DRIVING ENTREPRENEURIAL UNIVERSITIES: COMMERCIALIZATION STRATEGIES IN INDONESIAN UNIVERSITIES

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Abstract

Universities that initially carried out teaching and research missions are now carrying out a new entrepreneurial mission, which shifted to commercially oriented activities. This research proposes a theoretical framework for commercialization strategy in three leading Indonesian universities; Institut Teknologi Bandung (ITB), Universitas Gadjah Mada (UGM), and Institut Pertanian Bogor (IPB University). Using an abductive approach, the findings show that the Indonesian universities can adopt both technology push and market push in commercializing their research outputs. Each of these strategy adoptions has implications for subsequent commercialization mechanisms, such as by simply optimizing the role of TTOs and incubators or by optimizing holding companies and Science and Technoparks (STPs) by establishing closeness to industry.

Keywords : *technology commercialization, university, commercialization strategy, technology push, market pull*

1. INTRODUCTION

Technology commercialization is basically utilizing a technology into a product (Lane, 1999) that can be commercialized. The process of technology commercialization is often said to be like a black box where a suitable model that is right to describe it is challenging to find (Bradley, 2013). This process is a critical stage of the technological innovation process and is risky and expensive (Chiesa & Frattini, 2011). The presentation of commercialization success such as building a new business from this technology is small. A report says that the presentation of startup success which is generally from the commercialization of a technology product in Indonesia is only 10 percent (Kompas.id, 2021). Universities that have been essential sources of technological innovation (Shah & Pahnke, 2014) since the era of the Bayh Dole Act in 1980 in the United States are actively carrying out entrepreneurial missions with great support for this activity. This activity can be found in the general form of patent licensing and the formation of new businesses (Sangupta & Ray, 2017).

Studies on technology commercialization in universities often emphasize the institutional perspective by giving more roles to the University Technology Transfer Office (UTTO) or incubator (Siegel & Wright, 2015; Rasmussen et al., 2014), few studies emphasize the commercialization strategy especially in developing countries. Moreover, most studies are dominated by cases from developed countries, and few use the Indonesian context (Moeliodihardjo et al., 2012; Saad et al., 2017). Studies related to this strategy provide a practical perspective for the construction of a technology commercialization framework in universities especially in the Indonesian context. There has been no study that provides a practical perspective on technology commercialization for both technology push strategy and market pull strategy at the same time. Most studies only provide a technology push perspective for commercialization strategies in universities (Bozeman, 2000; Siegel et al., 2003). Therefore, this study emphasizes how a university implements both strategies and their implications in the commercialization process in universities.

This study uses three samples of universities in Indonesia, namely Institut Teknologi Bandung (ITB), Universitas Gadjah Mada (UGM), and Institut Pertanian Bogor (IPB University), to provide a complete picture of the dynamics of technology commercialization in developing countries. All three are top universities in Indonesia with excellence in science and engineering disciplines. In this exploratory study, we will answer two research questions; 1) how is the technology push and market pull strategy for technology commercialization in universities related to the mechanism of the commercialization process in universities? and 2) how is the mechanism of technology commercialization in universities that can combine the two strategies?

To answer the research questions, this manuscript is written by following the research structure starting from the introduction, followed by a literature review, methodology, results and analysis, and conclusions.

2. LITERATURE REVIEW

How is the technology commercialization process in university?

Technology commercialization activities in universities can be in the form of licensing and spin-off creation (Sangupta & Ray, 2017). A license is a right granted by a patent owner that allows another party to act under all or part of the owner's rights, usually under a written license agreement. This license agreement specifically describes the rights and responsibilities associated with using and exploiting intellectual property. Meanwhile, the formation of spinoff companies involves academics who participate in research and development programs that create technologies (Brown, 1985) that can be derived from university patents (Rasmussen et al., 2006). The founder of this company is very likely the inventor of the new technology (O'Shea et al., 2008).

Callan (2001), Lockett & Wright (2005), and Wright et al. (2005) state that a company can be categorized as an academic spinoff if; (1) owns a license or use of intellectual property from a university or public research institution, (2) owns an investment (equity) from a university or public research institution, and (3) is directly established by a university or public research institution. According to Rasmussen et al. (2006), spinoffs are diverse: some are made by students and others by university professors. The formation of a spinoff company is most beneficial because it can encourage high-paying jobs and regional and national economic development (Hayter, 2015).

Meanwhile, the University Technology Transfer Office (UTTO) plays a crucial role in evaluating invention disclosures, marketing inventions to potential licensees, filing patents, and licensing inventions to interested parties (Boh et al., 2016). UTTO manages the main outputs of commercialization, such as patents, licenses, and incubation (Etzkowitz, 2008). In general, the function of UTTO is to facilitate the transfer of technology from universities to the market or

industry. UTTO plays a role in assisting the patent process both in terms of increasing the number of patents and efficiency in generating new patents (Rothaermel et al., 2007) as well as facilitating technology transfer through licensing to existing or new companies (Siegel et al., 2007). Etzkowitz (2008) added that the role of UTTO is to find its place in the market. The existence of this intermediary organization is essential in increasing the productivity of university patents (Temel et al., 2021).

Apart from UTTO, incubators also play a role in facilitating the commercialization of technology and entrepreneurial activities (McAdam et al., 2006). University Business Incubator (UBI) is an incubator established by universities to provide office space, equipment, mentoring services, and other administrative support to assist in the formation of new companies (Wonglimpiyarat, 2016). Incubators are also innovation centers, science parks, and technology centers. In creating a spin-off, an essential initial stage is a research and development on a laboratory scale with the output of a prototype. This prototype was then tested for its commercialization feasibility by an institution explicitly formed by the university, namely the University Technology Transfer Office (UTTO). It was then incubated by the University Business Incubator (UBI) to become a spin-off.

In each stage of commercialization process, several essential factors come into play. In the R&D stage, the role of the network, social capital and previous experience in the commercialization process has a vital factor, while at the assessment stage by UTTO, the role of skilled staff in assessing the readiness of technology and commercial is very large (Lockett & Wright, 2005; Gonzalez-Pernia et al., 2013). Meanwhile, in the incubation process, UBI provides financial support for the incubation so that spin-offs are produced that can develop later. Meanwhile, in the whole process, university institutions play a role in providing policy support.

Technology push vs Market Pull

Technology transfer or commercialization can occur through supply-push and demand-pull (Bozeman, 2000) which is the first-generation innovation model (Rothwell, 1994). Supply push can be interpreted as a technology transfer process initiated by someone who knows technology and someone who will apply the technology to a new product. The supplied technology can encourage the market to seek unsatisfied demand (Paul, 1987). According to Dixon (2001), "Market pull" refers to a situation in which the market specifically requests a certain product or service, or identifies a problem that needs to be solved, and manufacturers then respond by manufacturing and delivering the requested goods. "Market Pull" product development is driven by client preferences and desires, with customers playing a significant role in the development of products or services. Customers determine solutions and enlighten manufacturers. The illustration of technology push and market pull can be shown in a linear model.

In contrast, demand-pull means that the technology transfer process is initiated by someone who has knowledge of the unmet demand for a product and then fulfills this demand with the appropriate technology product (Von Hippel, 1986). "Technology push" is a scenario where producers, seeing benefits for consumers that consumers do not see, create a type of product and demand for that type of product. Manufacturers run their businesses to fulfill a function for consumers. They use unique methods, technologies, or approaches to better fulfill functions in ways that consumers may not even initially realize. Product development driven by "technology push" is based on the belief that suppliers recognize market needs even before the market does. The difference between technology push and market pull is described in **Table 1** below.

Table 1. Difference between technology push and market pull (Ameka and Dhewanto, 2013)

Technology Push	Market Pull
Risk of starting with what can be researched and evaluated easily	Risk of looking only at needs that are easily identified but with minor potential
Risk of addressing the needs of the atypical user	Continuing to change the definition of the 'opportunity'; 'miss the epportunity'
Potential for getting locked into one technical solution	Lack of being a 'champion' or 'true believer'

In its development, commercialization does not occur in isolation, namely the role of technology and the market cannot be separated, both are interrelated. It's just that which role is more dominant can be one of them. Model from Trott (2017) shows that interaction between market pull and technology push constructed into an interactive model. The technology commercialization stage is a stage that has revenue growth and strengthening relations with industry as its objectives. Referring to the commercialization process model, commercialization from research institutions such as universities is more about technology push rather than market pull (Bozeman, 2000; Siegel et al., 2003).

3. METHODOLOGY

Research Approach & Strategy

This research adopts abductive apparoach with case study as research strategy. According to Saunders et al. (2019), abductive is an approach that moves back and forth, combining deduction and induction (Suddaby, 2006). Dubois & Gadde (2002) revealed that the abductive approach constantly goes back and forth between one type of research activity and between empirical observation and theory. The objective of this strategy is to confront theory with the empirical world. The abductive approach is different from a mixture of deductive and inductive approaches. The main concern of this approach is related to the generation of new concepts and the development of theoretical models rather than confirmation of existing theories.

As part of qualitative study, we do Forum Group Discussion (FGD) and analysis secondary data such as from website. This research is an exploratory study because of finding out 'what is happening: to seek new insight; to ask questions and to assess phenomena in a new light' (Robson 2002 in Saunders et al. 2009). We use a comparative case study to build a mid-range theory for the research strategy. Through this case comparison, a complete understanding of the context is obtained. Robson (2002) defines a *case study* as a strategy for doing research that involves an empirical investigation of a particular contemporary phenomenon within its real-life context using multiple sources of evidence. According to Dubois and Gadde (2002), case studies provide unique means of developing a theory by utilizing in-depth insights into empirical phenomena and their context. Furthermore, they explained that case studies cannot build on statistical inference but must rely on analytical inference.

Data Collection

This research uses cross-sectional as a time horizon. According to Saunders et al. (2009), cross-sectional is the "snapshot" time horizon. Cross-sectional studies a particular phenomenon (or phenomena) at a particular time. Furthermore, for case study criteria, we set as the following. (1) the university has an official institution that handles technology commercialization activities (established more than the last five years) with success stories for licensing or new venture

creation, and (2) the university has policies governing the commercialization of technology, (3) the university has a major in science/engineering and has a good reputation for research in this field, (4) top 100 Indonesia best university. From these criteria, we propose three case studies, namely Institut Teknologi Bandung (ITB), Universitas Gadjah Mada (UGM), and Institut Pertanian Bogor (IPB University).

Data Analysis & Triangulation

The analysis procedures followed the grounded theory approach formulated by Glaser and Strauss (1967) and, more recently, employed by others (Kram, 1983; Kram & Isabella, 1985; Sutton, 1987; Sutton & Callahan, 1987). Stausss & Corbin (1990) identify three types of substantive coding: open, axial, and selective coding, although the distinctions between different types are artificial.

- Open coding, is the process of breaking down, examining, comparing, conceptualizing, and categorizing the data.
- Axial coding involves a set of procedures whereby data are put back together in new ways after open coding. Here identifying connections between categories is crucial.
- Selective coding is the process of selecting a core category and systematically relating this to other categories in need of further refinement and development.

For the data triangulation, we use two or more independent data sources or data collection methods to corroborate research findings within a study. Triangulation is a double-check finding (Huberman & Miles, 1994). In addition to using interview data from interviewees, this study uses other sources to strengthen the data such as website. Meanwhile, reliability refers to the extent to which your data collection techniques or analysis procedures will yield consistent findings (Saunders et al., 2009). To minimize bias as an outcome of reliability, in this research, we explain every procedure in the research design, starting from proposing the research question, taking data, analyzing the data, and drawing conclusions. Even though this research uses one researcher during the interview, this research adopts a triangulation process by combining field data with other data such as archives and documents.

4. FINDINGS AND DISCUSSION

Commercialization process in Indonesian Universities: Case study from ITB, UGM, and IPB University

Institut Teknologi Bandung (ITB)

Institut Teknologi Bandung (ITB) is the oldest engineering college in Indonesia, established in 1920, which has 12 faculties, 128 study programs, and 111 expertise groups (KK) with national and international reputations. In 2019, ITB received the best national university award from the Ministry of Research, Technology and Higher Education (Ristekdikti). In 2015, ITB declared itself as a campus towards an entrepreneurial university marked by optimizing the role of LPIK ITB and Rekacipta Innovation in helping ITB academics commercialize the technology.

LPIK ITB was established in 2010 to encourage the utilization of ITB research results through innovation and entrepreneurship. Meanwhile PT. Rekacipta Inovasi (RII) was established in 2016 to accommodate the profit side of technology commercialization. Initially, it was established to market startups to the right market and facilitate the meeting of startups with capital owners while also carrying out the licensing process for established companies.

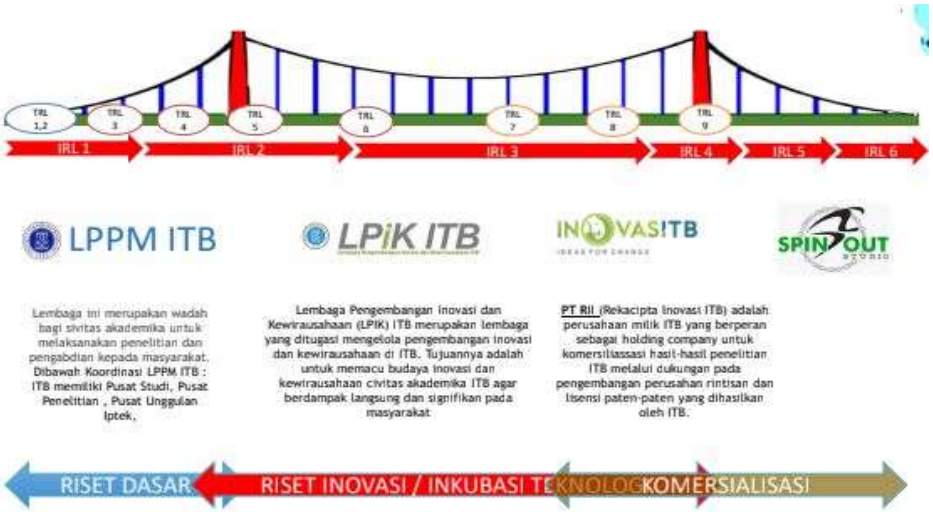

Figure 1. Commercialization process in ITB (LPIK-ITB, 2020)

Universitas Gadjah Mada

Universitas Gadjah Mada (UGM) was established on December 16, 1949. In the beginning, this university had six faculties: Faculty of Medicine, Faculty of Law, Faculty of Engineering, Faculty of Literature and Philosophy, Faculty of Agriculture, and Faculty of Veterinary Medicine. Now UGM has 18 faculties, one Postgraduate School, and one Vocational School with dozens of study programs (ugm.ac.id).

The strategic role in increasing the productivity of business units and accelerating incubation and downstream of UGM research results is carried out by the Directorate of Business Development and Incubation (Dit PUI). The director who occupies this institution is under the coordination of the Vice Chancellor for Cooperation and Alumni. There are three main tasks of this institution, first, downstream of academic research products within UGM. Second, downstream research products in collaboration with strategic partners to meet industrial needs, and third, downstream products from combining business development and community empowerment.

The cooperation scheme is carried out through joint ventures, joint operations (KSO), licenses, and other collaborative activities that do not burden the university's financial budget. Meanwhile, several programs support commercialization, such as incubation support for student start-ups through the innovative academy. Second, Technology Transfer Office (TTO) services, namely the downstream of UGM innovation products; and third, Science and Technology Park (STP), a research and innovation-based productive vehicle to support learning processes in synergy with industry and the Government. The establishment of STP is expected to develop the surrounding area's economy so that, in the end, it can support technological independence and increase local resources to support technological independence in Indonesia.The process of commercialization of inventions at UGM is described as follows.

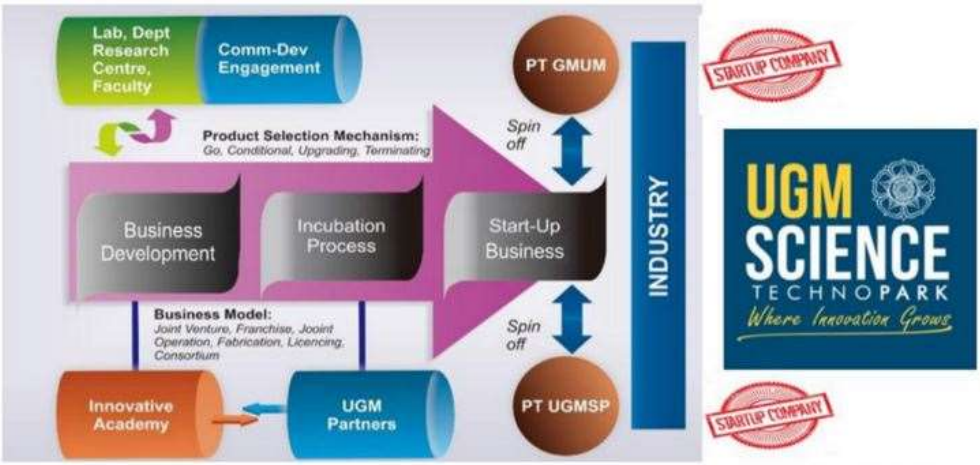

Figure 2. Commercialization process in UGM (ditpui.ugm.ac.id)

Institut Pertanian Bogor

Institut Pertanian Bogor (IPB University) was established on September 1, 1963, as a university projected to excel in agriculture, biosciences, and various related fields. From 2008-2018, IPB's innovation was considered the most compared to other universities in Indonesia based to the Business Innovation Center of the Ministry of Research, Technology and Higher Education of Indonesia in the most prospective innovations.

Based on the MWA regulation number 06/MWA-IPB/P/2020, it is said that the Science and Techno Park (STP) of IPB has a function related to the commercialization of inventions, namely carrying out the commercialization of IPB's inventions as income-generating based on e-commerce and m-commerce. Commercialized inventions include plant varieties, formulas/compositions, processes/methods/systems, pharmaceuticals/biomedical products, processed and post-harvest products, tools and machines, and software.

IPB established several policies that encourage commercialization. The university proposed the IPB Long Term Plan (RJP) 2019-2045 to develop innovation and business as the future of IPB. Then, IPB's strategic research agenda includes food, energy, ecology, poverty alleviation and bombing, Research Master Plan 2016-2025, Decree of the Chancellor of the Invention Commercialization Committee, Orange Revolution, blueprint, Agro Maritime 4.0, and Agro Maritime Research Roadmap 4.0. The programs include promoting innovation through the media, exhibitions and business meetings, grants, and business startup financing. The supporting facilities include the agribusiness and technology park (ATP), Botani Mart IPB, Science Techno Park, the gallery building for innovation and entrepreneurship of IPB, the Serambi Botani innovation outlet, and the IPB Innovation mobile application and information system for intellectual property ki.dik.ipb.ac.id.

The forms of commercialization of inventions include exclusive and non-exclusive licenses, business incubation/startup, and SUA, SUP, and SUK. The existence of the IPB Rector's Regulation number 6/IT3/PG/2020 concerning the guidelines for the commercialization of IPB's innovations explains the support for commercialization. First, IPB has a holding company named PT Bogor Life Science and Technology. Second, the instrument for assessing the feasibility and business potential of the invention towards innovation (product novelty, business prospects. Third, the commercialization mechanism, and Fourthly royalty management. Meanwhile, the issuance of SK 065/2006 concerning amendments to SK 209/2004 regarding guidelines for

managing IP in IPB is regulated in proportion to the distribution of royalties regulated in which the party that produces (40%), the work unit of the party that produces (20%), and IPB (40%). The commercialization process at IPB is as follows:

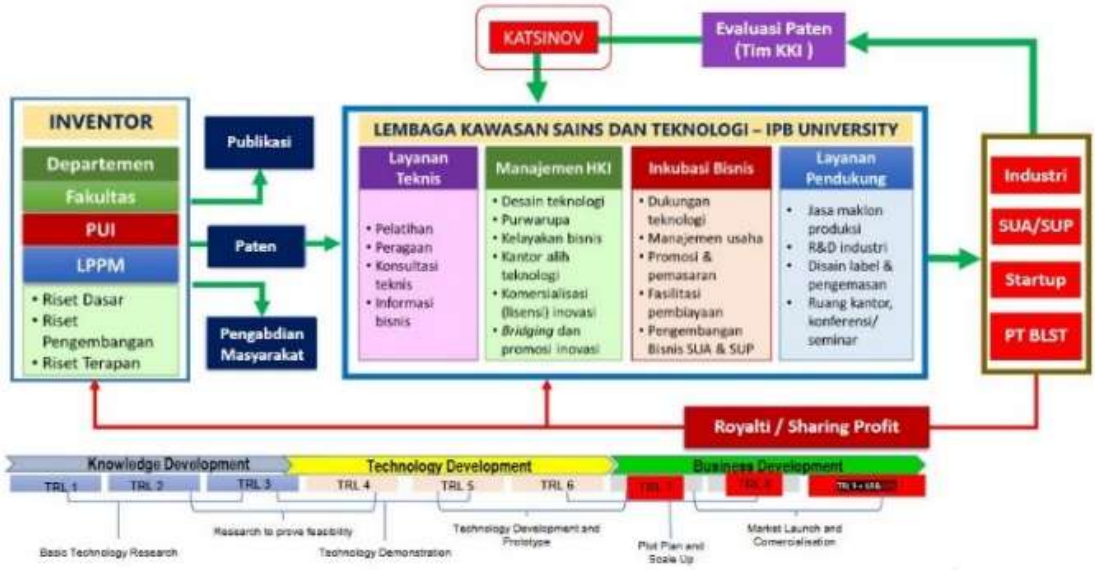

Figure 3. Commercialization process in IPB University (stp.ipb.ac.id)

Table 2. Differences in technology commercialization mechanisms from three case studies

Case	Strategy		Channel		Revenue center organization		Cost center organization	
	Technology push strategy	Market pull strategy	Licensing	Spin-off	Special company	Holding company	TTO	Incubator
ITB	V		V	V	V		V	V
UGM	V	V	V	V		V	V	V
IPB	V	V	V	V		V	V	V

Implication of Technology Push and Market Pull Adoption to Commercialization Mechanism

Universities in Indonesia generally adopt technology push. ITB adopts this strategy by making university organizations such as TTO and Incubator play a more active role. These organizations are cost centers. The special companies that it establishes are still in the early stages of development where the business model it adopts is not yet settled. This is different from UGM and IPB with their holding companies that are more market-oriented, while the TTO and incubator functions continue to run. These two universities make spin-offs/startups formed by academics such as students as subsidiaries of the university. Despite not yet fully profiting from this mechanism, this method is a corporate strategy that is in line with the principles of a business organization. In addition, the functioning of STP on both campuses encourages the established industry to be more interested in creating proximity with the university. Proximity with this industry is a prerequisite for encouraging the creation of a strong innovation ecosystem

(Boschma, 2005; Fitjar & Rodríguez-Pose, 2013).

The technology push strategy makes research products have a high potential for failure, as experienced by ITB with the adoption of Vent-I which lost market potential when Covid-19 subsided. This is different from the adoption of the market pull strategy, where the products produced by universities are needed by industry so that there is industry involvement from the beginning of the research (Brem & Voigt, 2009; Fernandes et al., 2023). The adoption of the technology push strategy makes the commercialization mechanism run linearly by referring to three phases; research, product development, and commercialization (Trott, 2017), while the combination of the two strategies, especially when combined interactively, makes the commercialization mechanism run in two directions. This makes the commercialization process not run in isolation which makes the linear stages of commercialization irrelevant (Tidd & Bessant, 2018). The implication of the combination of these two strategies is that research carried out by universities is an industrial problem, not just the will of researchers but also because of the encouragement of the existing market. Industry is involved from the start, not just in the final phase of commercialization. In practice, the interaction between these two strategies is bridged by optimizing the role of STP in which there is interaction between stakeholders ranging from researchers, industry, government, investors, and so on (Vásquez-Urriago et al, 2014; Phan et al, 2005).

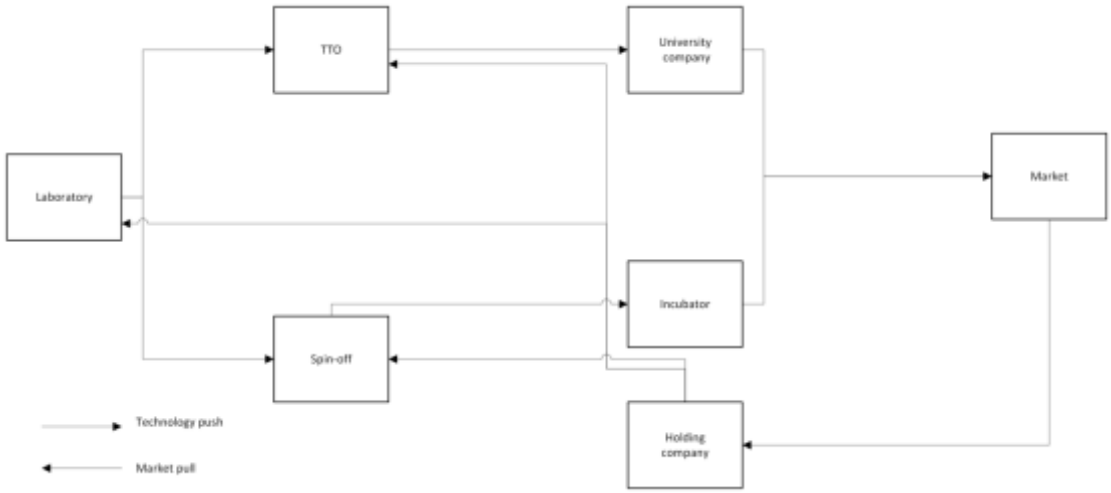

Figure 4. Commercialization mechanism of Indonesian universities

5. CONCLUSION

This study answers two research questions; 1) how is the technology push and market pull strategy for technology commercialization in universities related to the mechanism of the commercialization process in universities? and 2) how is the mechanism of technology commercialization in universities that can combine the two strategies? by proposing a model of university commercialization mechanisms in Indonesia. This model, in addition to having a practical side, namely being a practical guidance for universities in carrying out commercialization activities, also has a theoretical contribution in a commercialization model that explains the practice of technology push and market pull commercialization strategies practically for the Indonesian context. However, this study has several limitations to be input for further research in the future.

Future research is recommended to carry out the following two recommendations. First, it is necessary to conduct data collection with in-depth interviews with research sources such as university management, TTO managers, Incubator managers, university company managers, holding company managers, spin-offs, and licensing from the three cases. Second, it is necessary to generalize the construction of a commercialization mechanism model in universities in Indonesia by adopting the latest commercialization strategy. By following these recommendations, the proposed commercialization mechanism model will increasingly have high generalization so that it becomes the basis for studies related to this topic, especially for the Indonesian context.

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