels: farm, society, and shareholders where vertical farming is up taken. The selected data will then be shown and depicted in various figures to identify links and patterns and to reach judgments and perform verification.

Saunders et al.,(2018) suggest two alternative locations for data analysis in the qualitative method. The study may begin from either an inductive perspective, where the researcher aims to develop a theory that is sufficiently grounded in the research data, or a deductive perspective, where the researcher will utilize the existing theory to define the strategy to be used in the data analysis. This research took an analytical stance based on induction.

There are several inductively based analytical techniques that may be used to examine qualitative data, including data presentation and analysis, template analysis, analytic induction, grounded theory, discourse analysis, and narrative analysis (Saunders et al., 2018). The data presentation and analysis technique combine three concurrent subprocesses - drawing and validating conclusions, data reduction, and data display - into the analysis process. Data display aims to turn the reduced data into a visual display to be analysed. Based on the displayed data, the researcher can then identify relationships and patterns in the data as well as draw conclusions and verify them. Data reduction simplifies the collected data to aid in the coding process.

3.6. Thematic data Analysis

The data analysis is an essential part of the research project, as it enables researchers to draw conclusions based on the data collected (Braun & Clarke, 2012). Data analysis involves identifying patterns and themes in the data, drawing inferences, and making conclusions based on the findings (Braun & Clarke, 2012). The use of data analysis ensures that the research findings are based on evidence and provide a comprehensive understanding of the subject under study (ibid.).

The collected data was then organized, and information relevant to the research questions and objectives was highlighted for further analysis. The next step involved coding the themes proposed by Robson (2011) in the collected data. This was done with the help of theories and tools presented in the literature review and theoretical framework. Specifically, the researcher applied the theories to explore the internal and external factors related to opportunities and barriers that may influence the uptake of the vertical farm under study.

To evaluate whether vertical farming is sustainable, the researcher identified and analysed the opportunities and barriers in three levels. This involved examining the environmental, social, and economic aspects of vertical farming which were referred to as farm, society and stakeholders respectively.

The analysis of the collected data was further enhanced by utilizing value mapping theory as a framework. This approach enabled the researcher to better understand the data and to get create a narrative from the cods and themes. The researcher applied the value mapping theory approach to the collected data and analysed the findings to recognize barriers associated with the uptake of vertical farming practice.

3.7. Ethical Criteria

During the research, the author adhered to the General Data Protection Regulation (GDPR) measures to ensure the protection of personal data. As outlined by the European Union (EU, 2016), GDPR is designed to safeguard the rights and privacy of individuals in relation to the processing of their personal data. To comply with GDPR, the author took several measures, including obtaining informed consent from all interviewees prior to data collection. This involved providing clear and comprehensive information about the purpose of the research, the types of data that will be collected, and how the data will be handled and stored. The author also ensured that interviewees have the right to withdraw their consent at any time during the research process.

The impact of GDPR measures on interviewees primarily involved protecting their privacy and ensuring that their personal data is handled in a secure and confidential manner. By obtaining informed consent and providing clear information about data handling procedures, interviewees can be assured that their personal data will be used only for the purpose of the research and will not be shared without their explicit consent. This helped to build trust and credibility in the research process, as the interviewee felt confident that their rights and privacy are being respected.

In terms of data handling, all personal data collected during the research was stored securely and is only accessible to the researcher. Data was anonymized, and any identifying information was removed to ensure confidentiality. Data was stored on password-protected devices and will be deleted after the research is completed, in accordance with GDPR requirements.

The use of GDPR measures in the research process enhances the credibility of the research by demonstrating a commitment to ethical data handling practices. Adhering to GDPR guidelines ensures that personal data is protected, interviewees' rights are respected, and the research process is conducted in an ethical and transparent manner. This strengthens the validity and reliability of the research findings, as it demonstrates the author's dedication to upholding high standards of data protection and research ethics (EU, 2016).

3.8 Quality Assurance

Ensuring quality and validity of data is crucial in maintaining the integrity of research (Elassy, 2015). In this study, several measures were taken to enhance the quality and validity of the data collected. The research employed a rigorous data collection process using semi-structured interviews. This approach allowed for open-ended questions and in-depth discussions with participants, enabling a rich and comprehensive understanding of the research topic (Elassy, 2015). The interviews were conducted by a trained researcher who followed a predetermined interview guide, ensuring consistency and minimizing potential bias in data collection.

To enhance the validity of the data, multiple sources of information were utilized. In addition to interviews, peer reviewed articles, reports, and literature were thoroughly reviewed and analysed. According to Patton, (1999); Johnson et al., (2020), data triangulation involves the utilization of various data sources and methods, such as observation field notes and interview transcripts which is one of the common academic rigors applied in qualitative research. Its primary purpose is to identify the alignment and consistency in the data gathered. This approach aims to reduce the potential for errors or biases while enhancing the precision of data collection and analysis processes (ibid.). This triangulation of data from various sources helped to corroborate and validate the findings, reducing the likelihood of relying solely on one perspective or source of information. Moreover, during the interviews, probing questions and follow-up inquiries were employed to ensure clarity and depth of responses. This iterative process allowed for a deeper exploration of participants' experiences, perspectives, and insights, contributing to the richness and validity of the data.

To further ensure quality, data analysis was conducted in a systematic and transparent manner. The researcher employed a rigorous coding process, using established qualitative analysis techniques, to identify patterns, themes, and relationships within the data. This iterative process involved multiple reviewers to enhance inter-rater reliability and minimize personal biases. Furthermore, throughout the research process, regular discussions and peer debriefing sessions were held with the supervisor and advisors. These engagements provided an opportunity for critical reflection, feedback, and discussion of emerging findings, helping to ensure the rigor and accuracy of the research.

Overall, by employing robust data collection methods, utilizing multiple data sources, engaging in thorough data analysis, and seeking feedback from experts, the research project was able to maintain high standards of data quality and validity. These measures contribute to the credibility and trustworthiness of the research findings and enhance the overall rigor of the study (Elassy, 2015).

3.8.1 Credibility

In this sub-chapter, the credibility of the research process is discussed, focusing on the steps taken to ensure the validity and reliability of the empirical findings. According to Bell et al., (2022), establishing the credibility of qualitative research is essential to maintain the trustworthiness of the study. This research philosophy aligns with constructivist ontology and interpretivist epistemology, which allows for a deeper understanding of the social phenomena associated with vertical farming (Bell et al., 2022). By embracing these philosophical perspectives, the multiple subjective realities inherent in this context. A semi-structured interview was conducted to gather data directly from a key stakeholder, specifically a farmer at Tatton Agriculture Park. The use of open-ended questions enabled a collection of rich, context-specific information (Patton, 1999).

3.8.2. Transferability

According to Bell et al. (2022); Kuper et al. (2008), transferability is a critical aspect of research validity and reliability which is context-based. In the context of this study, transferability refers to the extent to which the findings and conclusions drawn from the research can be applied or generalized to other settings or contexts beyond the specific case studied (ibid.).

Bell et al. (2022) emphasize that the transferability of research findings depends on the richness and depth of the data collected and the transparency in reporting the research methods. In this study, the use of a single case study approach, along with semi-structured interviews and a comprehensive literature review, contributes to the depth and richness of the data. By examining the vertical farming practices in a specific context (Tatton Agriculture Park in Kenya), this research provides a detailed and context-specific understanding of the opportunities and barriers associated with vertical farming.

Kuper et al. (2008) argue that the transferability of qualitative research findings depends on the degree of congruence between the context of the study and the context to which the findings are to be transferred. In this regard, it is essential to consider the specific characteristics of the Tatton Agriculture Park and the Kenyan agricultural landscape when assessing the transferability of the findings to other vertical farming initiatives or regions with a similar environment. Factors such as climate, infrastructure, policy environment, and socioeconomic conditions may influence the applicability of the research findings to different settings.

Therefore, while the findings of this research provide valuable insights into the opportunities and barriers of vertical farming in the context of Tatton Agriculture Park, their transferability to other regions or countries should be approached with consideration of the contextual differences. Researchers and policymakers interested in applying these findings to different settings should carefully assess the congruence between their context and the context of this study to determine the extent to which the findings can be extrapolated or adapted.

3.8.3. Dependability and Confirmability

Dependability and confirmability, as discussed by (Patton 1999; Korstjens et al., 2018; and Bell et al., 2022), are vital aspects of ensuring the rigor and trustworthiness of qualitative research. Dependability refers to the stability and consistency of research findings over time and under varying conditions. In this study, dependability is enhanced through a systematic and well-documented research process. Patton (1999) highlights the importance of maintaining an audit trail, which involves keeping records of all research activities, decisions, and changes made throughout the study. This audit trail ensures transparency and allows for the replication of the study, contributing to the dependability of the research. Additionally, Bell et al., (2022) stress the significance of using multiple data sources and methods, such as interviews, observations, and literature reviews, to triangulate findings. This triangulation approach helps confirm the consistency and reliability of the results.

Confirmability, on the other hand, relates to the objectivity and neutrality of the research process and findings (Korstjens et al., 2018). It is essential to minimize researcher bias and subjectivity (ibid.). Korstjens et al., (2018) argue that confirmability is achieved by clearly documenting the research process and decisions made at each stage. In this study,

confirmability was ensured through transparent reporting of the research methods, including data collection and analysis processes. Patton (1999) emphasizes on the importance of reflexivity, where the researcher acknowledges their own perspectives and biases and takes steps to minimize their influence on the research. By addressing potential sources of bias and maintaining a reflexive stance, the study enhances the confirmability of its findings (ibid.). Overall, this research strives for both dependability and confirmability by adhering to systematic data collection and analysis processes, maintaining comprehensive records, and acknowledging and mitigating potential sources of bias and subjectivity. This approach aligns with the recommendations of (Patton 1999; Korstjens et al., 2018; and Bell et al., 2022), for conducting rigorous and trustworthy qualitative research.

4. Empirical Findings

The following section includes the empirical background of the case-study and the responses received from the interview conducted. The interview covered information about the company, as well as the opportunities and barriers the case faces with regards to the uptake of vertical farming as a crop production method in Kenya. This section aims to provide crucial insights necessary for the subsequent chapter while also delving into the empirical findings.

4.1. Background of the Case study

The case study used for this research is a farm recognised as Tatton Agriculture Park. The park is an Egerton University unit established in 2011 as a government project under Vision 2030. The interviewee considers that its objective is to promote the development of education, science, technology, and innovation to contribute to the country's knowledge-based economic growth. The Park aims to create new business opportunities and value addition, leading to rapid national development. Its primary role is to promote innovations including vertical farming, products, and services to be commercialized and link the university with the agricultural industry for the uptake of these products. It envisions a one-stop-shop that brings together academics, farmers, graduate students, businesses, agro-processors, and manufacturers to share information, innovative ideas, and wealth creation.

The Park is situated next to Egerton University's Ngongongeri Farm. The Park owns 50 acres of land for demonstration facilities and meeting points with farmers and the private sector. The park's strategic activities consist of several components. It provides infrastructure for incubating agro-innovation and encourages and facilitates strategic partnerships. Additionally, it commercializes innovations in partnership with the industry and facilitates the creation of new businesses through incubation and spin-off mechanisms. The park also focuses on accelerating the growth of small and medium-sized companies and resource mobilization to sustain the park.

4.2. Findings on the case study

The interviewee was asked a series of questions regarding the uptake of vertical farming and identified the method as hydroponics according to Despommier (2019). The interviewee stated that they use an in-house (greenhouse) system with a drip system for their hydroponics. This system involves growing plants in a controlled environment, which leads to higher yields and better-quality crops.

When asked about the profitability of hydroponics in Kenya, the interviewee responded that it had been able to provide sufficient fodder for livestock even during dry seasons. This indicates that hydroponics could be a viable method of crop production in Kenya, especially in areas that are prone to drought. Through this, the sales increased, and profits margins were increased as well.

When asked about the factors that affect the profitability of hydroponics, the interviewee mentioned the type of crop and financial constraints. The interviewee also noted that diversification to other crops, such as sorghum and millet, has been beneficial, especially for livestock fodder.

Additionally, the initial investment costs for hydroponic systems are high, however, in the long run, the operational costs become minimal and eventually low. This enabled the business to save costs which in turn reflected in profitability with an increased margin.

The interviewee noted that the uptake of hydroponics is low in Kenya, mainly because most people have not been able to conceptualize the idea of hydroponics. The interviewee suggested that local media and seminars could be used to capture the attention of small-scale farmers to increase awareness of the farming practice.

The government, NGOs, and industry associations are involved in promoting hydroponics in Kenya by subsidizing input costs on raw materials for hydroponics production. This support can help to lower the financial barriers to entry for hydroponics farmers according to the interviewee which reduces production costs.

When asked about the potential challenges or barriers to implementing hydroponics as a business model in Kenya, the interviewee identified financial constraints as the main challenge. The interviewee suggested that concerned stakeholders should subsidize most of the components used in hydroponics, especially for construction.

Finally, the interviewee was asked for opinion on the use of artificial lighting while using hydroponics. It was mentioned that artificial lighting depends on the type of crops that the business is focused on that may require them to make a decision on such an investment. However, for the area of expertise artificial lighting was not required for the farm since they utilize the sun by trapping the warmth in a greenhouse setting.

From the interview, it is inferred that the interviewee is supportive of hydroponics as a method of crop production in Kenya, especially for livestock fodder. However, the interviewee also recognizes that there are challenges to the uptake of hydroponics, as highlighted.

From this data collection method, this study will apply the theoretical framework from the literature for analysis of barriers and opportunities surrounding vertical farming in the next section.

[4.3. Identification process for Opportunities of vertical farming](#)

From the perspective of the interviewee, there are various opportunities associated with the uptake of vertical farming in Kenya. One significant opportunity is the potential to produce high-quality crops with greater yields and better control over the growing environment. By implementing vertical farming systems, farmers can grow crops in a controlled environment with precise conditions such as temperature, humidity, and light, which can increase yields and ensure that crops are not affected by external factors such as pests and diseases. This results in high profit generation from sales of end products.

Moreover, vertical farming has the potential to produce crops throughout the year, regardless of the season, thereby ensuring a constant supply of fresh produce to the market. This is particularly important in Kenya where agricultural production is heavily reliant on seasonal rainfall. The interviewee notes that hydroponic systems have been able to provide sufficient

fodder for livestock even during dry seasons, which demonstrates the potential of vertical farming to address the challenges associated with climate change and variability.

Another significant opportunity of up taking vertical farming is the potential for cost savings in the long term. The initial investment costs for setting up vertical farming systems may be high, but the operational costs are relatively low. For example, the interviewee notes that in the case of hydroponics, diversification to other crops like sorghum and millet for livestock fodder has led to cost savings. Additionally, vertical farming can reduce the need for large land areas and can save on water and fertilizer costs through the precise application of nutrients and water directly to plants. This can result in cost savings for farmers, as well as reduced environmental impacts.

In terms of market opportunities, vertical farming has the potential to meet the growing demand for high-quality, locally produced food in Kenya. With increasing concerns about food safety, quality, and environmental sustainability, there is a growing interest among consumers in fresh, locally produced food. Vertical farming helps to meet this demand by producing high-quality, locally grown crops that are free from harmful chemicals and pesticides. Moreover, the controlled environment in vertical farming systems helps to ensure consistent quality and supply, which can be attractive to buyers such as supermarkets and restaurants.

Finally, the uptake of vertical farming can provide opportunities for small-scale farmers to increase their income and livelihoods. By using vertical farming systems, small-scale farmers can increase their crop yields, and produce high-quality crops that are in demand in local markets. This can enable farmers to access higher prices for their crops and increase their income. Additionally, vertical farming can be practiced in urban areas, which can provide opportunities for urban agriculture and help to improve food security in urban areas.

According to the entrepreneurial opportunity theory, opportunities arise through a process that involves four stages: as mentioned in chapter 2.3 of this research (Shane & Venkataraman, 2000). The application of this framework to the opportunities identified in the context of vertical up taking farming in Kenya.

1. Identification Stage:

In this stage, entrepreneurs identify potential opportunities by recognizing the untapped potential or unmet needs in the market (Shane & Venkataraman, 2000). The opportunities identified in the context of vertical farming in Kenya are shown in table 1.

2. Evaluation Stage:

Once opportunities are identified, entrepreneurs evaluate their feasibility and potential for success (Shane & Venkataraman, 2000). This involves assessing the market demand, competitive landscape, available resources, and potential risks (ibid.). In the case of vertical farming in Kenya, entrepreneurs would evaluate factors such as those shown in table 1.:

3. Planning Stage:

During the planning stage, entrepreneurs develop a strategic plan to capitalize on the identified opportunities (Shane & Venkataraman, 2000). This involves formulating business models,

designing operational strategies, and outlining marketing and distribution plans (ibid.). Some key things to focus on when practicing vertical farming in Kenya by farmers are shown in table 1.

4. Execution Stage:

In the execution stage, entrepreneurs implement their plans and take action to exploit the identified opportunities (Shane & Venkataraman, 2000). This involves setting up vertical farming operations, acquiring necessary resources, and actively marketing and selling the produce (ibid.). Key activities during this stage in the context of Kenya are shown in table 1 below.

Table 1. Opportunity identification

Stage	Opportunities identified
<i>Identification</i>	<ul style="list-style-type: none"> - The potential to produce high-quality crops with greater yields and better control over the growing environment. - The opportunity to address the challenges of climate change and variability by providing a consistent supply of fresh produce throughout the year. - The potential for cost savings in the long term through efficient resource use and reduced environmental impacts. - The market opportunity to meet the growing demand for high-quality, locally produced food.
<i>Evaluation</i>	<ul style="list-style-type: none"> - The size of the target market and the willingness of consumers to pay for locally grown, high-quality produce. - The availability of suitable resources, including land, capital, technology, and skilled labour. - The potential challenges and risks associated with scaling up vertical farming operations, such as energy costs and market competition.
<i>Planning</i>	<ul style="list-style-type: none"> - Designing efficient vertical farming systems that optimize resource use and minimize operational costs. - Developing partnerships with technology suppliers, investors, and market channels to access necessary resources and reach target customers. - Establishing quality control measures to ensure the production of high-quality crops that meet market demand.
<i>Execution</i>	<ul style="list-style-type: none"> - Constructing vertical farming facilities and installing the required equipment and technology. - Cultivating crops using appropriate techniques such as hydroponics or aeroponics. - Establishing distribution channels and partnerships with retailers, restaurants, and other potential buyers. - Monitoring and adjusting operations to optimize productivity, quality, and profitability.

By following these stages of the entrepreneurial opportunity process, entrepreneurs can leverage the identified opportunities associated with vertical farming in Kenya. However, it is important to note that each stage requires careful consideration and continuous adaptation to the specific context and market conditions to maximize the chances of success (Shane & Venkataraman, 2000).

4.4. Value mapping process (Figure 5)

According to the interviewee, there are several barriers to the uptake of vertical farming in Kenya. One of the main barriers is financial constraints. The initial investment costs for vertical farming can be high, and this is a challenge for small-scale farmers who may not have access to adequate financing or resources. Additionally, operational costs such as the cost of electricity, water, and nutrient solutions are also challenges that farmers deal with when up taking vertical farming.

Another barrier to the uptake of vertical farming is the lack of awareness and knowledge among farmers. The interviewee notes that many people in Kenya have not yet been able to conceptualize the idea of vertical farming, which may hinder its uptake. This lack of knowledge can also result in farmers not fully understanding the potential benefits and limitations of vertical farming, leading to a reluctance to uptake it.

In addition, the interviewee highlights the need for appropriate policies and regulations to support the uptake of vertical farming. For instance, there may be a need for government subsidies or incentives to help offset the high initial investment costs. Furthermore, policies and regulations need to be developed to ensure that vertical farming practices are safe and meet quality standards.

Another potential barrier to the uptake of vertical farming is the availability of skilled labour. Vertical farming requires specialized skills and knowledge, and farmers may struggle to find qualified individuals to operate and maintain the systems.

Finally, there may also be cultural barriers to the uptake of vertical farming. Farming in Kenya is traditionally done in open fields, and there may be a perception that vertical farming is not a viable option. Changing this mindset may require significant effort and time which may involve educating and raising awareness among farmers and other stakeholders.

Applying the value mapping tool to the purpose of the farm identified by the opportunity process, can analyse these opportunities to spot potential barriers that would be conceived through the uptake of vertical farming in Kenya in terms of value capture, value destroyed, value missed, and value opportunities.

1. Value Capture:

Value capture refers to the creation and capture of value by the stakeholders involved (Bocken et al., 2013). In the case of vertical farming in Kenya, the opportunities identified indicate potential value capture in various aspects as shown in table 2.

2. Value Destroyed:

Value destroyed refers to the negative impacts or losses associated with the uptake of a particular practice (Bocken et al., 2013). In the context of vertical farming in Kenya, there are potential instances of value destruction as shown in table 2.

3. Value Missed:

Value missed refers to the opportunities that are not fully realized or captured (Bocken et al., 2013). In the case of vertical farming in Kenya, there may be missed opportunities as shown in table 2.

4. Value Opportunities:

Value opportunities refer to the potential areas where value can be created and captured in the future (Bocken et al., 2013). In the context of vertical farming in Kenya, there are several value opportunities as shown in table 2 below.

Table 2. Analysis of values mapped from the Value Mapping process.

Type of value	Value Mapped
<i>Value Opportunities</i>	<ul style="list-style-type: none"> - Government subsidies or incentives can help offset the high initial investment costs, creating value by enabling more farmers to uptake vertical farming. - Developing policies and regulations that support the safe and quality practice of vertical farming can create value by ensuring consumer confidence and market acceptance. - Education and awareness programs targeted at farmers and stakeholders can create value by bridging the knowledge gap and promoting the benefits and potential of vertical farming. - Developing training programs and capacity-building initiatives can create value by providing farmers with the necessary skills and knowledge to operate and maintain vertical farming systems effectively.
<i>Value Missed</i>	<ul style="list-style-type: none"> - Lack of awareness and knowledge among farmers about vertical farming can result in missed value as farmers may not fully understand the potential benefits and opportunities associated with the practice. - Cultural barriers and traditional farming practices may lead to missed value as farmers may be reluctant to explore and uptake vertical farming methods.

*Value
Destroyed*

- High initial investment costs can pose financial challenges, potentially destroying value by limiting the ability of small-scale farmers to uptake vertical farming.
- Operational costs such as electricity, water, and nutrient solutions can be significant, potentially leading to value destruction if farmers are unable to manage and sustain these costs.

Value Capture

- Higher yields and better-quality crops through controlled environment farming can result in increased profitability and market competitiveness, capturing value for the farmers.
- The potential to provide sufficient fodder for livestock even during dry seasons through hydroponics enables farmers to capture value by ensuring consistent livestock feed supply.
- Cost savings in the long term through efficient resource use can result in increased profitability, capturing value for the farmers.

By analysing the opportunities and barriers through the lens of value mapping theory, according to Bocken et al., (2013), we can identify the potential value opportunities, value missed, value destroyed, and value capture associated with the uptake of vertical farming in Kenya. This analysis can provide insights into the overall value proposition of vertical farming and inform strategies to maximize value creation and minimize potential risks and challenges.

5. Data Analysis

In this chapter, the empirical data is analysed in the context of the conceptual framework to address the aim of the thesis and answer the research questions that were posed in Chapter 1.3. Specifically, the analysis presented here aims to shed light on the opportunities and barriers for vertical farming as perceived by farmers, as follows:

- What opportunities are conceived by Tatton Agriculture Park farmers to uptake vertical farming?
- What barriers are conceived by Tatton Agriculture Park farmers to uptake vertical farming?

The analysis of the empirical data collected on the uptake of vertical farming reveals the opportunities and barriers from the perspective of farmers. The analytical framework builds on three levels, namely the farm, stakeholders, and society. The opportunities present themselves in relation to the farm and its stakeholders, which include the human resources, investors, customers, and technology suppliers. These opportunities are context-dependent and must be studied as such to identify their relevance to the business.

The empirical findings reveal that Tatton Agriculture Park's internal resources, including the farm, management team, and investors, play a crucial role in generating value through vertical farming, thus, opportunities surrounding the uptake of vertical farming are influenced by them. The farm's external resources, such as customers and technology suppliers, also contribute significantly to its success. These resources must be optimized to increase efficiency and maximize profits.

The stakeholders, including the customers, investors, and technology suppliers, also play an essential role in the uptake of vertical farming. The analysis reveals that their support is vital to the success of the farm. For example, customers provide the demand for the farm's produce, while investors provide the necessary funds to run the farm. Technology suppliers are also crucial in providing the latest technology to enhance the farm's operations.

Society is another crucial level in the uptake of vertical farming. The empirical findings reveal that the farm's impact on society must be considered to identify opportunities and barriers. For example, vertical farming can contribute to food security by producing more food in limited space, but it may also have negative environmental impacts if not managed properly. Thus, the uptake of vertical farming must be approached holistically, considering its impact on society and the environment.

The analytical theme table, which employs coding and clustering, used to present the empirical findings. This method organizes the data collected from various sources, such as interviews and policy reports, into a coherent and structured format. The themes identified through this method reveal the opportunities and barriers in the uptake of vertical farming, which can be used to inform policy and decision-making.

Table 3. Analytical themes for empirical findings.

<i>Analytical themes</i>	Farm	Stakeholders	Society
<i>Opportunities</i>	<ul style="list-style-type: none"> • Reduction of soil acidity due to low usage of fertilizers and pesticides • High Yields • Lower food waste • Land space efficiency - other land areas can be allocated for other utility. • Reduced environmental impact from land degradation because of traditional farming practices 	<ul style="list-style-type: none"> • Profitability • Stability of food products in the market • Low transport costs with closeness to the market • Shorter supply chain • Low operational costs in the long run 	<ul style="list-style-type: none"> • Food security • Improved living standards of people • Job opportunities for people • Education of people through training of new farming practices
<i>Barriers</i>	<ul style="list-style-type: none"> • GHG emissions • Risk of biodiversity • Unequal distribution of natural resources e.g., water 	<ul style="list-style-type: none"> • Initial capital investment cost is high 	<ul style="list-style-type: none"> • The people's culture. • Specialized labour

6. Discussion

This chapter compares the results attained from this research to what others have studied in the past to in search of any overlaps between the study's results and that of others.

The findings from the interview conducted at Tatton Agriculture Park provide valuable insights into the opportunities and barriers associated with the uptake of vertical farming practices in Kenya. These findings can be linked to the theoretical frameworks of Entrepreneurial Opportunity Theory and Value Mapping Theory to gain a deeper understanding of the factors influencing the uptake of vertical farming in the specific context of Tatton Agriculture Park.

Entrepreneurial Opportunity Theory suggests that opportunities arise from the identification and exploitation of new or untapped resources, technologies, or markets (Shane & Venkataraman, 2000). In the case of Tatton Agriculture Park, the interviewee identified hydroponics as an opportunity to address the challenges faced by traditional agriculture in Kenya, such as limited arable land, soil acidity, and water scarcity. By implementing hydroponics, the interviewee was able to achieve higher yields and better-quality crops, providing sufficient fodder for livestock even during dry seasons. This aligns with the concept of entrepreneurial opportunities, as the interviewee recognized the potential of hydroponics to overcome existing limitations and improve agricultural productivity.

The Value Mapping Theory emphasizes the importance of understanding the value proposition of a business model and how it aligns with the needs and preferences of customers and stakeholders (Bocken et al., 2015). Even though the value mapping tool was successful to identify barriers for vertical farming in the given context, it also identifies the value of some opportunities that emerged through the process of mapping.

The profitability aspect of vertical farming, as highlighted by the interviewee, indicates the potential value creation associated with this farming practice. By diversifying crops, such as sorghum and millet, the interviewee was able to cater to the specific needs of the livestock market, leading to increased sales and profit margins. Additionally, the interviewee noted that the operational costs of hydroponic systems become minimal in the long run, resulting in cost savings and improved profitability. These findings suggest that the value proposition of vertical farming, particularly in terms of increased productivity and financial benefits, can contribute to its uptake and success in Kenya.

However, despite the opportunities presented by vertical farming, the interviewee also identified several barriers to its uptake. Financial constraints were highlighted as a significant challenge, primarily due to the high initial investment costs associated with setting up hydroponic systems. This aligns with previous research that has identified financial barriers as a common hindrance to the implementation of vertical farming (Nimaan & Sezgin, 2021). The interviewee suggested that subsidizing the components used in hydroponics, especially for construction, could help address this barrier. This recommendation reflects the importance of supportive policies and interventions to reduce financial barriers and promote the uptake of vertical farming.

The low uptake of hydroponics in Kenya, as mentioned by the interviewee, can be attributed to a lack of awareness, and understanding among small-scale farmers. This corresponds to the knowledge gap identified in the research problem, where limited research on vertical farming in Kenya has resulted in a lack of effective implementation strategies. To address this barrier, the interviewee proposed using local media and seminars to increase awareness and capture the attention of farmers. This highlights the need for knowledge dissemination and educational initiatives to promote the understanding and uptake of vertical farming practices.

Overall, the findings from the interview align with the theoretical frameworks used in the study. The Entrepreneurial Opportunity Theory helps explain how the interviewee identified and capitalized on the opportunities presented by vertical farming to address agricultural challenges. On the other hand, the Value Mapping Theory sheds light on the value proposition of vertical farming as it is tied to its barriers, its alignment with market needs, and the financial benefits it can offer. By linking the findings to these theoretical frameworks, the study provides a comprehensive understanding of the barriers and opportunities associated with implementing vertical farming practices in Tatton Agriculture Park and, by extension, in Kenya.

This research contributes to addressing the knowledge gap surrounding vertical farming in Kenya by examining the specific context of Tatton Agriculture Park. The identification of hydroponics as a viable method of crop production, its profitability, and the recognition of financial constraints and lack of awareness contribute to the existing knowledge on vertical farming in Kenya. The theoretical frameworks of Entrepreneurial Opportunity Theory and Value Mapping Theory provide a robust analytical lens to understand and discuss the findings in the broader context of entrepreneurship, value creation, and market alignment which are tied to the opportunities and barriers of developing vertical farming. By gaining a comprehensive understanding of the barriers and opportunities associated with vertical farming, policymakers, researchers, and practitioners can formulate effective strategies, policies, and interventions to promote sustainable agricultural practices, enhance food security, and stimulate economic growth in Kenya.

7. Conclusion

The findings and empirical analysis of this study shed light on the opportunities and barriers associated with the uptake of vertical farming practices in Kenya, focusing on Tatton Agriculture Park. Through the application of the Entrepreneurial Opportunity Theory and Value Mapping Theory, this research provides valuable insights into the factors influencing farmers' decisions to uptake vertical farming and the implications for sustainable agricultural practices, food security, and economic growth in the country.

The study revealed that Tatton Agriculture Park farmers perceive numerous opportunities in up taking vertical farming practices. These opportunities include overcoming challenges related to limited arable land, soil acidity, water scarcity, and harsh climatic conditions. Vertical farming offers the potential for increased productivity, higher-quality crops, and enhanced profitability, particularly for livestock fodder production. The findings highlight the significance of vertical farming as a solution to address the agricultural limitations faced in Kenya, particularly in drought-prone areas.

However, the study also uncovered several barriers that hinder the widespread uptake of vertical farming. Financial constraints emerged as a major challenge, with the high initial investment costs for infrastructure and technology being a significant deterrent for farmers. Limited awareness and understanding of the concept of vertical farming among small-scale farmers were identified as additional barriers. These findings emphasize the need for targeted interventions, such as subsidies and educational programs, to alleviate financial constraints and raise awareness about the benefits and feasibility of vertical farming.

Overall, this research contributes to the existing knowledge by providing empirical evidence on the opportunities and barriers associated with vertical farming in Kenya. The study underscores the importance of entrepreneurial opportunities and value mapping in shaping farmers' decision-making processes regarding the uptake of innovative farming practices. The findings have implications for policymakers, researchers, and practitioners, offering insights into the formulation of strategies and policies to support the development and implementation of vertical farming in Kenya and similar contexts.

In conclusion, this study underscores the crucial role of awareness and understanding in driving the uptake of vertical farming practices among farmers in Kenya. When farmers are well-informed about the implementation strategies, opportunities, and potential solutions to overcome barriers associated with vertical farming, they are more likely to embrace this farming practice. By equipping farmers with the knowledge and tools necessary to navigate the challenges and leverage the benefits of vertical farming, a greater inclination towards uptake can be fostered to embrace vertical farming as a viable and sustainable method of agriculture. Policymakers, researchers, and practitioners should collaborate to develop and disseminate effective implementation strategies, policies, and support mechanisms that enable farmers to successfully uptake and integrate vertical farming into their agricultural practices. This, in turn, can contribute to the advancement of agricultural productivity, food security, and economic growth in Kenya. Therefore, fostering awareness and understanding among farmers about the

implementation strategies, opportunities, and methods to overcome barriers is crucial in driving the wider uptake of vertical farming practices in the country.

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Appendix 1: Interview questions

1. In your opinion, based on your experience or knowledge, is hydroponics a profitable method of crop production in Kenya? Why or why not?
2. What type of hydroponic system do you use?
3. Can you describe the economic viability of hydroponics for crop production in Kenya, including factors such as initial investment costs, operational costs, and potential revenue streams?
4. What are the main factors or variables that affect the profitability of hydroponics for crop production in Kenya, and how are these factors being managed or optimized by practitioners?
5. How do you perceive the potential advantages of using hydroponics for crop production in Kenya, in terms of economic sustainability, market competitiveness, or other relevant factors?
6. Can you provide examples of profitable hydroponics operations for crop production in Kenya, and what factors do you think contributed to their success?
7. What strategies or approaches are being used to promote hydroponics as a method of crop production in Kenya? How are these strategies tailored to the local context and target audience?
8. How are stakeholders, such as government agencies, NGOs, or industry associations, involved in promoting hydroponics as a method of crop production in Kenya, and what initiatives or programs are being implemented to support its uptake?
9. Can you describe the key elements or components of a business model for implementing hydroponics as a method of crop production in Kenya, including aspects such as revenue streams, cost structure, and value proposition?
10. How do you envision the implementation of hydroponics as a method of crop production in a business model in Kenya, taking into consideration factors such as market demand, pricing, distribution, and other relevant considerations?
11. What are the potential challenges or barriers to implementing hydroponics as a business model for crop production in Kenya, and how can these challenges be addressed or mitigated?
12. What are the key success factors or critical considerations that entrepreneurs or investors need to consider when planning to implement hydroponics for crop production in Kenya, from a business perspective?
13. Can you share any insights or recommendations on how to optimize the profitability and sustainability of hydroponics for crop production in Kenya, based on your experience or expertise?

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