The Influence of Technopreneur ship and Innovation Systems on the Adoption of Agricultural Drones in Indonesia

(Case study: Todaytech drone)

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Abstract

The agricultural sector is one of the main commodities in Indonesia as an agrarian country. One form of Indonesia's development is directed towards advanced and efficient agriculture to maximize the output of agricultural commodities. Drones or Unmanned Aerial Vehicles (UAVs) have emerged as a solution to create smart agriculture in Indonesia. Todaytech operates in the field of agricultural land spraying services using drones. Over time, the growth of the agricultural drone market will have an impact on the development of the agricultural drone industry. Based on these issues, this study aims to identify the study of technopreneurship and innovation systems in the spray drone industry to understand the opportunities for developing strategies in commercializing Todaytech's new product in response to the innovation measurement of the spray drone market in Indonesia. The tools used to identify the business models are the Goldsmith Model, Value Chain, SWOT analysis, and the Business Model Canvas (BMC). The results of this study show that the implemented Goldsmith model faces various technical, market, and business challenges. These challenges should be considered by technopreneurs in developing relevant innovation systems.

Keywords

Technopreneur and innovation system, Goldsmith Model, Business Model Canvas, SWOT analysis

1. Introduction

The dynamism of technological development will always continue and cannot be halted, as it pertains to the transformation of the socioeconomic landscape of global society. The impact of technological advancement in the era of globalization will yield significant benefits and challenges for developing countries, including Indonesia. Increased accessibility to technology, improved efficiency and effectiveness, and enhanced access to services are examples of the positive impact stemming from various inventions and innovations in technology development occurring in Indonesia (Hariyono 2013). This transformation has significant impacts on various aspects of life, including the agricultural sector, which holds a strategic position in national development due to its relation to national food security

(food estate program) (Ayu Mutia et al. 2022). National development will be directed towards advanced, resilient, and efficient agriculture that can support regional development and expand employment opportunities. (Hafsah 2011).

Indonesia possesses significant economic and social potential in the agricultural sector, such as its vast agricultural land area of 10.61 million hectares and plantation area of 91.4 million hectares (BPS 2022). However, the magnitude of economic potential in the agricultural sector is accompanied by complex issues in its implementation. For example, challenges such as the gradual reduction of agricultural land due to land conversion and change in land use, land degradation, urbanization, and urban sprawl, the vulnerability of farmers to poverty, low productivity of cultivated land, and inadequate agricultural technology have led to a lack of interest among the millennial generation in the agricultural sector (Hafsah 2011). This needs to be addressed for the sustainability of the agricultural sector through *Sustainable Smart Farming* practices (Rachmawati 2020). The utilization of technological advancements and innovations is expected to enhance efficiency and productivity in the agricultural system in Indonesia, starting from selecting suitable seeds, utilizing appropriate fertilizers and pesticides, to optimizing irrigation and harvesting. Smart farming systems, such as the use of drones in the agricultural sector, aim to maximize the spraying of pesticides or fertilizers to increase land productivity in farming operations (Hafeez et al. 2022).

Drones, also known as Unmanned Aerial Vehicles (UAVs), are unmanned vehicles that serve as a replacement for human pilots in various activities, including agriculture. UAVs are equipped with a range of flight control systems such as hardware and software cameras, GPS, and other components (Rachmawati 2020). The utilization of UAVs in the field of agriculture includes their use as systems for monitoring crop growth, assessing soil conditions, managing drainage and irrigation systems, optimizing plant populations (Nzaramba et al. 2017). The invention and innovation of agricultural drone technology are considered capable of entering the market *(escaping the valley of death problems)* because they can contribute to innovation measurement (Carayannis and Campbell 2010). The utilization of agricultural drones in Indonesia has great potential as the demand for their benefits continues to increase. Generally, agricultural drones are divided into two categories: spray drones and mapping drones (Nzaramba et al. 2017). Factors such as efficiency and accuracy, cost savings, and the effectiveness of spraying pesticides and liquid fertilizers, as well as providing accurate information, are key factors in the increasing utilization of agricultural drones in Indonesia (Rachmawati 2020). This statement is reinforced by Indonesia being the second-largest market share for agricultural drones in Asia (Zanelli and Bodecker 2022). These various potentials are driving the dynamic development of agricultural drone technology in Indonesia.

As the dynamic development of spray drone technology advances, it leads to significant growth in technopreneur ship and technological innovation to address existing challenges. The role of the Technology Transfer Office (TTO) in supporting the development of spray drones is carried out by various entities to produce innovative inventions. Before marketing the invention products, a feasibility analysis needs to be conducted to minimize potential future losses. Feasibility analysis of spray drone development has been conducted by several researchers, for example Khofiyah et al. (2019) conducted a business strategy analysis to commercialize drone technology with a focus on technological innovation and ecosystem development. In line with that, Hsu et al., (2019) conducted a feasibility analysis on the potential use of drones for precise crop monitoring in agriculture. Overall, the feasibility analysis of spray drone production shows a promising value for the economic sector. Consistent with this statement, spray drones have become a market/demand-pull product in meeting the needs of smart agriculture (Khan et al. 2021).

In response to the need for spray drone technology to support agriculture in Indonesia, CV. Sapta Teknologi Mandiri (known as Todaytech) has emerged as a business unit specializing in agricultural drone rental and production, as well as agricultural partnership consulting in Indonesia. In its business operations, this business unit has pioneered agricultural drone discovery through the development of spray drone products in response to the demand and market opportunities for spray drones in Indonesia. Thus, Todaytech plays a significant role in the development of spray drone innovation in Indonesia. This highlights the important role of technopreneurship and innovation systems in the development of spray drone innovation. Therefore, this article will examine the role of technopreneurship and innovation systems in the spray drone industry and its adoption in Indonesian agriculture.

1.1 Objectives

The purpose of this article is to provide an overview of the role of technopreneurship and innovation management in the spray drone industry for the commercialization and adoption of inventions. Additionally, this research also explores issues related to spraying drone technology innovation.

2. Literature Review

2.1. Innovation as a Management Process

Interactive process is the key to innovation management. Innovation management involves building a balanced field of interactive entities to generate sustained knowledge transfer (Carayannis et al. 2015). In innovation management, inventions may appear successful in the short term, but not necessarily in the long term. This is because the inventions may not contribute effectively to innovation measurement, leading to the valley of death problems (Markman et al. 2008). Implicitly, there is a connection between innovation management and the process of innovation diffusion in determining the success of an innovation.

2.1.1 Technology Innovation Diffusion

The diffusion of technological innovation is related to the adoption of new technology on an aggregate scale. Technological diffusion is described as the premise of technology adoption by society over time (Kemp and Volpi 2008). The factors of relative advantage, compatibility, trialability, complexity, and observability are accompanying factors of technology innovation adoption (Rogers 2003). Upon further analysis, the diffusion of technological innovation implicitly addresses the decision-making process of technology adoption (Kemp and Volpi 2008). he sustainability of government, universities, industry, society, and the environment *(Quintuple Helix Model)* as enablers and enactments shape the ecosystem of evolving technological innovation diffusion (Carayannis et al. 2017). The balance among these entities forms an ecosystem capable of supporting innovation and sustainable economic growth (Carayannis and Campbell 2010).

2.2. Innovation Systems

Innovation system in innovation management refers to the framework and processes used to systematically manage innovation within an organization (Carayannis et al. 2015). The innovation system encompasses various elements that interact to stimulate, guide, and support innovation activities. It involves people, processes, policies, and an environment that facilitate the generation of new ideas, concept development, implementation, and the application of innovation in products, services, or organizational processes (Markman et al. 2008). There are six main elements in an innovation system: innovation culture, innovation processes, entity collaboration, resources and infrastructure, risk and reward management, and measurement and evaluation (Drucker 1984).

2.3. Goldsmith Model

The Goldsmith commercialization model is a model that integrates technical, market, and business process elements for commercialization into a matrix of sequential activities. This commercialization model covers the entire process, from the initial idea, through development, production, and start-up of a spin-off company, to the exit strategy for inventors and investors (Goldsmith, 1995; 2003). Goldsmith (2003) describes it as a tactical model designed as a framework to help develop progressive steps, identify information and technical assistance needs, project development costs, and estimated financing needs. Lotfollah et al. (2014) argue that the Goldsmith Model is more suitable for commercializing completely new ideas and is not suitable for incremental innovations or improvements or upgrades to existing products, services, and processes. Rosa & Rose (2007) also argue that this model is not flexible enough to accommodate input or reordering of steps where circumstances dictate or desire it, especially in incremental innovation programs.

2.4. Technology Development of Spray Drone

Generally, there are two backgrounds that contribute to technological development in technological innovation, namely market pull and technology push (Trott 2005). Spraydrone is a product that emerged due to Market Pull or Demand Pull as a need in smart farming. Additionally, the development of the spray drone product is also influenced by Technology Push in the early research phase (Kim et al. 2023). The background of technological development is illustrated in Figure 1.

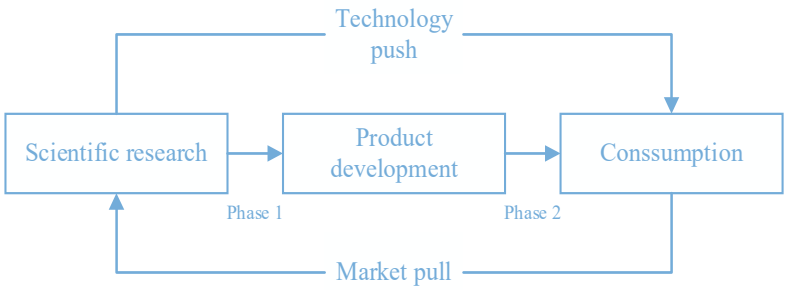

Figure 1. Technology Development

The development of product innovation and the readiness of the spray drone to enter the market can be measured by the Technology Readiness Level (TRL). Rauter et al., (2019) argue that the spray drone product has reached TRL 9, demonstrated by the actual system that has been proven in operational environments, fully operational, commercialized, and implemented. Similarly, the full production chain and all the materials required to assemble the spray drone are available and at a stable level. The system has been optimized for full production, enabling the actual application of this technology to be ready for large-scale production (Miron et al. 2023). However, despite the spray drone reaching TRL 9, there are still constraints due to certain indicators that have not been met, particularly in terms of high production cost estimation, which contributes to the expensive price of the spray drone product. The high production cost is attributed to the attributes, battery, and technology still being relatively new and continuously undergoing development, requiring significant labor and capital for the related processes (Hafeez et al. 2022). Additionally, there are business constraints on the commercialization of the spray drone, which, when measured by the Commercial Readiness Index (CRI), only reaches level 4 (Nzaramba et al. 2017). At this level, the commercialization of the spray drone is still in the supported commercial stage, which requires further development.

3. Methods

This article aims to examine the role of technopreneurship and innovation systems in the development of spray drone technology to understand the relevant innovation management process. Additionally, ecosystem factors and the role of Technology Transfer Offices (TTOs) will be considered in responding to the existing environment. The research design employed in this study is qualitative with a case study approach. Primary data for this research is derived from in-depth interviews with the CEO of Todaytech. A literature review on "technopreneurship and innovation management in spray drones" was conducted to explore secondary data to support the research. This article utilizes a flowchart as a reference for a systematic and structured approach to the study. The research flowchart can be depicted in the following Figure 2.

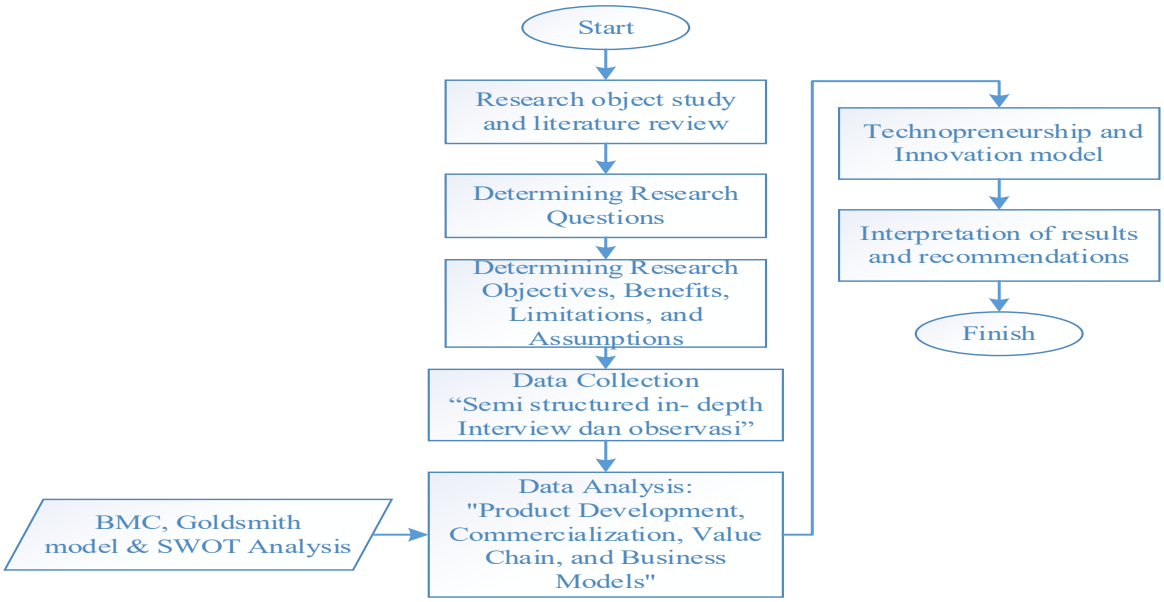

Figure 2. Research Flowchart

4. Data Collection

In this research, the author employed two data collection methods, namely interviews and a literature review. Interviews were conducted with the CEO of Todaytech to obtain detailed information about the innovation process and commercialization strategies employed. The interviews utilized *a semi-structured in-depth interview method*, where the researcher followed an interview protocol consisting of a list of questions supplemented with follow-up inquiries. This method allowed the researcher to delve deeply into the participants' thoughts. Additionally, ongoing communication through social media was established to facilitate discussions related to the research. Furthermore, a literature review was conducted to explore secondary data on the role of technopreneurship and innovation management in the field of spray drones, thus supporting the research conducted.

5. Results and Discussion

5.1 Commercialization Evaluation

The commercialization model approach by Goldsmith in spray drones encompasses three aspects: technical, market, and business aspects. In this stage, the technical aspect involves analyzing the technical concept, the market aspect evaluates market needs, and the business aspect assesses the business endeavor (Goldsmith 2003). The results of the commercialization evaluation based on the Goldsmith commercialization model can be illustrated in Figure 3.

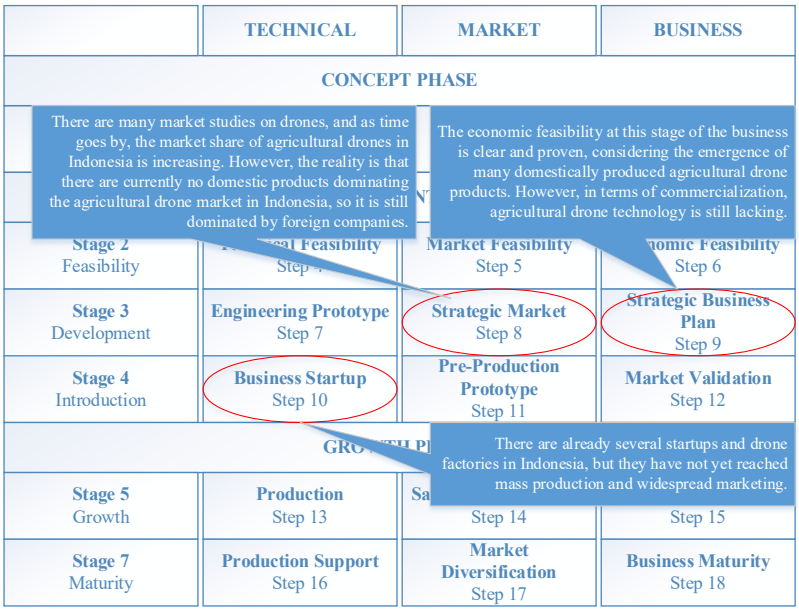

Figure 3. Evaluation of Drone Product Commercialization in Indonesia

According to the Goldsmith model, there are three challenges or constraints in the commercialization of technology at Todaytech, which will be elaborated on the following points:

a. Technical challenges
   1) The capacity and efficiency in land spraying processes involve ensuring that the spray drone can carry a sufficiently large payload to spray the materials efficiently. The battery capacity and lifting power of the drone need to be improved to handle heavier loads and perform tasks with adequate flight time.
   2) Precision and accuracy in land spraying processes must have high precision and accuracy to ensure that the sprayed materials reach the intended targets. The drone's navigation system must be accurate and capable of accurately identifying the target areas.

b. Market challenges
   The purchase of agricultural drones and the utilization of land spraying services using drones still have a relatively low market share. This is due to the lingering doubts among farmers and other consumers, mainly in rural areas, caused by the high costs of purchasing and renting drones. Additionally, the drone and agriculture industries can be highly competitive, with many companies striving to offer innovative spraying solutions. These challenges include the company's ability to differentiate itself from competitors, whether through unique technology, superior customer service, or creative market approaches.

c. Business challenges
   1) Building a sustainable and profitable business model is a major challenge. Companies need to consider factors such as operational costs, competitive pricing for drone spraying services, and the revenue generated from these services. Companies also need to consider how to acquire and retain a large customer base to ensure business sustainability.
   2) Similarly, developing a scalable business model is an important challenge. Companies must consider how to increase operational capacity and the number of drones used without sacrificing efficiency and service quality. This involves aspects such as drone procurement, operator training, and logistics management.
   3) Promoting drone spraying services and acquiring new customers can be a challenge. Companies need to develop effective marketing strategies, including educating the market about the benefits of drone spraying and identifying the right market segments. Communicating competitive advantages and offering tailored solutions to meet customer needs are also key to market penetration.

The development of spray drone technology in Indonesia is entering the growth phase. The readiness of drone technology for commercialization needs to be prepared with a strategic business plan, including the business regulations. The market share and business prospects for commercializing drones consist of delivery (transportation), inspection, and agriculture. The prospect of the drone business in Indonesia as a market or production destination is

likely to be a market destination at present. The business process diagram for spray drones can be presented in Figure 4.

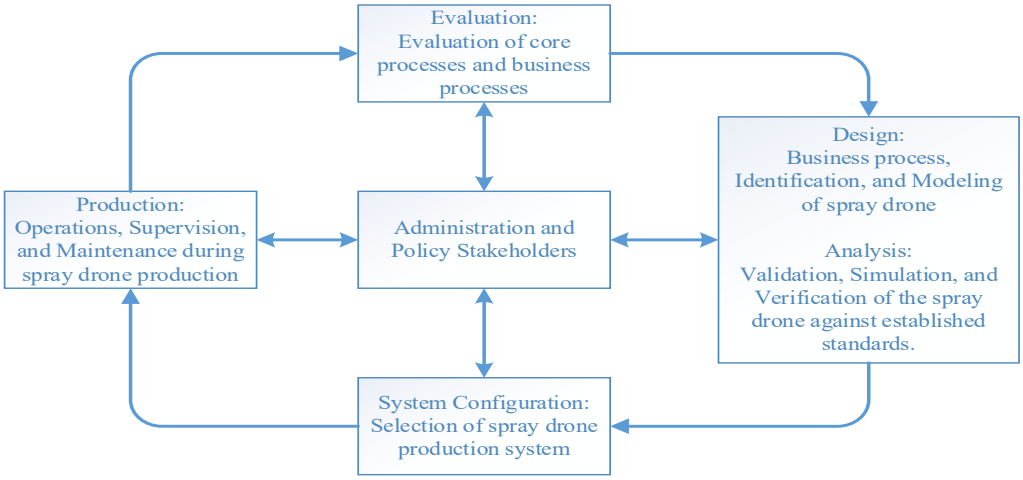

Figure 4. Diagram of the spray drone business process

5.2 Supply Chain dan Value Chain

Increasing the market share of spray drones must be accompanied by successful commercialization in order to dominate the existing market share. The success of commercialization is closely related to the process of technological innovation and supply chain engineering, where new entities will be formed in the supply chain through the process of technological innovation, such as technopreneurs, startups, suppliers, manufacturers, and distributors, to commercialize the technology. This is because innovative technological products have an unstable and evolutionary supply chain. (Sutopo et al. 2022).

During the conducted interview, it was found that the supply chain network design of Todaytech consists of suppliers, manufacturing services, and consumers. Todaytech supplies equipment used to produce services such as drones and their spare parts from Joyance Tech. As for its market segments, they include farmers, companies, and government entities. These supply chain entities are depicted in Figure 5.

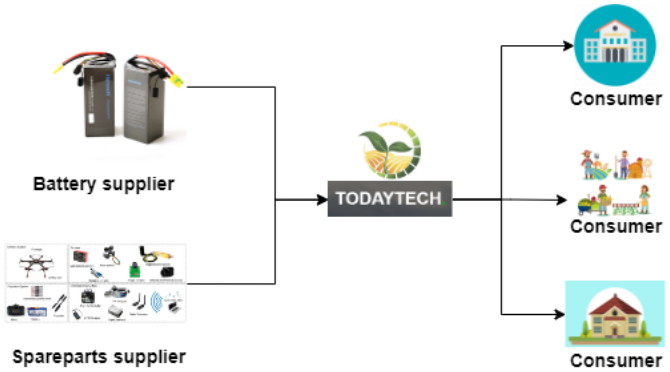

Figure 5. Supply Chain Network Design Todaytech

The overall illustration of the activities or tasks required to produce a product, either goods or services, ranging from the design process, input of raw materials, production process, distribution to end consumers, and post-consumer recycling conducted by Todaytech can be presented in Table 1.

Table 1. Value Chain Todaytech

Value Chain Todaytech		
Primary Activities	Inbound Logistics	Purchase of drone components and spare parts
	Operation	Meeting with clients.
	Outbound Logistics	Order management and monitoring of spraying results.
	Marketing & Sales	Promotion, website, collaboration with vendors
	Services	Customer-oriented service
Supporting Activities	Business Infrastructure	Business management of the company.
	HR Management	Recruitment, training, and development of employees, as well as employee compensation.
	Technology Development	Utilizing market research and involving consumers in company development.
		Using online promotional media for marketing purposes.
		Purchasing assets, components, and promotions.
	Procurement	Purchase of drones and components.

5.3 SWOT Analysis

The key to the success of technological innovation in the market is based on faster time to market and lower investment to create an effective and efficient supply chain, thus increasing the chances of successful technology innovation in the market. The performance measurement of a supply chain can be assessed using various methods, one of which is the SWOT analysis. The SWOT method highlights the strengths, weaknesses, opportunities, and challenges of an industry in the commercialization process. From these four aspects, solutions can be derived to develop the industry. The following is the SWOT matrix of Todaytech as presented in Table 2.

Table 2. SWOT Todaytech

TODAYTECH SWOT ANALYSIS			
Internal		External	
	Case		Case
S Strengths	1. Partnership with resource companies providing liquid fertilizer. 2. Rent prices are still affordable for farmers. 3. Accepting orders for small-scale land areas	**O** Opportunities	1. Agriculture becomes the largest commodity, leading to a rapid increase in market share. 2. Availability of licensed pilots. 3. Drone production in Indonesia is still relatively low.
W Weaknesses	1. Limited administrative resources. 2. Limited capabilities of the available drone resources. 3. Drones are prone to damage as they are electronic devices.	**T** Threats	1. Availability of spare parts in Indonesia is still limited. 2. Doubt among farmers or consumers in using agricultural drones. 3. Limited resources for one-time transport.

5.4 Business Model Canvas

The most widely used approach for defining a business model is the business model developed by Osterwalder and Pigneur in 2010, known as the Business Model Canvas (BMC) (Osterwalder et al. 2010). The BMC framework proposes a model consisting of nine components that depict different aspects of a specific business segment. Based on the interview results with the CEO of Todaytech, the BMC model can be presented in Table 3.

Table 3. Business Model Canvas Todaytech

<table>
<tr><th colspan="5">BUSINESS MODEL CANVAS Todaytech</th></tr>
<tr><th>Key Partners</th><th>Key Activities</th><th>Value Propositions</th><th>Customer Relationship</th><th>Customer Segments</th></tr>
<tr>
<td rowspan="2">• Vendor sparepart (Joyance Tech)
• PT. Pustaka Insan Madani
• Food Estate Program (Pemerintah Indonesia)
• Spare parts vendor (Joyance Tech).
• PT. Pustaka Insan Madani.
• Food Estate Program (Government of Indonesia).</td>
<td>• Production of spray drones with a carrying capacity of 25 liters.
• Providing spray drone services and drone pilot license training.</td>
<td rowspan="2">• Todaytech spray drones have a larger carrying capacity compared to the usual ones (typically 10-15 liters, product 25 liters).
• Focus on agricultural and plantation land.
• There is a warranty provided for the manufactured spray drones.</td>
<td>• Actively engaging in personal approaches to farmers.
• Actively participating in supporting activities and collaborative events of the Food Estate program.</td>
<td rowspan="2">• Indonesian government (relevant departments).
• Agricultural and plantation cooperatives.
• Entrepreneurs engaged in agriculture and plantation sectors.</td>
</tr>
<tr>
<td>Key Resources
• Physical assets (office space).
• Human resources.
• Specialized technology.</td>
<td>Channels
• Social media (website, Instagram, WhatsApp, and others).
• Collaborative partners.</td>
</tr>
<tr><th colspan="3">Cost Structure</th><th colspan="2">Revenue Streams</th></tr>
<tr>
<td colspan="3">• Asset and employee costs.
• Raw material costs (spare parts and custom spray drone).
• Maintenance costs.
• Drone pilot costs.</td>
<td colspan="2">• Cross cooperation dengan mitra (perusahaan dan universitas)
• Penjualan produk spraydrone Todaytech
• Penyewaan jasa semprot pada produk spraydrone Todaytech</td>
</tr>
</table>

The Business Model Canvas will change whenever a company undertakes business innovation. Therefore, the management involved in the Business Model Canvas will innovate the previous BMC model. From this BMC, the next steps for business innovation will be taken. The same goes for Todaytech, the company's BMC needs to be evaluated periodically and when the company undergoes innovation.

6. Conclusion

This research aims to identify the study of technopreneur ship and innovation systems in the spray drone industry in terms of commercialization and adoption of inventions. The identification based on the Goldsmith model implemented presents several technical, market, and business challenges. These challenges must be considered by technopreneurs in developing relevant innovation systems.

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Biography

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