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Business Analysis of Plant Factories Using the Business Model Canvas

Analis Usaha Pabrik Tanaman Menggunakan Bisnis Model Canvas

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ABSTRACT
A plant factory is a production system that operates in a controlled environment, where factors important for plant growth, such as light, temperature, CO2, and humidity, are artificially regulated. The system is also equipped with automated mechanisms for controlling fertilization and irrigation, as well as maintaining clean conditions for plants. The purpose of this study is to develop a business model canvas for a warehouse plant factory in MARDI, Serdang, Selangor, Malaysia. This research uses a descriptive qualitative approach method. In analyzing the warehouse plant factory business using the Business Model Canvas (BMC) method, this business model has significant prospects in overcoming the technology and knowledge gap in the agricultural sector. The successful implementation of this business model is largely determined by the alignment between the application of modern technology and the socio-economic conditions of farmers in the local area.
Keywords: Business model, Agriculture, Enterprise, Technology

ABSTRAK
Pabrik tanaman adalah sistem produksi yang beroperasi dalam lingkungan terkontrol, di mana faktor-faktor penting bagi pertumbuhan tanaman, seperti cahaya, suhu, CO2, dan kelembaban, diatur secara buatan (artifisial). Sistem ini juga dilengkapi dengan mekanisme otomatis untuk pengendalian pemupukan dan irigasi, serta menjaga kondisi yang bersih bagi tanaman. Tujuan dari penelitian ini adalah untuk mengembangkan model bisnis canvas pabrik tanaman gudang yang di bangun di MARDI, Serdang, Selangor, Malaysia. Penelitian ini menggunakan metode pendekatan kualitatif deskriptif. Dalam analisis usaha pabrik tanaman gudang menggunakan metode Business Model Canvas (BMC), model bisnis ini memiliki prospek yang signifikan dalam mengatasi kesenjangan teknologi dan pengetahuan pada sektor pertanian. Keberhasilan implementasi model bisnis ini sangat ditentukan oleh adanya keselarasan antara penerapan teknologi modern dengan kondisi sosial ekonomi petani di wilayah setempat.
Kata Kunci : Model bisnis, Pertanian, Usaha, Teknologi

INTRODUCTION

Horticulture is a commodity with substantial development potential and high economic value. As one of the most important agricultural sectors, it plays a crucial role in food production, health, and environmental sustainability (Sheilena et al., 2024). The availability of food remains a significant issue in every community, as the demand for food continues to rise due to rapid population growth (Surayasa et al., 2024). However, challenges such as climate change, conflict, economic pressures, and rising inequality hinder the world's efforts to overcome poverty by 2030. Moreover, the COVID-19 pandemic has exacerbated this situation, with an estimated 150 million people experiencing hunger by 2021 (UNDP, 2022).

In 2010, Malaysia`s population was estimated at round 28.6 million people and grew to 32.7 million by 2022. This growth has driven a higher demand for plant-based food sources. The combination of a rising population and potential risks of food supply shortages has made productivity a key focus to ensure food quality is minted. For instance, per capita vegetable consumption rose from 83.37 kg in 2018 to 85.12 kg in 2019. To meet local demands, Malaysia imported 1,821,000 metric tons of vegetables in 2019. However, productive agricultural land in the country decreased by approximately 2.5% in 2020. Therefore, modern technologies, such as plant factories, are essential to support Malaysia`s horticultural needs (Jabatan Perangkaan Malaysia, 2024).

Plant factories supported by information technology enable modern plant processing systems to be fully automated to meet the growth needs of various plant types, each with unique biological characteristics (Shamshiri et al., 2018). These plant factories ere classified into two categories. The first type is the fully artificial light plant factory, where vegetables are grown in a closed environment whithout the use of sunlight. The second type combines sunlight with artificial light. In this system, plant primarily rely on natural sunlight for growth within a greenhouse but are supplemented by artificial light as needed
(Rasmuna et al.., 2021).

Plant factories are efficient agricultural systems designed to provide stable farming conditions and have several key characteristics. One of these is the use of artificial lighting, such as LEDs, to enhance plant growth rates and improve quality (Watanabe, 2011; Shimizu et al., 2011). Cultivation takes place in a closed building equipped with a vertical farming system, maximizing space and land use. A soil-less irrigation system, specifically a hydroponic system, supplies the necessary air and nutrients to the plants (Hwang, 2012).

Intensive production techniques, specifically designed for high-value crops, are incorporated into modern agricultural technology, which is considered an effective strategy. The use of technology in agriculture offers several advantages, including increased productivity and resource efficiency. Farmers can leverage technology to obtain accurate information and make informed decisions regarding farm management (Efendi, 2016; Ekawati, 2019; Hasibuan, 2023). This approach efficiently utilizes air and nutrients, saves time and space, and reduces the need for constant tillage. By using LED lights in place of sunlight and providing nutrient-enriched air, the plant production system can operate year-round. Compared to traditional open farming methods, this technology can increase yield per unit area by up to four times.

A challenge with plant factories is the substantial initial investment required to build structures, set up irrigation systems, and install advanced technology, such as automated temperature and humidity controls. Additionally, operational costs including maintence, electricity, and labor are high. Many farmers lack sufficient access to or understanding of advanced technologies, such as automated sensors, and knowledge of crop management in plant factories remains unevenly distributed. The objective of this study is to develop a Business Model Canvas (BMC) for a warehouse crop plant at MARDI in Serdang, Selangor, Malaysia. The BMC, developed by Alexander Osterwalder and Yves Pigneur (2010), is a strategic management tool that provides a visual framework for creating, describing, and analyzing business models. It consists of nine essential components that collectively address the business`s value proposition, infrastructure, costumers, and financial aspects.

RESEARCH METHOD

This research employs a descriptive qualitative approach. Qualitative research is a method used to explain and describe findings based on the words, writing, and actions of the subjects studied (Nugrahani, 2024). Informants were selected purposively, focusing on those knowledgeable about the plant factory at MARDI, including assistant employees of horticultural researches and two related workers. Semi-structued interviews were conducted with questions pertaining to the Bussines Model Canva (BMC).

The research data consists of both primary and secondary sources. Primary data was collected in September 2024 at the Malaysia Agriculture, Holticulture and Agrotourism Show (MAHA) and through in-depth interviews, direct observation to the business location of the MARDI plant factory. Secondary data was gathered from relevant books, literature, and related agencies.

A descriptive qualitative analysis method was employed in this study to examine the implementation of the nine main elements of the Business Model Canvas (BMC) framework. This analysis aims to provide a deeper understanding of each block, including customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. The findings are presented descriptively, emphasizing the interrelationships among BMC components and their significance in promoting business sustainability and financial stability.

RESULT AND DISCUSSION

The results of this study are divided into two categories: findings from primary data collection and secondary data. Primary data includes interview results that will be summarized in the Business Model Canvas (BMC), while secondary data consists of information related to the cost analysis of building a plant factory at MARDI. This cost analysis is essential for providing additional insight to complement the findings derived from the Business Model Canvas (BMC). The following are the results of the Business Model canvas (BMC) mapping.

Business Model Canvas (BMC) For a Plant Factory

The recorded research results were gathered from interviews with informants represented by the researcher, MARDI. The following are the findings obtained from these interviews. Here are the 9 elements of the Business Model Canvas (BMC).

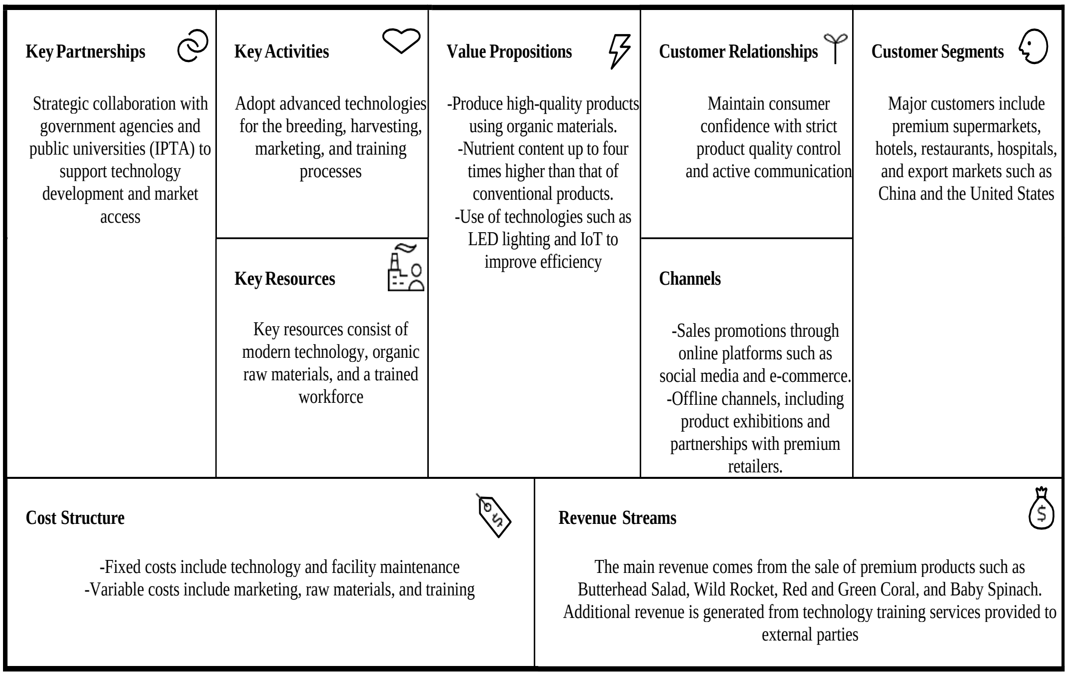

Figure 1. Mapping The Business Model Canvas (BMC) For a Plant Factory Business.

Key Resource

Identify key resources, which may include manpower, equipment, and technology. The availability and management of these resources have a significant impact on operational success and efficiency. The Plant Factory utilizes smart farming techniques, LED lighting, IoT devices, and hydroponic racking systems. Two workers are required at the Plant Factory to handle seedlings, monitor water and fertilizer applications, transplant, and manage the LED lights using the Smart Farming control system.

Key Partnership

Key Partnerships identify the network of suppliers, partners, and other stakeholders that contribute to the success of the business. The Crop Factory works closely with relevant local government organizations. Government support, such as participation in exhibitions or product promotions, provides the Plant Factory with a competitive advantage in product marketing. The Crop Factory also collaborates with public universities. Through these partnerships, the Plant Factory gains access to resources for innovation, research, and technology development, which can support business growth and manufacturing.

Key Activities

Activities that must be completed to ensure the smooth operation of the company include production, distribution, and marketing processes, which should be the main focus of any agricultural business. These activities are essential to meet customer demand and produce high-quality products. The main activities carried out at the Plant Factory involve the use of advanced technology for seeding, maintenance, harvesting, marketing, and conducting training.

Value Proposition

Activities that must be completed to ensure the smooth operation of the company include production, distribution, and marketing processes, which should be the main focus of any agricultural business. These activities are essential to meet customer demand and produce high-quality products. The main activities carried out at the Plant Factory involve the use of advanced technology for seeding, maintenance, harvesting, marketing, and conducting training.

Instead of using solar light sources during production, the Plant Factory utilizes LED lighting technology. Some of the benefits of LED lighting systems include high energy savings, longer service life, ease of installation and setup, and the ability to customize the light spectrum to meet the needs of the plants. This technology makes horticultural crop production more sustainable and efficient in the future. The Plant Factory is also implementing a smart farming system that uses Internet of Things (IoT) technology. IoT technology enables better monitoring and control of every aspect of the agricultural process, including post-harvest quality, irrigation systems, environmental conditions, and pest and disease management. As a result, the yield of horticultural crops becomes more consistent, high-quality, and predictable. Additionally, IoT-based smart farming facilitates easy control of plant pests and improves resource efficiency.

Channels

Channels describe the ways a company communicates with and reaches its customer segments to deliver its value proposition. Based on the available information, the Crop Refinery's distribution channel involves entrepreneurs who supply products directly to end users. The main focus is on the primary user to optimize costs, which is why middlemen and agents are avoided. The pre-order mechanism used for transactions allows buyers to pay according to the terms of the agreement, either on a monthly or annual basis. The Plant Factory also utilizes both offline and online marketing platforms. Social media sites such as Facebook and Instagram are used for online marketing to reach a larger audience. In contrast, offline marketing is carried out through participation in exhibition events, such as Expo MAHA Malaysia 1001, which attracts many Malaysians as well as tourists from other ASEAN countries. In this way, the Plant Factory aims to introduce its products and services to a broader consumer base in a direct and personalized manner.

Costumer Segment

Customer Segments (Target Market) aim to target a broad market to capitalize on significant opportunities for growth and profit, supported by a well-planned strategy. The Plant can divide its customers into various groups based on their demand, characteristics, and behavior, including hospitals, hotels, restaurants, and high-end supermarkets. In addition to the domestic market, the Plant has also exported goods to international markets, including China, Japan, and the United States.

Cost Structure

The cost structure describes all the expenses associated with operating a business. The costs incurred by the Plant Factory are divided into two categories: fixed costs and variable costs. Fixed costs include labor compensation, while variable costs include depreciation of technological tools and electricity expenses.

Costumer Relationship

The cost structure describes all the expenses associated with operating a business. The costs incurred by the Plant Factory are divided into two categories: fixed costs and variable costs. Fixed costs include labor compensation, while variable costs include depreciation of technological tools and electricity expenses.

Revenue Stream

Revenue Flow refers to the financial resources earned by the group from the sale of products and services. The premium products sold by the group include butterhead salad, wild rocket, red/green coral, and baby spinach. Marketing from the Plant Factory operates on a 100% cash basis with suppliers, while sales to certain segments are on credit. Approximately 10% of sales are made on credit to the hotel segment, luxury restaurants, and supermarkets, with a profit margin of 20-30%. Sales to the final consumer have a profit margin of 30%.

As part of its revenue stream, the Plant offers training services in addition to selling its premium products. These training programs aim to enhance the skills of entrepreneurs and improve their understanding of modern technology applications. By offering a range of premium products and training services, the group seeks to diversify its sources of income, thereby strengthening its financial stability and fostering business growth.

Figure 2.The Plant Factory is located at MARDI
Source: Field research at MAHA (2024)

Cost analysis and production progress of the Plant Factory

In 2019, MARDI developed vegetable production technology using a plant factory system. Three types of plant factories have been established: warehouse plant factories, shop plant factories, and MARDI Agro cube plant factories. However, this study primarily focuses on warehouse plant factories. These are large-scale facilities designed to produce high-quality vegetables to meet significant market demand. Warehouse plant factories can be set up in warehouses, industrial estates, or large-scale buildings with ample land.

Table 1. Cost analysis and production progress of the Plant Factory

Parameters	**Plant Factory**
Size	30' X 80' X 20'
Area (square feet)	2.400
Number of plant	22.000
Result:	
Price (minimum) (per kg)	RM 16,00 (RP 56.888,96)
Yield (kg) per year (15 seasons)	35,97 kg
Annual Sales (RM) (RP) Per Year	RM 574.992 (RP 2.042.969.575,68)
Cost:	
Infrastructure, air conditioning Antifungal paint, co2 injector Nursery room setup (RM) (RP)	RM20.000 (RP 71.111.200)
Raised Planting system (Shelves) LED lights, automatic irrigation System (RM)(RP)	RM300.000 (RP 1.066.668.000)
Environmental monitoring and Control system (RM)(RP)	RM65.000 (RP 231.111.400)
Equipment and machinery (RM) (RP)	RM15.000 (RP 53.333.400)
Estimated total cost (RM) (RP)	RM700.000 (RP 2.488.892.000)
Net present value (NPV) 10% (RM) (RP)	RM891.341,93 (RP3.169.219.712,63)
Internal Rate Of Return (IRR) 10%	37,4 %
Benefit-Cost Ratio (BCR) (RM) (RP)	RM 1,38 (RP 4.906,67)
Production Cost (RM/kg) (RP/kg)	RM 10,34 (RP 36.906,71)
Net Profit (RM/kg) (RP/kg)	RM 5,66 (RP 20.124,47)
Break Event Point (kg/season)	799 kg

Source: Rasmuna et al. (2021); MARDI Crop Production Book: Modern Technology of Food Crop Production (2022)

Table 1 presents the cost analysis and production development of the plant. With an area of 2,400 square feet and a capacity of 22,000 plants, it generates an annual production of 35.97 kg with 15 harvest seasons per year. With a minimum selling price of RM 16 per kg (equivalent to IDR 56,888.96), the annual revenue reaches RM 574,992 (IDR 2,042,969,575.68). The total investment cost, which covers infrastructure such as air conditioning, environmental monitoring systems, LED lights, and automatic irrigation, is estimated at RM 700,000 (IDR 2,488,892,000). It is estimated that the production can generate a gross revenue of RM 38,000 per month, with a net present value (NPV) of RM 891,341 (IDR 3,169,219,712.63), an internal rate of return (IRR) of 37.4%, and a payback period of three years.

According to the author, the study's findings support the idea that modern, technology-based plant factories offer profitable business opportunities, particularly in meeting the demands of high-end industries such as restaurants, hospitals, and supermarkets. While high startup costs present a challenge, they can be offset by the potential for long-term profits driven by technological innovation and production efficiency. However, the success of this venture also depends on market stability, effective management of technological risks, and the control of operating costs, such as electricity and raw material prices. Overall, this model can serve as a valuable reference for the development of sustainable agribusiness in the modern agricultural era.

CONCLUSION

Based on the analysis of the plant factory business model using the Business Model Canvas (BMC) method, it can be concluded that this business model holds significant potential for bridging the technology and knowledge gap in the agricultural sector. The successful implementation of this model largely depends on the alignment between modern technology application and the socio-economic conditions of local farmers. The findings of this study are expected to serve as a reference for the development of similar facilities aimed at enhancing the capacity and technological competence of farmers in developing countries.

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