A Framework for Developing Technopreneurship and Innovation System: A Comparative Study of Agricultural Drone Technology Development in Indonesia

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Abstract
This study aimed to determine a framework for developing technopreneurship and innovation systems in agricultural drone technology development in Indonesia. The methodology used in this research is a comparative study of three technology development drones in Indonesia. The research approach uses four frameworks that are combined. This framework consists of market pull vs. push technology, Process Innovation, closed innovation vs. open innovation, and the Technology Transfer Office. The data used in analyzing this comparative study is qualitative data that is secondary data obtained on the internet and previous research. The results obtained are that management and innovation systems are essential to grow and develop successful technology-based entrepreneurs, which is learned from how agricultural drone technology development in Indonesia is analyzed. At the core of their success in launching products is the management and innovation system that they do well and measure. Then the evaluation framework has been carried out, which is divided into two, namely the strategy stage and the development stage. The strategy phase consists of a Technology Push and Market Pull and Closed Innovation vs. Open Innovation framework. The development phase consists of the Innovation Process and Technology Transfer Office. This framework model is following the framework for the development of agricultural drone technology.

Keywords: Agricultural Drone, Comparative Study, Commercialization Technology, Innovation systems, Technology Development, and Technopreneurship,

1. Introduction
The definition of Technopreneurship is an attempt to create an IT-based business, so it is expected that the business movement will always and get better. Technopreneurship is a combination of two words, namely technology and entrepreneurship. Both of these are important, and a framework is needed to analyze them. According to Siyanbola et al. (2011), the framework for technological entrepreneurship Development consists of 4 significant aspects that must be considered, namely, aspects of policies, institutional support, education, and finance. Then from these four aspects, there are stages that must be done by a technopreneur. Starting with the creation of ideas & screening of R&D, the invention aims to choose which innovation will be realized.

Furthermore, a feasibility study for development of a prototype was conducted to determine the feasibility of the innovation. Do not also forget to register a Patent and Agreement to safeguard inventions. The next step is to do Production, Marketing, and Adoption of Technology. After all the steps have been done, do not stop there. The inventor will evaluate the findings, make new ideas, proceed to the next stage, and continue to spin until the results of these findings are better accepted in the market. Opportunities for technological innovation for newcomers are wide open, which can create an 'innovation shock' for old players who have been involved in the technology (Argyres et al. 2015) compared to Parrot Drone which had already been involved in the world of drone technology (Chin et al., 2017). However, predicting and understanding the evolution of technology is a challenge for old players or newcomers (Dedehayir & Steinert, 2016).

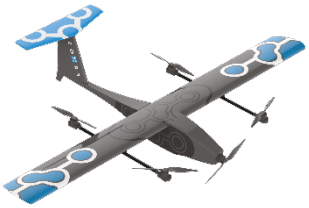
Technological innovations open opportunities for new entrants to transform and recreate industries, creating disruption known as 'innovation shocks.' Argyres, Bigelow use this term, and (Argyres et al, 2015) "as the introduction by a firm of a new product that stimulates a substantial surge and acceleration in demand for that product——a surge that was generally unexpected by market participants." However, understanding and predicting such emerging technologies is a challenge for new entrants and incumbents (Dedehayir & Steinert, 2016).

The drone is one of the technologies that can disrupt previous industries such as the aircraft or helicopter industries. Although drone technology has long emerged, its technology continues to develop, making this drone as a newcomer technology that damages or beats the previous technology. No day passes without the announcement of a new product introducing a new way the drone can be used in a different context just like a smartphone today (Norman & Verganti, 2014). In addition the trend of drone sales is increasing every year (Khofiyah et al, 2018). Which indicates that this drone is a newcomer technology that is accepted in the market.

According to fulldronesolution (2019), Indonesia is currently still trying to increase its agricultural sector productivity, especially food crops. This is done to support sustainable food self-sufficiency, which is done by increasing national rice production. The increasing population demands the agricultural sector to continue to be more productive in meeting food needs. The data show that there are still deficiencies in efforts to increase the productivity of all agricultural commodities. Then the need for technology helps increase productivity in the agricultural sector.

In recent years, their drone companies have begun entering Indonesia. One of them is the DJI drone whose ambition is to control the drone market in Indonesia. Besides, drone-maker startups in Indonesia also began to emerge by producing agricultural drone products. This research aims to develop agricultural drone technology in Indonesia, namely the Indonesian frog, Famindo technological innovation, and terra drones. These three technology developments, produce drone sprayer products and drone supervision with each startup product's specification according to their market share. These three companies will be the object of research in this article with comparative study analysis for agricultural drone technology development in Indonesia to see the technology and innovation systems of these four companies. The following table 1 explains the comparison of agriculture drone technology development products in Indonesia.

Table 1. Comparison of agriculture drone technology development product in Indonesia

Inventor / RnD	Sprayer Drones	Surveillance Drones
Frogs Indonesia Indonesia	 Function: It makes it easier for agricultural land managers to spray fertilizers and pesticides with a much shorter time.	 Function: For supervision of agricultural land
Famindo Inovasi Teknologi		
Terra Drone	 Function: Can be used in very dense forest situations, reaching high locations, or windy beaches.	 Function: For aerial mapping and modeling activities

In addition to technopreneurship, innovation systems are also crucial in building an IT-based business, according to Carayannis et al. (2015), primarily on the idea of innovation systems related to the flow of knowledge and its impact on economic growth. So the need for innovation management, to regulate innovation itself so that it is balanced between the flow of knowledge with learning, as in the framework of Carayannis et al. (2015), which consists of 3 elements, namely Creativity, Innovation and Competitiveness. These three elements are interrelated, where creativity can produce a finding where the findings can become innovations. The innovation is produced so that there is competition, from which competition comes competitiveness.

The problem statement is that not all technological innovations can be present in the market (valley of death problems) so that they do not contribute to innovation measurement (Carayannis et al., 2015), there is an impact on competitiveness problems (Carayannis et al., 2015). So that researchers have a hypothesis that needs to be improved (technopreneurship & innovation system), then this study becomes relevant and interesting to study. Table 2 below explains the state of the art in this study.

Table 2. State of The Art

	Siyanbola et al (2011)	Brem and Voigt (2009)	Lubik et al (2012)
Objectives	A framework for developing technological entrepreneurship, particularly for developing countries with supporting policy directions.	To introduce a theory-based conceptual framework that can be used in today's corporate environment.	Focus on market-pull and technology-push orientations in manufacturing ventures, specifically Examining how and why this orientation shifts during the firm's formative years.
Methodology	Technological Entrepreneurship	Market-pull and technology-push	A multiple case study approach with Market-pull and technology –push approach.
The object of the research	Exploits existing scientific and technological knowledge to meet market needs	A technology-based service company is managing the connection of these two alternatives	25 UK startups in emerging Industries are used to examine this seldom explored area.

2. A Comparative Study Approach

2.1. Innovation as a Management Process; Innovation Systems; and Introduction to Technological Entrepreneurship

a. Innovation as a Management Process

Innovation management is a very interactive process. This is the result of the ongoing knowledge transfer between various entity points, where the participation of each team member can influence the outcome (Cooke et al., 1998). Innovations often seem to work in the short term, but do not seem to be very successful in the long run. The main reasons for this are often unrealistic expectations in the future evolution of technology and a lack of insight into unexpected effects. The second observation is that in only a few cases, the primary obstacle is a scientific or technological problem. Usually, organizational, administrative, and institutional problems get in the way (Carayannis et al., 2015).

Innovation management is very complicated and risky. Analysis of company failures revealed, among others, a large number of innovative companies that failed to translate their technological creativity into profitable business operations. Therefore the challenge is not just the creation of innovation, but the right management to generate profits in the company. Because the role of innovation management in a company's performance is clear, its management process must be standardized and used to achieve sound business operations (Carayannis et al., 2015).

b. Innovation Systems

According to Edquist (1997), an innovation system is defined as: "all-important economic, social, political, organizational, and other factors that influence the development, diffusion, and use of innovations." An innovation system's goal may be the creation, diffusion, and exploitation of innovation (Carayannis et al., 2015).

Bauwhof has argued that Hughes and Latour, by taking into account the process of invention–innovation, identified a communication (i.e. interactive learning) where different forms of knowledge were integrated through transformation processes, promoting new combinations of knowledge. At this early stage of inventions, the product (innovation) was an abstract concept that was then redefined and transformed by actors looking for a way into the market. The 'invention system' was 'open' as different options were being tested. In contrast to the invention phase, the mature product appears in a technological model with a fixed set of different forms of knowledge in a particular structure. In this case, the innovation system's internal complexity may be higher than the complexity during the invention stages, but the 'weak-tie' prospects are not the same as before. In the learning economy, this occurs during a new species (Carayannis et al., 2015).

c. Introduction to Technological Entrepreneurship

Technology and Entrepreneurship as two more key input factors in the early twentieth century (Joseph Schumpeter, 1934). The role and dynamic nature of technological change and innovation, as well as their interdependencies, were thus acknowledged as main factors shaping the world economy's future. On this basis, we believe that there is a clear role, opportunity, and challenge for entrepreneurs around the world to accelerate and affect economic growth and leverage the Digital Divide through business initiatives in the private sector. Therefore, knowledge-based and knowledge-supported entrepreneurship will be the pre-eminent driver of innovation in the twenty-first century, via real/virtual and global/local infrastructures such as the incubator networks. This vision is particularly promising and appealing in e-Development towards the Knowledge Economy (Carayannis et al., 2015).

2.2. Framework Selection Technopreneurship & Innovation System

The technopreneurship framework and the innovation system in this study use four frameworks that are combined. This framework consists of market pull vs. push technology, closed innovation vs. open innovation, and the Technology Transfer Office. The combination of these four frameworks aims to develop a comprehensive system of technopreneurship and innovation. Moreover, from the merging of these four frameworks can be a recommendation in carrying out the process of innovation in other development technologies. This study uses secondary data obtained from research conducted through the internet. Figure 1 explains the Technopreneurship & Innovation System framework. So that in the analysis of the results in this study consisted of 4 stages of the framework. After analyzing the results of the research framework's stages, a comparative analysis was carried out with the development technology that had successfully become the market leader in this agricultural drone, the DJI MG-1 drone after that lesson is learning analysis by looking at the similarities/differences and weaknesses/strengths of the results of the comparative analysis so that the final result is a technology-based entrepreneurship model that is suitable for agricultural drone technology.

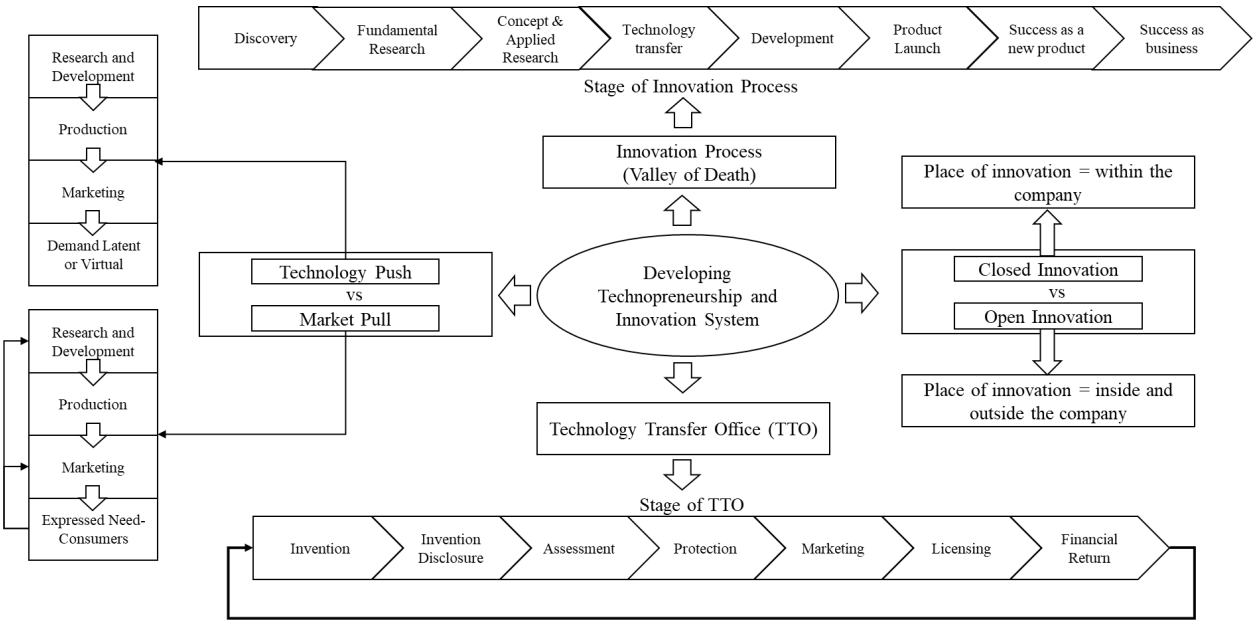


Figure 1. Framework Developing Technopreneurship & Innovation System

3. Result and Analysis

The results and analysis of a comparative study of 3 drone development technologies (Frogs Indonesia Indonesia, Famindo Inovasi Teknologi, and Terra-drone) that use a combined framework in developing a technopreneurship & innovation system.

3.1 Technology Push vs. Market Pull

Technology push is a term used for the approach in which technological innovation is pushed to the market, starting from internal development via production to the marketing function. In the "market pull" approach, on the other hand, the signal for development starts from the expressed market need (Martin, 1994). From this framework, drone technology development will be seen as having a push or market pull technology strategy in running its business as shown in table 3.

Table 3. Technology Push and Market Pull Table of Agriculture Drone Technology Development in Indonesia

Inventor/R&D	Technology	Technology Push	Market Pull
Frogs Indonesia Indo	Drone Sprayer 20L V3	v	-
Frogs Indonesia Indo	Surveillance UAV-VTOL	v	-
PT. FIT	SKYRO MA01-A/Drone Sprayer	v	-
PT. FIT	SKYRO V5/Drone Surveillance	v	-
Terra Drone	Sprayer Drone	v	-
Terra Drone	Surveillance Drone	v	-
DJI Drone	Agras MG-1S	v	v

Determines the fundamental between push technology and market pull is the reason the product is made or received. Technology encourages departing from research and development, while attractive markets depart from consumer needs. For some products, bias can quickly depart from the need for the product needs many people, for example, such as primary needs in contrast to technology products that need to be processed for this technology to be customer needs. Likewise, with drone technology, this technology is arguably a new technology for Indonesia, this connection technology is arguably only about the last five years. The development of agricultural drone technology in Indonesia is still a small player; some startups have succeeded in producing and selling their products. Furthermore, there is still much research, and it has not been sold officially.

Frogs Indonesia Indonesia is an Indonesian Transportation Disruptor Startup, developed by UMG Idealab. FROGS INDONESIA products are Drone Sprayer, Airmap Drone, Passenger Drone, and Cargo Drone. Drone Sprayer 20L V3, The presence of Drone Sprayer, provides the managers of agricultural land in terms of spraying fertilizers and pesticides. It is complete with a shorter time compared to soil that was previously done manually, which can reach for hours or now. UAV-VTOL Surveillance, Surveillance Drone, as the name suggests, is used to conduct surveillance. For this type of Surveillance, Frogs Indonesia itself has been developed and developed in two versions. The first version of this drone has been done many times and will always be improved for its development. In the first version, Frogs Indonesia has also approved and produced for the second version, and shortly Frogs Indonesia will conduct testing for Drone Surveillance, both versions 1 and 2. Both of these drone products are both pushing technology, which is latent or virtual demand.

PT. Famindo Group is a company that has established good cooperation with National Police Headquarters, National Police, BASARNAS (Badan Nasional Pencarian dan Pertolongan), and BIN (Badan Intelijen Negara), making the production quality of PT Famindo Inovasi Teknologi (PT FIT) unquestionable. This company produces many drones. One of them is an agriculture drone with type SKYRO MA01-A and SKYRO V5, a sprayer, and a drone surveillance drone. Both of these products include encouraging technology, as well as Indonesian frog products.
Terra Drone Indonesia (ex. PT Aero Geosurvey Indonesia) provides Unmanned Air Vehicles (UAVs) or uses drones for air surveying activities in industrial applications that complement aerial mapping & modeling, as well as providing & transferring air. The same is true for Indonesian Frogs Indonesia drones and famindo groups, which are the same skeleton, which is a technology push. Table 3 explains the comparison table of the technology used in agriculture drone products in two Indonesian Frogs Indonesia and Famindo Inovasi Teknologi Companies, and both companies make their agricultural drones.

3.2 Innovation Process (Valley of Death)

The process innovation stage, according to Chirazi et al. (2019), is an innovation process that is seen based on the stages of BID (Biologically Inspired Design). In this process, innovation consists of 8 stages, which can be seen in Figure 1, which at this stage is related to the valley of death of innovation. Valley of death is a valley of death for innovation that does not make it into the market, or its products have not yet been received in the market. According to Sutopo (2019a) the valley of death usually cause various technology products that are unsuccessful to be launched in the market. So that in this process innovation framework, researchers want to see which technology development drones are at which stage of innovation. Compares the technology used in agriculture drones in two development technologies as shown in table 4.

Table 4. Compares the technology used in agriculture drones in two development technologies

Frogs Indonesia Indonesia	Famindo Inovasi Teknologi
Drone Sprayer 20L V3 PAY LOAD Max Take-off Weight: 42 kg No-load Weight: 22 kg Liquid Load: 20 L LONG RANGE Flight Time: 10-20 minutes Radio Link Range: 3 km nominal (up to 8 km) The Altitude of Spraying: 1-5 m Spraying Swatch: >5 m Spraying Speed: 2-6 m/s Droplers Sprayer: 5-100 micron Spaying Coverage: 3 hectare/hour OTHER SPECIFICATION Dimension: 1500 mm x 1500 mm x 660 mm Motor: Industrial Brushless Motor Chemical Proof Frame Material: Carbon Fiber Sandwich Control System: Autopilot, fly by wire, and manual Controller Frequency: 2.4 GHz Battery Capacity: 22.000 mAh Battery Type: 12 Cell Lithium Polymer Sensor: 3 Ultrasonic Range Finder	SKYRO MA01-A/Drone Sprayer Drone Diameter | 1630 mm Height after folded | 710 mm Tank material | Fiberglass Tank Volume | 20 L Work Efficiency | 3.5-4.5 Acre / 15min Flying time | 10-15 min Flying Speed | 0-15 m / s Flying Radius | 1.5 km Flying height | 0-200 m How to landing | Takeoff and vertical landing Anti-wind | < 12.0 m / s Sprinkler Diameter | 80-200 μm Number of sprinklers | 6 pcs Watering speed | 4-8 m / s Sprinkler width | 5-8 m Watering height | 1-3 m on land
Surveillance UAV-VTOL PAYLOAD Max Take-Off Weight: 9 Kg Maximum Payload: 2 Kg LONG RANGE Cruising Speed: 60 Km/h Maximum Speed: 160 Km/h Max Endurance: 2 hours Range radius: 25 Km OTHER SPECIFICATIONS Length: 1.7 m Wingspan: 3.41 m Height: 0.6 m	SKYRO V5/Drone Surveillance Dimensions | (PxLxT: 2 m x 3 m x 0.19 m) Wing Span | 3 m Carrying capacity | 3-5 Kg * Control radius | 60 km Maximum flying time | 3.5 hours ** Maximum weight at take off | 21 Kg Roaming Speed | 72 Km-126 km / h Maximum height | 5500 m ASL Maximum take off height | 4500 m ASL Take off | one-click vertical take-off Landing | one-click vertical landing Other Specifications Tilt capability, Rotor design, VTOL capability more effectively. Does not require a large take off/landing area.

Frogs Indonesia Indonesia stood as an idea for the manufacture of air taxi/drone passenger. With UMG Idealab, as an incubator of this business idea, Frogs Indonesia developed this innovative idea into a startup in July 2018. Until finally, this startup was formed with Kiwi Aliwarga as CEO of Frogs Indonesia. The CEO, along with the Frogs Indonesia team, designed this passenger drone well and required a lengthy process in its design until finally, in September, the prototype wings air taxi production process began. After that, the process of marketing and government relations for Frogs Indonesia Indonesia was carried out.

Furthermore, testing and manufacturing of drone and surveillance drone products will be conducted in 2019. At that time, there has been a demand for agricultural drones (sprayers and surveillance drones). This agricultural drone product supports MSMB Indonesia in the framework of integrated smart farming, which MSMB Indonesia is a startup incubated by UMG Idealab as well. Frogs Indonesia Indonesia continues to grow and develop every month by continuing to improve drone technology and test it. Until 2020, the drone sprayer has begun to be used to spread disinfectants in Malioboro to overcome the spread of the COVID-19 virus in Yogyakarta. Then the first VTOL drone surveillance flight test was conducted in April 2020. From this explanation, it was concluded that currently, the Indonesian Agricultural Frogs Indonesia Drone Products (Drone Sprayer and Surveillance Drone) are at the product launch stage for drone sprayers and drone surveillance. Innovation Process Agriculture Drone Technology Development as show in table 5.

Table 5. Innovation Process Agriculture Drone Technology Development

Technology name	Discovery	Fundamental research	Concept & applied research	Technology transfer	Development	Product launch	Success as a new product	Success as a business
Frogs Indonesia Indonesia / Drone Sprayer 20L V3	v	v	v	v	*v*	*v*		
Frogs Indonesia Indonesia / Surveillance UAV-VTOL	v	v	v	v	v	*v*		
PT. Famindo Inovasi / SKYRO MA01-A/Drone Sprayer	v	v	v	v	*v*			
PT. Famindo Inovasi / SKYRO V5/Drone Surveillance	v	v	v	v	*v*			
Terra-drone / Sprayer Drone	*v*	*v*	*v*	*v*	*v*	*v*		
Terra-drone / Surveillance Drone	v	v	*v*	*v*	*v*	*v*		
DJI Drones / Agras MG-1S	v	v	v	v	v	v	v	v

PT. Famindo Inovasi Teknologi is a drone-making technology company located in Bogor, West Java. In April 2018, the company was inaugurated. The resulting drone products consist of several types of products: multicopter wing copter drones, fixed-wing, and helidrone. One of the various types and uses is the sprayer drone with the SKYRO MA01-A type and surveillance drone with the SKYRO V5 type. Both of these technologies have been successfully created, and are promoted on the glexindo.com website. To buy this product, you can directly contact the company. From this explanation and some of the data searched on the internet, there are no users who use this drone product, so it is assumed that this drone product has not yet reached the product launch stage, it is still in the development stage.

Terra Drone Indonesia (ex. PT Aero Geosurvey Indonesia) provides Unmanned Aerial Vehicle (UAV) or drones for air surveying activities in industrial applications that include air mapping & modeling, as well as air inspection & monitoring. In addition, Terra Drone Indonesia (TDID) also provides training & consulting for companies that already use drones for their daily operations. Terra Drone Indonesia is part of the Terra Drone Group, which focuses on providing services to the construction, mining, oil & gas, energy, and utility industries. From the explanation of this analysis, it can be seen that the terra drone products (surveillance drone and sprayer drone) have started to be used in the industry, and it appears that it has entered the product launch stage.

3.3 Closed Innovation vs. Open Innovation

A closed innovation is based on the view that companies themselves develop innovations. From the generation of ideas for development and marketing, the innovation process takes place exclusively within the company. Open innovation means opening up the innovation process beyond company boundaries in order to increase one's innovation potential through the active strategic use of the environment (Daniel, 2018). Closed Innovation vs. Open Innovation Agriculture Drone Technology Development as shown in table 6.

Table 6. Closed Innovation vs. Open Innovation Agriculture Drone Technology Development

Inventor/R&D	Technology	Closed Innovation	Open Innovation
Frogs Indonesia Indonesia	Drone Sprayer 20L V3		v
Frogs Indonesia Indonesia	Surveillance UAV-VTOL		v
PT. FIT	SKYRO MA01-A/Drone Sprayer	v	
PT. FIT	SKYRO V5/Drone Surveillance	v	
Terra Drone	Sprayer Drone		v
Terra Drone	Surveillance Drone		v
DJI Drone	Agras MG-1S		v

Researchers analyze closed and open innovation viewed from website pages and information obtained from the internet, it can be concluded that for Frogs Indonesia and terra drones included in open innovation because both technology development is open information. Unlike Famindo Inovasi Teknologi (FIT), which is a closed innovation for its technology, and indeed its form is a company so that it will be more limited to find out information. At the same time, Frogs Indonesia and terra drones are startup form.

3.4 Technology Transfer Office (TTO)

According to the CDC (2017) Stage of Invention is the conception of an invention initiates the technology transfer process. It can be new technology or developing a diagnostic test for novel isolates collected during a surveillance study. Stage of Invention Disclosure is once the invention has been conceived, inventors need to disclose it to the TTO formally. Then the stage of Assessment is when TTO receives an EIR, the disclosure is evaluated to determine the marketability and patentability of the technology. TTO assesses the technology, discusses it with the scientist, and evaluates the potential of the technology. Stage of Protection is If the technology can be made into a commercial product that will potentially interest commercial partners, efforts are made to protect the invention. Then Stage of Marketing is TTO markets available technologies to attract licensing opportunities. Stage of Licensing is when a company is interested in securing the rights to a CDC technology, a license is usually required. A license is an agreement where the owners of the invention give another party right to the technology, allowing them to produce, use, or sell it. Furthermore, the final stage is the Financial Return. According to Sutopo et al (2019b) Understanding of technology commercialization route can be beneficial for an organization with the primary function of commercializing new technology, also known as a technology transfer office (TTO). Technology Transfer Office Agriculture Drone Technology Development as shown in table 7.

Table 7. Technology Transfer Office Agriculture Drone Technology Development

Technology name	Invention	Invention Disclosure	Assessment	Protection	Marketing	Licensing	Financial Return
Frogs Indonesia Indonesia / Drone Sprayer 20L V3	*v*	*v*	*v*	*v*	*v*		
Frogs Indonesia Indonesia / Surveillance UAV-VTOL	*v*	*v*	*v*	*v*	*v*		
PT. Famindo Inovasi Teknologi / SKYRO MA01-A/Drone Sprayer	*v*	*v*	*v*	*v*			
PT. Famindo Inovasi Teknologi / SKYRO V5/Drone Surveillance	*v*	*v*	*v*	*v*			
Terra-drone / Sprayer Drone	*v*	*v*	*v*	*v*	*v*		
Terra-drone / Surveillance Drone	*v*	*v*	*v*	*v*	*v*	*v*	
DJI Drones / Agras MG-1S	*v*	*v*	*v*	*v*	*v*	*v*	*v*

For the analysis of technology transfer offices, which consist of 7 stages. At startup Frogs Indonesia Indonesia has reached the product marketing stage. In contrast to PT. Famindo Inovasi Teknologi that is still at the protection stage. Furthermore, Terra drones are in the marketing stage too. These three technology development strategies differ in conducting their business, which of course, wants to reach the financial return stage. Which has been achieved by Chinese companies, according to Wikipedia DJI Drones has achieved revenue of USD 2.83 Billion in 2017 with 14,000 employees.

3.5 Comparison Strategy Agricultural Drone Technology Development in Indonesia vs. China

In the previous analysis in the table, the researchers added product analysis for DJI China Drone, Agras MG-1S. DJI Drones control almost 70% of the drone market in Indonesia. The market that is controlled is not only the market for commercial drone products such as photographer/videographer drones, but agricultural drones have also begun to be mastered. For example, if a farmer wants to buy a DJI drone sprayer, it can be easily reached by simply opening the internet and ordering it on a digital platform such as Tokedia, Bukalapak, Shopee, which can also be quickly shipped because this product is already available in DJI Drone stores in Indonesia. Besides, the price of this drone is lower and more affordable with farmers' pockets.

Unlike the technology development of agricultural drones in Indonesia, such as Frogs Indonesia and Terra-drones, they are still in the developing stage, so the products produced have not been mass-produced, still at the product pre-order stage. You also need to contact the startup directly. The price offered is also still relatively higher compared to DJI Drone products. Nevertheless, the advantage is that the targeted market is not open; they collaborate with Ministry to support the work of the Ministry, as in The Ministry of Agriculture or Transportation, which requires its technology to perform performance. Besides, market coverage can directly target farmer groups or farmers who need technology and provide intelligence on the use of these drones. The strategy used is the strategy of public intelligence and the government of the usefulness of this drone technology. This is what technology development in agricultural drones in Indonesia does not have.

3.6 Lesson Learned

Concrete comparison results from Technopreneurship & Innovation Systems: A Comparative Analysis for Drone Technology Development in Indonesia. It can be seen in the summary analysis table of results from the Technopreneurship & Innovation System framework. The core of the results and analysis to get lessons learned are as shown in table 8.

Table 8. Comparison Result Technopreneurship & Innovation System Agriculture Drone Technology Development

Technology name	Technology Push and Market Pull	Innovation Process	Closed Innovation vs Open Innovation	Technology Transfer Office
Frogs Indonesia Indonesia / Drone Sprayer 20L V3	Technology Push	Product launch	Open Innovation	Marketing
Frogs Indonesia Indonesia / Surveillance UAV-VTOL	Technology Push	Product launch	Open Innovation	Marketing
PT. Famindo Inovasi Teknologi / SKYRO MA01-A/Drone Sprayer	Technology Push	Development	Closed Innovation	Protection
PT. Famindo Inovasi Teknologi/ SKYRO V5/Drone Surveillance	Technology Push	Development	Closed Innovation	Protection
Terra-drone / Sprayer Drone	Technology Push	Product launch	Open Innovation	Marketing
Terra-drone / Surveillance Drone	Technology Push	Product launch	Open Innovation	Marketing
DJI Drones / Agras MG-1S	Technology Push and Market Pull	Success as a business	Open Innovation	Financial Return

The equation in the results of this study is that the stages of the innovation process in technology development are the same, namely at the product launch stage for Indonesian and Terra-drone Frogs Indonesia. And the development

stage for Famindo Inovasi Teknologi. Likewise, with the Technology Transfer Office (TTO) where technology development is still in the marketing and protection stages. This illustrates the stages in the development of drone technology in Indonesia at this stage. And have not yet reached the stage of mass production. But the three of them both have the desire to advance Indonesia in the field of drone technology in the future. The difference between each technology development is the strategy used by each of them, where Indonesian Frogs Indonesia use a collaborative strategy to market their products, Terra-drone uses the name of its parent company to market its products. And Famindo Inovasi Teknologi uses its internal strength which forms a limited liability company.

The weakness of the results of this study is that the Technopreneurship & Innovation System framework only illustrates the current state of technology and does not look at strategies in depth related to what needs to be done to advance the stages so that the technology becomes successful. However, the strength of the results of this study can be an example of a framework for comparison of other technology development in order to successfully commercialize the technology.

Lesson learned from the results of this study that management and innovation systems are essential to fostering successful technology-based entrepreneurs. The framework for developing technopreneurship and innovation systems has been carried out using a combination of 4 frameworks, namely the push and market pull technology framework, innovation systems based on valley of death, closed innovation vs. open innovation and technology transfer offices. Of the four frameworks, this can be used as a framework for commercializing technology / innovation to achieve success.

Recommendations that can be obtained from the results of this study are that if you want to succeed in commercializing technology, you need a good and mature design, the strategies used and the stages that are carried out. For technology-based businesses, the primary strategy should be to use technology push, meaning that technopreneurship must pay serious attention to designing the technology to be sold. Furthermore, for market pulls, how to use the technology will follow when there is a target market segment, and the user already understands the technology. Then the next strategy is to use an open innovation strategy, in which the technology created is not closed. It can quickly adapt technologies that emerge from the outside, which can also increase the value of the product. The innovation process and technology transfer office must also be a concern in carrying out the stages of the process to commercialize the technology.

4. Conclusion

This study concludes that the analysis of the Technopreneurship & Innovation System framework in 3 Agricultural Drone Technology Development, namely Frogs Indonesia Indonesia, Famindo Inovasi Teknologi, and Terra-drone. The research approach uses four frameworks that are combined. This framework consists of market pull vs. push technology, Process Innovation, closed vs. innovation. Open innovation; and the Office of Technology Transfer. The combination of these four frameworks aims to develop a comprehensive technopreneurship and innovation system. So that the conclusion obtained is that management and innovation systems are essential to be able to grow and develop successful technology-based entrepreneurs, which is learned from seeing how the agricultural drone technology development in Indonesia is analyzed. At the core of their success in launching products is the management and innovation system that they do well and measure. Then the evaluation framework has been carried out, which is divided into 2, namely the strategy stage and the development stage. The strategy phase consists of a Technology Push and Market Pull and Closed Innovation vs. Open Innovation framework. The development phase consists of the Innovation Process and Technology Transfer Office. This framework model is following the framework for the development of agricultural drone technology. Nevertheless, the lack of this framework is that there is no tactical strategy that needs to be done to achieve success, it is necessary to do more in-depth research related to the framework in this study.

Recommendations on the results of this study are that if want to be successful in commercializing technology, need to have a good and mature design, the strategies used, and the steps involved. For technology-based businesses, the primary strategy should be to use technology push, meaning that technopreneurship must pay serious attention to designing the technology to be sold and how to use it. For market pulls will follow when there is a target market segment, and the user already understands the technology. The next strategy is to use an open innovation strategy, in which the technology created is not closed. It can quickly adapt technologies that emerge from the outside, which can also increase the product's value. The innovation process and technology transfer office must also be a concern in carrying out the stages of the process to commercialize the technology.

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