

Overcoming the Challenges of Commercializing Research's Products of Higher Education in Indonesia: A Qualitative Approach

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ABSTRACT

The research products produced by tertiary institutions are intellectual property that benefits the community and provide an economic contribution. Even Universities are encouraged to increase their research products' economic value because innovation considers successful when commercialized. Higher Education is direct to produce innovative products with high added value so that these products can be beneficial to the community and commercialized. However, not all innovation results are successful or can be commercialized, although, in principles, the commercialization of research products is no different from standard products' commercialization. This paper outlines various efforts undertaken by universities/polytechnics in Indonesia to increase research output commercialization. The purpose of interviews is to determine how universities respond to the challenges of expanding the commercialization of their research output. The participants were the heads of research institutes and community service from twenty-one (21) tertiary institutions in Indonesia, consisting of nine (9) universities and twelve (12) polytechnics. The finding shows that only a few university and polytechnic have commercialized their research products; however, most higher education keeps doing their best to increase their capability to commercialize their research products. This study's two implications are: 1) researchers need to involve "user" needs before developing a research proposal. 2) Management at the university needs to facilitate the commercialization of the academicians' research products.

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INTRODUCTION

The research products produced by tertiary institutions are intellectual property that benefits the community and expects to contribute economically. Higher Education has integrated the utilization of research products to help the community in Indonesia in three missions, namely integration between education, research, and community service. Generally, Higher Education

encourages researchers to disseminate their research products/services to increase community capacity. Even nowadays, Universities are encouraged to improve the economic value of their research products. The condition is in line with the opinion of Jobber (2001); Abishovna (2014) statement that innovation considered successful when commercialized. The term down streaming of research products to be commercialized is an issue in the Higher Education environment. Therefore, higher education must have strategies to overcome obstacles in commercializing their research products.

Referring to data from the Ministry of Research, Technology, and Higher Education, the number of Higher Education in Indonesia reached 4646 institutions, both public and private. Figure 1 shows the number of higher education institutions based on their type, namely Academy, Polytechnic, College, Institute, University, and Community College.

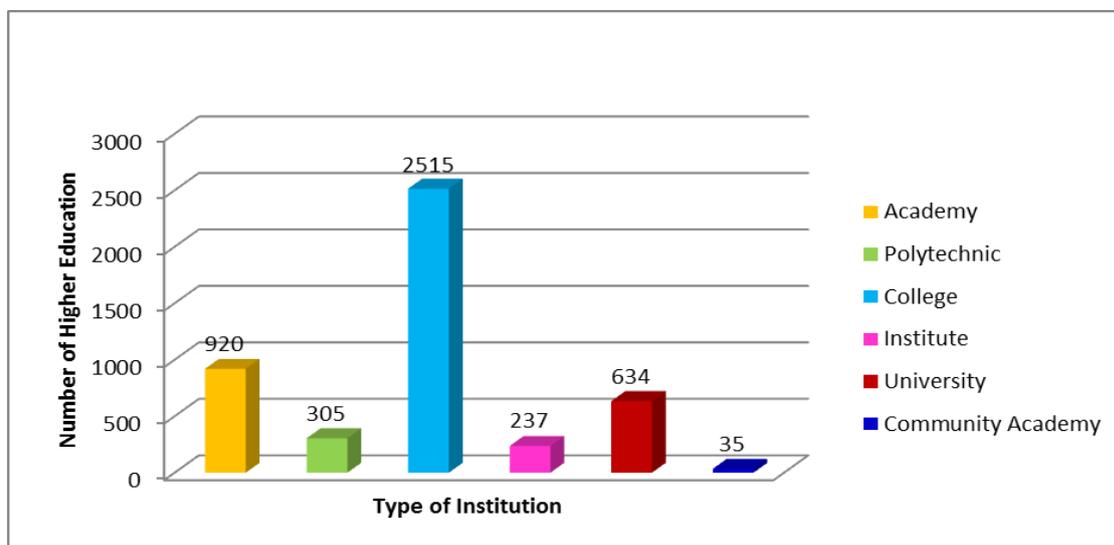


Figure 1: Number of Higher Education Institutions in Indonesia
Source: PDDDiikti (2019)

Currently, the Ministry of Research, Technology, and Higher Education in Indonesia encourages higher education institutions to produce more than just scientific publications. Even Higher Education is directed to produce innovative products with high added value to be beneficial to the community and commercialized. The implication is that research is considered an investment, not just an academic activity. Research achievement measure by completing the research report and the successful commercialization of the research products. Commercialization is regarded as a prime example of generating educational impact because it constitutes immediate, measurable market acceptance for academic research output (Markman et al., 2008).

However, not all innovation results are successful or commercialized (Karaveg et al., 2014; Ludmila and Denys, 2016). In principle, the commercialization of research products is no different from the commercialization of conventional products. (Anthony, 2012). The difference is more difficult in practice. This condition happens because the stages of processing research results into real products, according to the community's needs, and identifying markets and

marketing these products require a phase of not easy activities. Thus, commercialized innovation results are more difficult in practice compare to ordinary products.

Previous researchers from abroad have researched commercialization strategies (Behboudi et al. 2011); (Ukwuoma et al., 2013). While in Indonesia, there are not many studies relating to the commercialization of research outputs. Reza A Nasution (2009) examines the commercialization of technology in tertiary institutions. Even though the commercialization of research outputs in tertiary institutions has long been encouraged to carry out in Indonesia, many research results have successfully commercialized is still very small. The commercialization process of research results has not yet become the mainstream of various research institutions, especially for government-owned research institutes and universities (Media Indonesia, 2017). On one side, higher education continues to produce research products. While on the other side, funders began to ask for economic returns from their investment funds. Meanwhile, in practice, commercializing research is challenging. Therefore, the gap that becomes the focus of this research is the unavailability of tools to measure the potential feasibility of research products to be commercialized. The study aims to elaborate on universities' efforts in Indonesia to overcome commercializing research products' challenges.

This paper outlines various steps undertaken by universities in Indonesia to increase the commercialization of their research outputs. The heads of research institutes and community services advise on how universities respond to the challenges of expanding their research output commercialization. Ideally, the research should cover all higher education institutions (HEIs), both state and privates. Unfortunately, because of the limitation of time and resources, only 21 HEIs are selected, which consist of nine (9) universities and twelve (12) polytechnics in islands of Java, Sumatera, Kalimantan, Sulawesi, and Bali. The selection of the HEIs uses the criteria, which discuss the methods section.

The stages of processing research result in real products according to user needs, and the process of identifying markets and commercializing research products is not easy. Universities face various challenges in their efforts to commercialize research products. This paper describes part of the research results that aim to find a feasible / potentially commercialized assessment model of research output based on a comprehensive study of the commercialization process elements, indicators of each measurable component, and integrated with the Technology Readiness Level (TKT).

Literature Review

Commercialization of Research Output

Research output is interpreted as products produced from research activities. Referring to the Research and Community Service Guidelines Book published by the Directorate of Research and Community Service (DRPM, 2018), various types of products or services can be classified into 14 (fourteen) types through research activities. Including scientific articles up to academic text and policy recommendations. The categorization of research results is a broad topic; therefore, a holistic approach needs to evaluate the research outcomes. In line with the current era of the knowledge-based economy, assess various types of research outcomes is necessary to identify and find results that can be disruptive products.

The commercialization of research outcomes has become imperative. The study of technology commercialization in universities has been carried out by various earlier researchers, such as Owen-Smith & Powell (2001), who have discussed SMEs' role in product commercialization. Whereas Markman et al. (2008) state that commercialization is considered a prime example for generating academic impact because it constitutes immediate, measurable market acceptance for outputs of academic research, Wu (2009) discusses the management and provision of commercialization incentives of research results of universities in China. Jalili, N. et al (2011) have also developed a national model for the commercialization of research products in Iran. Furthermore, Ukwuoma et al. (2013) have examined R & D's management in Nigeria for commercialization. Research and development results at the University and Polytechnic, in the Asia Pacific region. Anas Al Natsheh (2015) has sought to identify the challenges in commercializing high technology.

Furthermore, Wagner & Wakeman (2016) explore what patent-based measures tell about product commercialization. They found that the speed of commercialization increased with value but reduced with uncertainty. While in Indonesia, research on the commercialization of research output products is still rare. Existing literature tend to discuss more on commercializing education (Anwar, 2008; Zulfikar, 2012; Syaefudin Andrianto, 2017) compare to the literature on the commercialization of research products. A complete study was made by Reza A Nasution et al. (2009) as earlier mentioned – examine the commercialization of technology in tertiary institutions: the processes, potential, and actors involved.

In comparison, Ediana et al. (2019) discussed the development of metrics for research output commercialization in Indonesia. Neneng (2019) confirms Goldsmith's commercialization model according to higher education researchers' perceptions in Indonesia. At the same time, Lasambouw (2019) describes the importance of collaboration to support research outputs' commercialization.

Based on the literature review, it is known that for the commercialization of research results produced by tertiary institutions, each institution has a different strategy. However, several things tend to be the same, including the role of leadership in tertiary institutions, the industry's roles in collaboration with tertiary institutions, and government policies in the form of incentives. Nevertheless, the literature studies have not explicitly mentioned the entire research process's government from preparing the research plan until it can produce commercialized research outputs. As a result, the failure rate of commercialization is still high.

Commercialization Process

Related to the commercialization process, Ferguson (2008) has presented a comparison of 7 models of commercialization, as described in Table 1 below.

Model Name	Year	Description
Goldsmith Model	1995	This model elaborates concurrent technical, market, and business activity; each stream consists of six sequential stages: Investigation; Feasibility; Development; Introduction; Growth, and Maturity. These streams are grouped into three sequential phases: the Concept Phase, Development Phase, and Commercial Phase.

Rothwell & Ziegfeld model	1985	This model defines the relationships between the commercialization process components and how they interrelate with each other. This model places the technical stream at the centre of the process. Its path to the market is influenced by emerging and evolving market needs on the one hand and by technology evolution. Business issues are implicit but not explicitly addressed.
Andrew & Sirkin Model	2007	This model is very suitable for demonstrating the importance of speed to market to minimize the cumulative cash loss before launch. The equal importance of speed in achieving volume sales to reach a profitability threshold and recoup the investment rapidly. It also highlights the importance of product support post-launch: advertising, marketing, technical support, and product enhancements
AIC Commercialisation Progression Model	1998	The AIC model accommodates a critical shift in emphasis as the filtering process takes effect. In the early stages of the process, ideas are subjected to ruthless scrutiny and weeded out rapidly. This prose is the first model to explicitly identify the need for predictive tools to guide innovators and investors' efforts and resources by identifying the technical and market-related features of a promising idea that would help it across the chasm.
Carnegie Mellon Innovation Transfer Process Model	2002	This model aims to help a university researcher determine the commercial prospects for an idea by involving financial, technology, and marketing experts at an early stage, developing the idea, and then presenting it to potential licensees or investors. If the process does not result in successful commercialization, the IP is then licensed to the innovator
Unique Model	2008	This model places stress on the 'front end' R&D in a commercialization program and less on the process's downstream elements. Most of the models examined earlier place relatively greater emphasis on the downstream processes.
Functional Model	2006	The Functional Models do not prescribe a sequence of steps but rather describes the various components of the commercialization process and their relationships to each other, without overlaying them upon a linear, time-based process. This model places ideas at the heart of the process in an iterative cycle which innovators, entrepreneurs, and investors follow through the technology ('R&D'), Business ('Firms'), and Market elements of the process.

Table 1: Comparison of Commercialization Model
 Ferguson, 2008 [source]

The Goldsmith model, developed in 1995, is considered the complete model. Therefore it tends to be used as a basic model by which researchers reference the commercialization of research product output. Goldsmith (1995) as cited in Ferguson (2008) divides the commercialization process into three phases: (1) the concept phase. (2) the development phase, (3), and the commercialization phase. Each step is divided into several stages, namely investigation, feasibility, planning, introduction, full-scale production, and maturity. Whereas according to

(Allen, 2003; Ches Brough, 2006; Logas, Ponzurick, Spears & France, 2001; Miller et al., 2011; and Tid & Bessant, 2009 as cited in Karaveg, (2014), the commercialization process of research results consists of four stages namely the stage search for research institutions as sources of innovation. Resources, the stage of selecting research products that have the potential to be commercialized and building a multidisciplinary team, the step of developing research output to become a new product, and the stage of commercialization, when innovation is launched into the market.

METHODS

The approach used in this research is an explorative- qualitative approach, which is elaborate descriptively. The research identifies the type of research outcomes and the main activities of the research output commercialization process. Information collection begins with a literature study to identify the types of research outcomes and aspects used in assessing research product results. In-depth exploration is carried out to find elements from each element and criteria. Interview and Focus Group Discussion conduct with respondents that purposively selected. The aim to confirm and complete the literature study results with the head and staff of the research division and community service and representatives of lecturers from 12 Polytechnics and 9 Universities.

The interview questions' objective is to explore how universities face challenges in commercializing their academic community research outputs. The focus is on Universities that have implemented commercialization. In line with the research objectives, Universities and Polytechnics are invited to participate in this research based on higher education rankings from the Ministry of Research, Technology, and Higher Education (Primary or Superior). The assumption is that Universities and Polytechnics in the ranking have quite several commercialized research products. Hence the following criteria are defined: (1) Excellence in research and development as evidenced by several patents, the number of academic publications, and others; (2) The excellent quality of research management shown by the research institute organization; (3) Good position in the national Higher Education Institution (HEI) ranking.

The researcher writes the transcript of each interview and Focus Group Discussion (FGD) in sequence according to the interview's schedule. Then, the researcher coded each statement in the transcript. After all the interviews and FGD transcripts were completed coded, the researcher moved to compile each research question's responses. As a result, researchers obtain bulky data and information from all respondents to answer each research question. The reduction of data has occurred continually throughout the analysis process.

In the early stages, this happens through editing, segmenting, and summarizing the data. In the middle stage, this happens through coding and memoing, and associated activities such as finding key aspects, themes, clusters, and patterns. At a later stage, this happens through the drafting of concept and explaining. Finally, the researcher tested the validity and reliability of the qualitative data collected through expert validation. The researcher needs to ensure that experts confirm the construction themes identified by the researcher. In this study, the proof was

carried out by the expert. After the researcher received confirmation from the experts, interview data was analyzed and conclude.

RESULTS AND DISCUSSION

Commercialization is a mechanism for turning knowledge into a product or service so that an institution can have a competitive advantage that supports regional economic growth (Mueller, 2005). Therefore, the commercialization of research output products can generally be defined as the process of introducing new products or new production methods resulting from research activities to the market or potential users. Regarding the commercialization of technology, consequences are defined as a series of processes of developing and marketing a technology carried out in such a way as to reach a point where the technology can be applied to a production or consumption activity that produces profits (Siegel et al., 1995 as cited in Cakrasiswi, et al., 2016). In recent years, technology products have generally been produced from research activities that can be commercialized. The selection of the right commercialization model greatly influences the success of the products being marketed (Sutopo et al., 2013 as cited in Khofiyah et al., 2019). Referring to the focus of the study, the initial findings described in this section are about the types of research outcomes. Identification of the types of research outcomes made regarding the existing field of science in Indonesia based on the Research Guidelines and Community Services XII edition, revised in 2019. However, the types of research outcomes generated refer to the types of research outcomes that apply internationally. Table 2 shows the fields of science in Indonesia and identifies the types of research outcomes that are potentially produced.

No.	Field of Sciences	Type of Research Outputs
1	Mathematical and Natural Sciences	<ul style="list-style-type: none"> • Published papers • Articles • Books • Chapters • Processed data
2	Plant Science	<ul style="list-style-type: none"> • Patent • Articles • New plant varieties • Published papers • Articles • Books • Chapters
3	Veterinary Science	<ul style="list-style-type: none"> • Community knowledge • Published papers • Articles • Books • Chapters • Patent
4	Medical Sciences	<ul style="list-style-type: none"> • New drugs • Published papers • Articles • Books • Chapters

		<ul style="list-style-type: none"> • Patent • Raw data • Processed data
5	Health Sciences	<ul style="list-style-type: none"> • Published papers • Articles • Books • Chapters • Consultancy reports • Contract research • License • Community knowledge • Processed data
6	Engineering Sciences	<ul style="list-style-type: none"> • Published papers • Articles • Books • Chapters • Patent • Contract research • Startup company • License • Technical reports • Community knowledge • Prototype • Software application
7	Literary Studies, Language Sciences, and Linguistics	<ul style="list-style-type: none"> • Publications – books, articles, magazines, editing, design • Education packages, short courses, training, workshops • Sound/dialogue recording
8	Economics and Management Sciences	<ul style="list-style-type: none"> • Member services, advocacy, governance • Consulting • Contract research • Community knowledge • Model • Draft policy
9	Social Humanities Sciences	<ul style="list-style-type: none"> • Consulting (including auditing and information services) • Education packages, short courses, training, workshops • Contract research • Publications – books, articles, magazines, editing, design • Member services, advocacy, governance • Community knowledge • Draft policy
10	Religious and Philosophy	<ul style="list-style-type: none"> • Education packages, short courses, training, workshops • New teaching methods • Publications – books, articles, magazines, editing • Member services, advocacy, governance

		<ul style="list-style-type: none"> • Community knowledge
11	Art, Design and Media Sciences	<ul style="list-style-type: none"> • Production – IT, DVDs, CDs, media, recordings, websites • Exhibitions, curatorial, artwork, images • Event management and festivals • Performance, films • Sound/dialogue recording
12	Education Sciences.	<ul style="list-style-type: none"> • Education packages, short courses, training, workshops • New teaching methods • Publications – books, articles, magazines, editing • Community knowledge
13	Others	<ul style="list-style-type: none"> • Education packages, short courses, training, workshops • Publications – books, articles, magazines, editing • Community knowledge

Table 2: Types of Research Outcomes literature review [source]

Based on the table above, the types of research output products are summarized in Table 3. Furthermore, it is possible to identify the commercialization process of the research output products, namely research results that can be commercialized directly (direct commercialization) and research results that cannot be directly commercialized (indirect commercialization). Examples of research results that can be commercialized directly include patents, copyrights, software applications, books, prototypes, and other Information Technology (IT) products. While examples of research results that cannot be immediately commercialized include draft policies, learning methods, sound recordings, and so on.

No.	Type of Research Outputs	Type of Commercialization
1	Published papers	In-Direct
2	Articles	In-Direct
3	Books	Direct
4	Chapters	In-Direct
5	Processed data	Direct
6	Patent	Direct
7	New plant varieties	Direct
8	Community knowledge	In-Direct
9	New drugs	Direct
10	Raw data	In-Direct
11	Consultancy reports	In-Direct
12	Contract research	In-Direct
13	License	Direct
14	Start-up company	Direct
15	Technical reports	In-Direct
16	Prototype	In-Direct
17	Software application	Direct
18	Technical reports	In-Direct
19	Publications – books, articles, magazines, editing,	Direct

	design	
20	Education packages, short courses, training, workshops	Direct
21	Sound/dialogue recording	In-Direct
22	Member services, advocacy, governance	In-Direct
23	Model	In-Direct
24	Draft policy	In-Direct
25	Consulting (including auditing and information services)	Direct
26	New teaching methods	In-Direct
27	Production – IT, DVDs, CDs, media, recordings, websites	Direct
28	Exhibitions, curatorial, artwork, images	Direct
29	Performance, films	Direct

Table 3: Types of Commercialization data processing [source]

Based on the identification, as shown in the table above, it can be seen that of all types of research output products, more products are marketed by In-Direct Commercialization. While the rest of the institutions (48%) can be marketed by Direct Commercialization. Thus, it can be understood that each university has a product of research output that can be commercialized. However, it is necessary to identify what products can be commercialized directly. The treatment of this type of product needs to be followed up related to the commercialization process.

The following table summarizes tertiary institutions' condition in facing the challenges of commercialization of research output products. Table 4 shows the Readiness of Universities Implementing the Commercialization of Research Output.

Institution Name	Availability of Research Output Product to Commercialized	Commercialization Process	Availability of Commercialization Process Institutions (Other than Research Unit)	Readiness for Commercialization
University A	Diverse products. Focus on health. It has been successfully commercialized.	It is complete until the commercialization stage	Teaching Industry, Business Incubator, Technology Transfer Office / TTO, and Company, Holding Company are available.	Has commercialized Research Output Products. Currently, in the process of preparing a Holding Company.
University B	Products focus on education and have not yet been commercialized	Not clear. Depending on the individual researcher.	Not complete. It still depends on individual researchers.	In the process of preparing commercialization.
University C	Products are diverse, and some products are commercializing. Focus on biopharma products.	It is complete until the commercialization stage	Business Incubator, Technology Transfer Office / TTO is available.	Has commercialized Research Output Products in collaboration with industry.
University D	Diverse products tend to be commercialized by TTG through	It is complete until the commercialization	Already available Research Output and Research Product	Has commercialized Research Output Products through

	Community Service activities.	stage	Gallery. Community, Business Incubator, and Company.	Community Service. There is already a Commercialization Management Company
University E	Diverse products. Focus on telecommunications products. Just beginning to be commercialized	The commercialization process is straightforward but has not yet been implemented.	Not complete. It still depends on individual researchers.	In the process of preparing commercialization.
University F	Products tend to focus on the traditional culinary variety of the region. Some products are commercializing	It is complete until the commercialization stage	Already available Gallery Product output Research and Peng.Masyarakat, Business Incubator.	In the process of preparing commercialization.
University G	Diverse products. Some products have been commercialized. Especially to the local government. Product policy focus.	It is complete until the commercialization stage	Teaching Industry, Business Incubator, Technology Transfer Office / TTO, and Company, Holding Company are available.	Has commercialized Research Output Products in collaboration with industry and local governments.
University H	Diverse products. The focus is on agricultural products. Some products have been commercialized.	It is complete until the commercialization stage	Research and Community Service output products are available. Society, Business Incubator.	Has commercialized Research Output Products in collaboration with industry.
University I	Various products. There are no products ready for commercialization.	Not clear. Depending on the individual researcher.	Not complete. It still depends on individual researchers.	In the process of preparing commercialization.
Polytechnic 1	Diverse products. There are no products ready for commercialization.	Not clear. Depending on the individual researcher.	Not complete. It still depends on the individual researcher.	In the process of preparing commercialization.
Polytechnic 2	Product focus on electronics. Products have been commercialized through the Business Incubator.	It is complete until the commercialization stage	Already available Teaching Industry, Business Incubator, Technology Transfer Office / TTO.	Has commercialized Research Output Products through Community Service. There is already a Commercialization Management Company.
Polytechnic 3	Products focus on agriculture. Products have been commercialized through the Business Incubator.	It is complete until the commercialization stage.	Business Incubator is available.	Has commercialized Research Output Products through Community Service. There is already a Commercialization Management Company.
Polytechnic 4	Diverse products. There are no products ready for commercialization.	Not clear. Depending on the individual researcher.	Not complete. It still depends on individual researchers.	In the process of preparing commercialization.
Polytechnic	Diverse products. Just	Sudah lengkap	Sudah tersedia Galery	In the process of

5	commercialization through cooperation with the Regional Government.	sampai tahap komersialisasi	Produk luaran Penelitian dan Peng.Masyarakat, Inkubator Bisnis.	preparing commercialization.
Polytechnic 6	Diverse products. There are no products ready for commercialization.	Not clear. Depending on the individual researcher.	Not complete. It still depends on individual researchers.	In the process of preparing commercialization.
Polytechnic 7	Diverse products. There are no products ready for commercialization.	Not clear. Depending on the individual researcher.	Not complete. It still depends on individual researchers.	In the process of preparing commercialization.
Polytechnic 8	Diverse products. There are no products ready for commercialization.	Not clear. Depending on the individual researcher.	Not complete. It still depends on individual researchers.	In the process of preparing commercialization.
Polytechnic 9	Diverse products. There are no products ready for commercialization.	Not clear. Depending on the individual researcher.	Not complete. It still depends on individual researchers.	In the process of preparing commercialization.
Polytechnic 10	Diverse products tend to be commercialized by AT through Community Service activities.	It is complete until commercialization through Community Service.	Not complete. It still depends on individual researchers. Commercialization already exists through Community Service.	It already started to complete the commercialization unit.
Polytechnic 11	Diverse products. There are no products ready for commercialization.	Not clear. Depending on the individual researcher.	Not complete. It still depends on individual researchers.	In the process of preparing commercialization.
Polytechnic 12	Diverse products. The focus is on tourism products. Some products have been commercialized.	It is complete until commercialization through Community Services.	Not complete. It still depends on individual researchers. Commercialization already exists through Community Service.	Already started to complete the availability of commercialization units.

Table 4: Readiness of Universities in Implementing Commercialization of Research Output interview and FGD data processing [source]

Referring to the table above and the respondents' answers to the FGD / interview questions, the following summary can be found.

First, research conducted at universities is generally focused on the findings of knowledge (science) and a small portion of products. However, it depends on the field of science that is the object of research. This is supported by various research schemes implemented, both research schemes. Several universities and polytechnics have galleries to showcase the products of their lecturers and students. In contrast, research in polytechnics is applied research that can lead to appropriate technology products and only a few basic research. As a result, the number of published papers from polytechnics is usually less than the number of published papers from universities.

Second, based on the interview results, there were quite some universities that had commercialized their research products. A total of 6 (six) of the 9 (nine) universities interviewed have begun to commercialize their research products (67%). In comparison, the

polytechnic environment tends not to commercialize the research products. There are 42% of polytechnic respondents who have started to commercialize their research products. Generally, the research products are disseminated for their usefulness through community service activities. In this activity, the value of returns received by universities is not in the form of economic value but in the way of “intangible” values. They are considering that the research results are directed to be made militarized at this time. The leadership of the research institute and community service at the university and the polytechnics have begun to encourage the research lecturers to obtain information and data about products needed by the community and have the potential to be commercialized. Even universities require research lecturers to have user partners (markets) for the research products they propose.

Third, the obstacles faced by tertiary institutions when commercializing their research products differ and are influenced by their tertiary status. For example, for tertiary institutions with work unit status, the challenges faced are related to the financial management of partners/industries. This is because the funds received by the institution cannot be directly used, but rather all activities must refer to the institutional budget plan. Simultaneously, universities with Public Service Entity status and Education Legal Entity status tend to be more flexible in managing financial management processes for product commercialization. Including searching and collaborating with investors. Besides, universities also face challenges in finding investors for their commercialization products. Market search for product users is also a challenge that needs to be anticipated.

Fourth, the parties responsible for commercializing research outcomes in each tertiary institution are different. In several universities that have had the experience to commercialize lecturer research products, they have Technology Transfer Office responsible for processing patented products to be commercialized. Including searching for markets for these products and investors who will produce them. The university also involves business incubators in the process of commercializing innovative products (Ab Aziz et al., 2012). When the demand for products increases, some universities open holding companies to meet the needs of the market. Especially universities that have BHP status. Whereas in higher education institutions that have just begun to process downstream of their research products, they usually use access to community service activities as a “bridge” to promote the availability of research products that can be utilized to improve the community’s welfare. Starting with the utilization, as part of the dissemination of research products, there is usually an increase in demand for these products’ availability. Indeed the number of products that can be commercialized is still within the capabilities of the tertiary institution. Suppose a university cannot provide innovative products according to the needs of the community; one strategy is to collaborate with business incubators and/or start-up companies owned by alumni.

Fifth, the collaboration between universities and industry partners is crucial in increasing production to meet market needs. Given the small industry built in the college, the environment is usually intended as a “teaching factory” with a limited amount in production. Apart from that, related to specific products, such as drugs and food/drinks, it is necessary to process various licenses, some of which are only given to industries. Therefore, some universities partner with the industry as producers in the commercialization process. Permits that are owned by industry can be utilized for the downstream / commercialization of higher education research products.

Sixth, strategies used by tertiary institutions to commercialize research output vary. Some through cooperation with cooperatives, some through alumni who become tenants of business incubators, others collaborate with various government / private agencies. Some universities utilize “internal users” as their tenants, then the research products that are used by “internal users” subsequently become promotional “products” that can be seen directly. Other users who visit the tertiary institution can see the products being implemented and are expected to be continuous access to commercialization.

In summary, based on the research findings, it is known that several universities commence commercialization through products that are produced for Community Service activities, especially the research output in the form of Appropriate Technology (AT).

The commercializing research output is generally aimed at large industries. In comparison, the commercialization of research output through Community Service activities is primarily aimed at increasing the competitiveness of Micro, Small, and Medium Enterprises (MSMEs) or solving problems that are faced by SMEs.

Commercialization of research results through community services is generally not initially conducted directly (In-Direct) unless the research is in the form of pre-order research. In this case, the actual commercialization has not been carried out, because in general, the number of products is still minimal (generally 1 or 2). The commercialization of research results begins when the user has felt the impact of using Appropriate Technology or other research outcomes. There are at least four main challenges faced by universities in Indonesia to commercialize their research products successfully. First, convincing that the research product meets the needs of users, both the general public and the industrial community. Moreover, realizing that commercialize research products is somewhat more difficult than commercialize ordinary products. (Fletcher & Bourne, 2012). Therefore, the process to ensure product alignment resulting from the research activity should ideally be carried out from the initial research plan stage to commercializing the research product stage. This means the product that will be produced through research already has a market. The implication is that the products’ quality standard meets the industry’s standard, even though testing of the product’s prototypes is still carried out at the laboratory scale.

This becomes very important for the products produced in technology because (1) in the commercialization of technology products, there acknowledges the existence of a stage called “the valley of death.” That is the gap between academic-based innovations and their commercial application in the market place (Osawa & Miyazaki, 2006); (Islam, 2017). (2) the technology adoption follows a cycle approach called the “technology adoption life cycle”. The cycle has five stages: innovator, early adopters, early majority, late majority, and laggard. (Moore, 1999); (Taylor & Taylor, 2012). “The first individual to accept a new technology solution are the innovators. They will try anything at any cost because they are simply excited about new things. The second group is the early adopters who excite about the innovation, although they prefer more practical products. The early majority group required a solution that meets their main needs and is affordable. The second to last segment of a population to adopt innovative technology in the late majority. They will adopt a new product only after seeing most of the population already has successfully adopted it. The last group to adopt an innovative product is

the laggards. They tend to adopt only when they are forced to, or everyone else has already implemented it. Moreover, (3) collaboration with various agencies to succeed in the commercialization process. Especially to bridge the valley of death stage.

Through industrial cooperation, research product aims tend to direct toward the industrial or community needs. There are at least three forms of collaboration between industry and higher education in Indonesia. First, collaboration prior to developing the research plan. Thus the research product is an order from the industry that must provide at the agreed timeline. The majority of higher education already conducted this kind of collaboration. Second, partnering in the direct commercialization of research products. The strength of this kind of collaboration is the place on higher trust between the parties. The more closes link between higher education institutions and the industry will increase the industry's trust in acknowledging higher education researchers' ability to provide quality research products. Third, higher education releases its products to be commercialized by the industry. This kind of collaboration makes it easier for researchers and higher education management to overcome the death stage's valley in commercializing their innovative products. And (4) funding available to support the commercialization of innovative products. Bearing in mind that the available research funding in higher education in Indonesia is limited, funding to commercialize their research products becomes a major problem. Collaboration with the investor can be the solution.

CONCLUSION

Each university has different experiences in managing its research products to be commercialized very diverse. Given that the commercialization process of development needs to undergo a series of processes, it is necessary to have integration between various units/divisions to work together. The availability of the Gallery to display the research products (outputs) as well as the Incubator unit and Technology Transfer office will greatly help accelerate the product to be commercialized. Based on the findings, all higher education faced similar obstacles in commercializing their research products. A view universities have start commercialized their research products in various ways, including collaborating with industry. However, most higher education institutions are still struggling to find the best pattern to commercialize their research products. This study's two implications are: 1) researchers need to involve "user" needs before developing a research proposal. 2) Management at the university needs to facilitate the commercialization of the academicians' research products.

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