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Research and Development – Commercialization Bridge: A Refined Model

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Abstract. *Research product commercialization becomes the problem in delivering research into commercialization. The objectives of this research are to understand research product commercialization, develop a framework, and generate a refined research product commercialization model. An in-depth interview method by purposive sampling was used to gather qualitative data. Interview transcriptions were analyzed through three steps networking processes. Those processes are proposed to generate a research product commercialization framework. The R&D flow and commercialization flow were developed based on that framework. A research product commercialization model was built through gaps and solutions arrangement on commercialization flow. Research and Development-Commercialization bridge (R&D-C Bridge) model was developed based on improved commercialization flow. R&D-C Institute, as an independent institute, runs that model. R&D-C institute also interconnecting stakeholders involved in the technology commercialization process that has already established on the technology park concept. While the Goldsmith and Stage-Gate commercialization model has un-clear tasks division and un-objective commercialization process, the R&D-C bridge model gives a research product commercialization flow through R&D-C institute as a stakeholder hub. It is where the R&D-C bridge model stands on its position. This research offers insights into developing a new research product commercialization model for science and technology park development.*

Keywords: *A valley of death, commercialization constraints, commercialization model, research product, R&D-C bridge model.*

1. Introduction

One of the national development and growth factor comes from technology investment, which comes from the technology commercialization process (Bandarian, 2007). Commercialization has an impact on local and regional economic growth, knowledge transfer, entrepreneurship, and job creation (Jamil, Ismali, & Mahmood, 2015). While the technology itself can not suddenly exist and used massively by the people, it has to pass many stages that sometimes bring new technology into failure on entering the market. A picture of the "Universal industrial success curve" shows that from 3000 fresh ideas, only one can succeed (Stevens & Burley, 1997). New products to launch into the market will face a lot of constraints and obstacles, where it is could be figured through a valley of death curve. It is a phase where technology meets commercialization. That is why the valley of death become a barrier to technology commercialization (Frank, Sink, Mynatt, Rogers, & Rappazzo, 1996). Struggle at the beginning of technology commercialization on the valley of death phase become the major risk on the technology commercialization process. Goldsmith and Stage-Gate model ("Nebraska Business Development Center, University of Nebraska Omaha: Goldsmith technology commercial-ization model," 2019; "Stage-Gate International: Stage-Gate Discovery to Launch Process," 2019) as technology commercialization models give phases of technology commercialization process with a purpose to help facing constraints on the valley of death process. But, the question, does it match for Indonesian research product commercialization process? Indonesia in rank 28 of 116 countries with research and development (R&D) expenditure USD 10,23 billion in 2018 or 0,92% of Gross Domestic Product (GDP) (Djunedi, 2018). Different

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from product innovation that used Goldsmiths or Stage-Gate model on its activity, Indonesia has Science and Technology Park on developing product innovation. It is a collaboration space between academics, business, government, and community (Kusharsanto & Pradita, 2016). On the implementation of technology commercialization, Indonesia still does not have a clear pathway in the process and steps of commercializing the technology. Some technology commercialization tools have already legalized in Indonesia like TKT and Katsinov as the adoption of Technology Readiness Levels (TRL) and Innovation Readiness Level (IRL) (Ministry of Higher Education, 2017; "Tingkat Kesiapan Teknologi-TKT atau TRL," 2016), but for the process of technology commercialization itself, Indonesia does not has it yet, and this becomes the gap of technology commercialization process in Indonesia.

Constraints, obstacles, or even challenges in delivering research into commercialization should be understood first before beginning to optimize R&D expenditure for national growth. A refined model from the existing technology commercialization model (Goldsmith and Stage-Gate model) was proposed through this research that can be fit with Indonesia's technology commercialization activity, to improve technology commercialization nationally. It can fulfill the gap of the technology commercialization model in Indonesia that has already mentioned before. The objectives of this research were to explore and get an understanding of the technology/research product commercialization process and constraints in the research and development institute. The next question then, can we develop a framework and model of research product commercialization? The development of a general framework of research to the commercialization process would be the output of that exploration process. By doing it, then a refined model of research commercialization was proposed based on exploration findings. This is the final objective of this research.

2. Literature Study

Successfully commercialized technology comes from knowledge into a product that can give value for humans and also advantage for economic growth (Jamil et al., 2015; Stevens & Burley, 1997). Technology transfer from a research institute to a company in commercialization is influenced by several variables: type of technology, research institute as a technology provider, and company as technology receiver (Sohn & Moon, 2003). The valley of death considered a gap between research products to commercialization in the business stage (Osawa & Miyazaki, 2006). In nanotechnology, as new emerging technology also facing some challenges on its commercialization, where it comes from: time lag (time delay from research until commercialization), the valley of death, funding limitation, lack of infrastructure, bureaucratic delays, lack of standard of evaluation, lack of trained professionals, public support, and brand image (Aithal & Aithal, 2016).

Before a research product or technology enter the market and commercially used, it has to be proven first. There are several tools used for technology assessments. Technology Readiness Levels, known as TRLs or TRL, used to assess technology from the R&D step until before it is ready for full-scale development (Mankins, 2009a). There are nine levels of TRLs that represented the maturity of technology, from level 1 in basic principles until level 9 in actual system proven (Clausing & Holmes, 2010). R&D Degree of Difficulty known as $R\&D^3$, this tool has functions to understand the probability of success or failure on R&D programs, efforts, and objectives (Mankins, 2009b). The other means to indicate technology maturity is technology needs value (TNV). It uses a weighting factor to assess the importance of technology development (Mankins, 2009b). Integration readiness level (IRL) is an integration metrics to understanding integration between two or more technologies, reduce uncertainty in

technology integration, and giving system requirements during integration (Sauser, Ramirez-marquez, & Tan, 2009). Another technology readiness assessment was proposed by Sauser et al. in 2006, named by "systems readiness level" (Straub, 2015). It has a purpose in understanding technology readiness or maturity to be integrated into a system. TRL measures the maturity of individual technology, while SRL for system maturity. The gap among that tools that did not measure innovation (Lee, Chang, & Chien, 2011). Innovation Readiness Level (IRL) is proposed to be used in innovation management activity (Tao, Probert, & Phaal, 2010). Innovation readiness diagram (IRD) is a tool in managing technology transfer processes (Paun, 2012).

Different from technology readiness assessments, technology acceptance gives a point of view from a person who uses the new technology. Parasuraman (2000) developed Technology Readiness Index (TRI) with a purpose to understand technology receptivity on customers. Technology Acceptance Model or TAM was developed in 1985 by Fred Davis, and it is a tool to understand acceptance or intention to use new technology in organizations (Erdoğmu & Esen, 2011).

Bekhradi, Yannou, Cluzel, Chabbert, & Farel (2015) proposed a scale to measure market maturity that called Marketing Maturity Level or MML. They said that this tool is better used for start-ups to understand their maturity. Market readiness level (MRL) defined by Linda from ea technology as a tool to understand and measure technology and market readiness (Hull, n.d.).

While innovation, research, and technology can be assessed through several assessment models, the technology commercialization process itself also needs to be measured. The technology commercialization assessment process has the purpose of finding the optimum ways of conducting it. Technology Commercialization Success Index (TCSI) is one of the ways to do it. In its process, the technology commercialization process is developed into several ways or scenarios, with the involvement of technology types and stakeholder intervention on it. The best technology commercialization scenarios can be predicted then through a measurement tool called Technology Commercialization Success Index (TCSI) (Sohn & Moon, 2003). Another technology commercialization evaluation is Strategic Technology Evaluation Program (STEP). The STEP evaluation process is consisting of six evaluation criteria: technology evaluation, economic evaluation, process evaluation, and market evaluation (Bandarian, 2007).

As one of the technology commercialization model, the Goldsmith Commercialization Model has six stages on its commercialization process (Atikah, Ghabid, Sutopo, Purwanto, & Nizam, 2014; "Nebraska Business Development Center, University of Nebraska Omaha: Goldsmith technology commercial-ization model," 2019). Stage 1 is the investigation, stage 2 feasibility, stage 3 development, stage 4 introduction, stage 5 growth, and stage 6 maturity. Each stage is analyzed or assessed into three domains: technical market, market, and business. It is started from technology analysis on step 1 as a technical market analysis on stage 1 and ended on step 18 that analyzed business maturity. Each step has its milestones to achieve, like in step 1 has a milestone in intellectual rights, or step 18 has a milestone in profits. Stage 1 on this model considered as concept phase, stage 3 until 4 as the development phase, and stage 5 until 6 as the growth phase. Based on its characteristics, the model is giving guidance on how to develop a conceptual technology into a commercial product that generating profits. Stage-Gate Model is commercialization tools that transform new ideas into commercialized products in an organization (Edgett, 2015). It is a process playbook to accelerate product innovation in an organization ("Stage-Gate International: Stage-Gate Discovery to Launch Process," 2019). Product innovation in the Stage-Gate Model is belief as a value creation process.

Five stages started from the idea discovery process until launch to commercialization. Idea generation is screened in gate 1 before entering stage 1: scoping or preliminary investigation, then go to gate 2: 2nd screen, stage 2 is built the business case, then go to development in gate 3, enter to stage 3: development and go to test in gate 4, stage 4 is testing & validation, and the last gate is going to launch in stage 5: launch commercialization. Stages define each process that should be passed through to transform ideas into commercialized products. Gates act as a decision process between each stage, whether it can go to the next stage or not.

There are several terminologies for the technology transfer institute. A business incubator has a purpose of delivering new ventures to be a success as entrepreneurs (Grimaldi & Grandi, 2005). The services they give such as space sharing, managerial support, advanced equipment, networking and market access, intellectual protection, training, industry/knowledge/financial capital linkages, and also conducting incubates selection (Jamil et al., 2015). Technology parks and university incubators have a role in accelerating commercialization (Jamil et al., 2015). Technology Park has broad terminology around the world, Research Park used in the USA, Science Park in Europe, and Technology Park in Asia. Technology Park in Indonesia is known as Science and Technology Park (STP) (Kusharsanto & Pradita, 2016).

STP in Indonesia is the center of excellence and as a space for collaboration among academics as innovators, businesses, government as a policymaker, and community (Kusharsanto & Pradita, 2016; Soenarso, Nugraha, & Listyaningrum, 2013). STP also acts as a place where resources, human capital, and public policy are connected (Soenarso et al., 2013). Interconnection between industry and university, in case of technology transfer, mostly mediated by Technology Transfer Offices (TTOs) (Owen-Smith & Powell, 2001). Another technology transfer institute is Technology Commercialization Centers (TCC), where the main objective is to link regional champions and enterprises to the international marketplace (Gibson & Conceiçao, 2003).

Technology commercialization remains some problems in its implementation. New business venture failure on facing the valley of death and ideas success curve slope still can not be solved, which caused a gap between research until commercialization. Existing technology transfer institutes, technology commercialization models, technology assessment, until technology marketing assessment still not optimally transform research product into commercialization. On the technology commercialization model, the Goldsmith model did not mention actors involved in the technology commercialization process, who or which institution should do the activity on each step. Stage-Gate, as another technology commercialization model, stands as a process for developing product innovation in an organization.

These models took the conclusion that the models are only giving steps for developing a product innovation in the organization without considering actors involved in the technology commercialization process and synergy. While technology transfer institute as an institution where the actors took place on technology commercialization activity only acts as a collaboration space. In the end, based on the review of some literature, there is still no integration on technology commercialization between the model, actors, collaboration space, and also technology commercialization tools. This is positioned this research on its standing position on building an integrated technology commercialization model between the existing technology commercialization model, technology transfer institute, and technology commercialization tools.

3. Methodology

There are three research choices on the research onion: mono method, mixed methods, and multi-method (Saunders, Lewis, & Thornhill, 2007). This research was conducted through the mono method, where it is only using a qualitative research approach. An in-depth interview was used to generate broad information in a related research topic. This method can generate some conclusions or framework then. The type of research study in this research was gained through exploratory studies because of the research commercialization process, and constraints topic in Indonesia are not fully understood by the researcher or by literature review. Interviewing experts was the way to conduct this research to get those understanding and also to explore a new way of research commercialization framework. An investigation of research commercialization problems was the aim of why qualitative research was selected. Data collected through non-probability sampling techniques with purposive sampling (Saunders et al., 2007), researcher judgment was used on selecting the informants with guided through some criteria. This technique was chosen because of its characteristics that can answer the research objectives in understanding the technology commercialization process in institutions related to R&D. Multiple informants from stakeholders related to technology commercialization were arranged to get understanding research commercialization in multiple organizations. In this research, there are four organization types involved in this research. There are academics, government R&D institute, R&D regulator/coordinator, and research-based company. Fourteen informants vary from 12 institutes who replied on their agreement to participate in this research. All informants were selected based on criteria of their expertise, table 1 show detail of informant expertise.

Table 1.
Detail of Informants

Institution	Informant position	Stakeholder domain
1. Center for Innovation and Entrepreneurship Development of University of Bandar Lampung (PPIK UBL)	Head of the institute	Academics
2. Institute for Research, Community Service, and Quality Assurance of Sumatera Institute of Technology (LP3 Itera)	Head of the institute	Academics
3. Research and Community Service Unit of State Polytechnic of Lampung (UPPM Polinela)	Ex-head of institute	Academics
4. Research and Community Service Institute of University of Lampung (LPPM Unila)	Head of business incubator division	Academics
5. Faculty of Engineering on University of Lampung	Lecturer	Academics
6. Mineral Technology Research Center of Indonesian Institute of Sciences (BPTM LIPI)	Head of the institute	R&D institute
7. Mineral Technology Research Center of Indonesian Institute of Sciences (BPTM LIPI)	Researcher	R&D institute
8. Starch Technology Center of the Agency for the Assessment and Application of Technology (B2TP BPPT)	Secretary of institute	R&D institute
9. The Center of Microelectronics of Bandung Institute of Technology (PME ITB)	Head of the institute	R&D institute
10. Regional Research and Development Agency of Lampung Province (Balitbangda Lampung)	Head of the institute	R&D regulator
11. Regional Research and Development Agency of Lampung Province (Balitbangda Lampung)	Head of division	R&D regulator
12. Lyco Farm Bandung	Company owner	Research-based company
13. PT BIOPS Agrotekno Indonesia	Company owner	Research-based company
14. UD Tami	Company owner	Research-based company

Cross-sectional studies were used in this research rather than longitudinal studies. Before the interview process was conducted, the interviewer was asking the research informant to fill the participant consent form as a part of research ethics. Questions asked to the informants are related to the technology commercialization process in the institute where the informant works. The outline of interview questions is about the research process, commercialization process, business process, institute job description, technology commercialization model and tools used, research/commercialization/ business constraints, etc. The research was conducted in two locations area, with informant participation from 14 institutions located in Bandung City and Lampung Province area. The time duration of this research took 5 months that started from March 2019 until July 2019.

4. Finding and Discussion

Recordings in the form of voice were transcripted into the text to be analyzed in the next steps. Qualitative data processor software was used as a tool to analyze interview data in the form of text. Each transcription was coded through Atlas.ti 8 software through the open coding process. Eight codings generated from the transcriptions coding process. Each coding has its case/topics that would be used for the networking process or findings determination. After transcriptions were coded, the next step is the coding networking process. Each informant has its coding network, and this process called a hierarchical networking process. There are three steps of hierarchical networking process:

1. Networking representing individual statements: this process is the first process to networking each informant coding in individually;
2. Networking representing individual statements in groups: this second process of networking, generating findings from individual networking result which categorized into several stakeholders: academics, R&D institute, R&D regulator, and research-based company;
3. Networking representing the integration of the groups: this final networking was used for framework generation. It is a combination of stakeholder domain networking.

The objectives of these three steps networking are to get findings in each layer network, and answering the research question. Findings generated in hierarchical steps were used to develop a framework that conducted in the general networking process as the last networking process.

Networking representing the integration of the groups' process generates a research product commercialization framework that divided into three phases: R&D phase, commercialization phase, and business phase. In the R&D phase, it is consists of a research structure, concept & mechanism, system & regulation, funding, and resources that were figured as the research ecosystem. In the commercialization phase, it is consists of commercialization structure, concept & mechanism, system & regulation, funding, and resources were figured as commercialization processes. In the business phase, it is consists of a research product, commercialized product, and market ecosystem.

This research product commercialization framework generally consists of research to commercialization process, constraints, structure, system, funding, resources, and ecosystem. On developing a research product commercialization based on a framework that has already generated, it needs to arrange the research product commercialization process into a flow. Based on that flow arrangement, two flows can be generated, that is R&D flow and commercialization flow. Steps on R&D flow are started from research stimulus, it can be in the form of bonuses or other rewards.

This stimulus is used for research idea source step, where research ideas can come from internal (literature, research discussion forum, and internal institute) or external (field problem, natural resources potency, technology trend, external institute, and customer problem and behavior). The next step is the research process, where research can be conducted in basic research, experiment, applied research, or product development. The research process is directed in a specific research institute or regional-based research institute with a research agenda/road map. Research cooperation and synergy is a partnership with user or stakeholder. The model of research coordination is in the shape of regional or cluster coordination. Regional and policy and also an external factor as R&D support. Research funding and also resources from research potency and infrastructure as parts of R&D flow. The output of R&D flow is a research product that can be in the shape of product/technology invention, industrial development, policy paper, or journal & book. Research assurance is needed to protect research products through research failure incentives and intellectual right royalty. Then, to maintain the research process, it needs research performance assessment at the end of R&D flow.

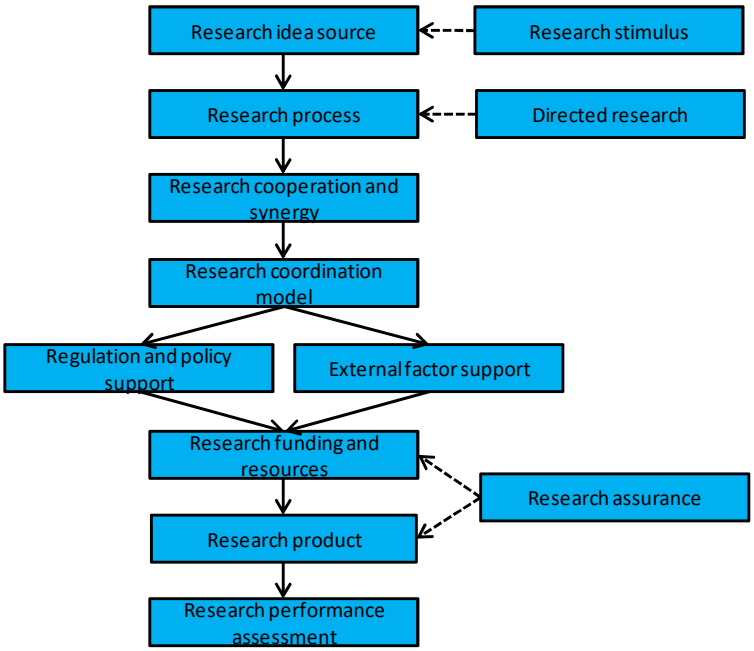

Figure 1.
R&D Flow Generation

Steps on commercialization flow are started from research mapping and selection; it is mapping and selects the technology to be commercialized in the next steps. But, before that, technology has to be assessed through several technology assessment tools. This step is used for commercialization decision making, research to commercialization guidance, and as a technology advisor. The next step is commercialization model decision making, what is the right commercialization model for the selected technology. A process of commercialization can be developed through business incubation, technology transfer to community, or policy paper implementation. Commercialization subject selection is a selection of the subject who will run the technology in its implementation or business process. Commercialization advising,

facilitation, and linking are a process to give an improved capacity of the commercialization subject. There are four domains of commercialization cooperation and synergy: in community service, in business incubation, in private partnership, and business linking. The commercialization process is coordinated by a business incubator or commercialization institute. Regulation, policy, and external factors act as a supporting factor. Commercialization funding and resources like business skills are the success factor of commercialization. Products of commercialization are in the shape of technology for business, technology for the community, technology for industry, and technology for policy. Market analysis is the next process before technology enters the market. The technology introduction process is a process of technology to accepted in the market. And, the last step is commercialization performance indicator to assess the whole commercialization process.

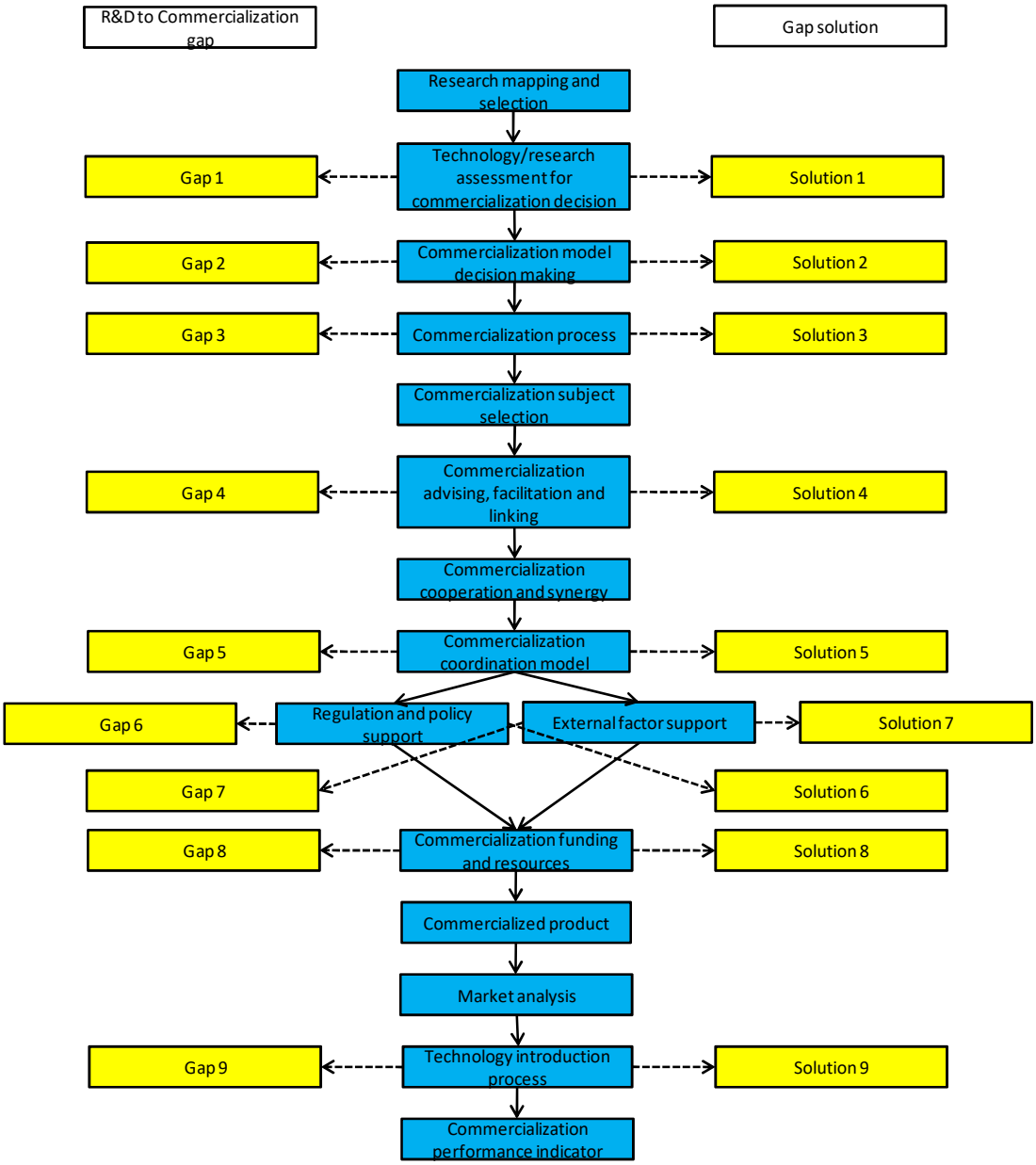

Figure 2.
Commercialization Flow Generation and Its Gap

Figure 2 shows how the commercialization process is arranged in a flow chart. Based on qualitative data collection, it is found that there are a lot of gaps in commercialization flow. These gaps are considered as problems or holes in bridging research products into commercialization. After commercialization flow was generated, the next process was fulfilling the gaps with solutions then. Solutions were generated from the informant statement and also came from the literature review. Solutions are analyzed and arranged through root cause analysis that explored from gaps/problems mentioned by informants. After the root caused were gathered, the next process is arranging the solutions. The generation of this solution also comes from informant statements related to gaps/problems analyzed.

Table 2.
R&D to Commercialization Gaps and Solutions Arrangement

Gap		Solution	
Stage: Technology/research assessment for commercialization decision			
1	- Existing technology assessment did not use, not objective, and not fit with Indonesian bureaucracy procedural - Not all R&D institute use technology assessment - Need another technology assessment as complementary	1	- Technology assessment tools for commercialization decision, pre-implementation test, and feasibility study - Technology assessment conducted by an independent institute
Stage: Commercialization model decision making			
2	- Marketing model decision making process problem	2	- Market maturity measurement - Marketing model selection and decision making - Conducted by an independent institute
Stage: Commercialization process			
3	- Business incubation for alumni failure - Low commercialization partnership success	3	- Commercialization process: business incubation, technology transfer/dissemination to the community, industrial partnership and consultation, partnership with the private sector, or policy implementation
Stage: Commercialization advising, facilitation, and linking			
4	- Research to a business gap - No access to capital and market - Commercialization task limitation regulation	4	- Research commercialization, capital and business linkers, technology advisor and facilitator to market conducted by an independent institute
Stage: Commercialization coordination model			
5	- Research institute limitation in the commercialization - Commercialization task limitation regulation	5	- Independent institute who has a specific task on research product commercialization
Stage: Regulation and policy support			
6	- Product to market regulation constraints - Political and policy condition	6	- Development of policy and regulation that support research product commercialization
Stage: External factor support			
7	- Environment factor problems	7	- Develop external factors that support research commercialization environment
Stage: Commercialization funding and resources			
8	- Commercialization funding/budget limitation - Lack of researcher knowledge in the commercialization - Human resource mindset and education problem - No access to capital and market - Natural resources problem	8	- Business incubation, community service, and capital funding - Human resources in the commercialization - Capital funding access - Commercialization potency from natural resources
Stage: Technology introduction process			
9	- Technology acceptance constraints - New technology uncertainty - The high price of new technology to the market	9	- Technology acceptance measurement tools for technology introduction process - Production process standardization

The new improved commercialization flow by fulfilling gaps with solutions would be an answer to developing a commercialization model for the R&D process in Indonesia. Gaps that found on the research product commercialization process are likened to holes between research to commercialization bridge.

This proposed model then called research and development to commercialization bridge (R&D-C bridge). As an improved bridge by filling holes in the existing process with solutions, this model can answer challenges and constraints on the technology commercialization process. In this model also developed a technology commercialization institute which called an R&D-C institute. It is an independent institute outside academics institute, R&D institute, R&D regulator, and research-based company. R&D-C institute has the main task of commercializing research product, as research to commercialization bridge. It is answering the commercialization problem on the commercialization task division. R&D-C institute act as a hub between the technology provider and technology receiver. Four commercialization models can be run by R&D-C institute: as a business incubator that produces technology for business, as community technology transfer institute that produces technology for the community, as industrial/private partnership institute that produces technology for industry/private, and government policy facilitator that generates technology for policy.

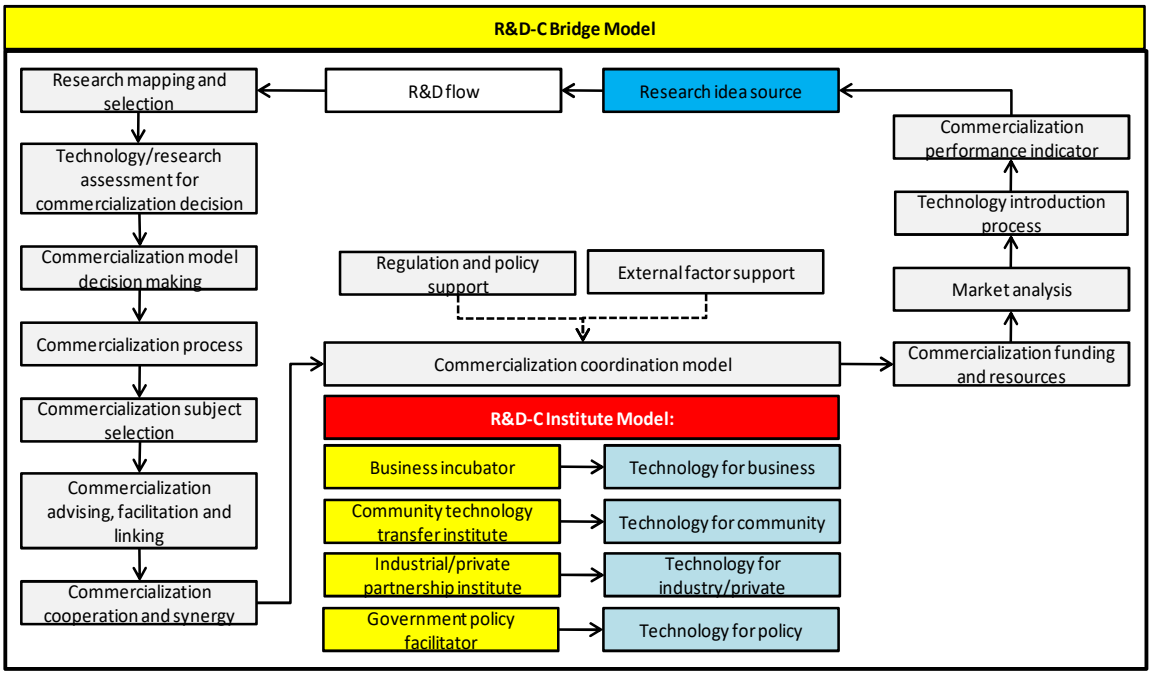

Figure 3.
R&D-C Bridge Model

R&D-C Bridge model in explanations:

1. Research mapping and selection
   This is the starting point of the research product commercialization process. Started with research mapping, research products can come from research results in the journal, research for community service, research in the form of product/prototype, etc.
   After that, the next process is the research selection. Commercialization or research implementation is the central vision of the research selection process. The selection process can be active or

passive. Active selection means that the technology owners proposed their invention to be commercialized through proposal or competition selection. Passive means that the R&D-C institute makes a technology selection by research mapping result.

2. Technology/research assessment for commercialization decision
   Selected technology or research product is assessed through some technology/research product assessment tools then. Technology/research product assessment used for research product commercialization decision, pre-implementation test, and feasibility study. Technology/research product assessment tools: TRL, R&D^3, and TNV for technology or research assessment, IRL or SRL for technology integration in system assessment, and IRL and IRD for technology in market position assessment. Technology/research product assessment conducted by R&D-C institute.
3. Commercialization model decision making
   This process consists of two steps: first, market maturity measurement: tools that can be used in this measurement process are MML, MRL, etc. Second, marketing model decision making: a mechanism to run marketing model selection and decision making. This step is conducted by the R&D-C institute.
4. Commercialization process
   It is a commercialization process form selection. Commercialization process selection in the form of business incubation, technology transfer/dissemination to the community, industrial partnership and consultation, partnership with the private sector, or policy implementation. Technology meets commercialization form the matching process.
5. Commercialization subject selection
   After the commercialization process form is selected, the next step is selecting a subject on commercialization. In the form of business incubation, the selection is for the start-up. In the form of technology transfer, the selection is for the technology receiver. In the form of industrial/private partnership, the selection is for industry/private as a technology user. In the form of policy implementation, the selection is for the policymaker.
6. Commercialization advising, facilitation, and linking
   Capital funding and business linking, technology/research product advisor and facilitator conducted by R&D-C institute.
7. Commercialization cooperation and synergy
   R&D-C institute as a hub in the process of cooperation and synergy among stakeholders. Cooperation and synergy in the scope of community service, business incubation, private partnership, business linking, etc.
8. Commercialization coordination model
   The process on coordinating research product commercialization is run by R&D-C institute through four task category: business incubator which generating technology for business, community technology transfer institute which generating technology for community, industrial/private partnership institute which generating technology for industry/private, and government policy facilitator which generating policy for government. R&D-C institute is an independent institute in commercialization task outside academics institute, R&D institute, R&D regulator, and research-based company.
9. Commercialization funding and resources
   This step is a process of facing the valley of death phase. Valley of death curve is the process where no profit was generated and stop after research product generating profit in business the phase (Osawa & Miyazaki, 2006). This is means that funding is the main factor in supporting the gap between research products to commercialization. Funding in the commercialization process:

business incubation, community service, etc. and also access on capital funding. Human resources and natural resources as support and potency on the commercialization process. This process is conducted by the R&D-C institute.

10. Market analysis
    Analysis of market means market or business feasibility study. It is consists of an analysis of technology trust on the market, product life cycle, market standard, market opportunity and threat, market targeting, etc. MOA can be a tool to arrange market feasibility.
11. Technology introduction process
    Technology/research product that has already proven and feasible to enter the market are introduced to the market then. Technology acceptance measurement tools are used for the technology introduction process. Production process standardization to meet market standards.
12. Commercialization performance indicator R&D-C institute, as an independent institute needs to be assessed to, besides the research product itself. It is an assessment process to measure the technology commercialization process success. TCSI and STEP are some tools that can be used for that.

A feedback process:
On this R&D-C bridge model, there is a research idea source that fed to the R&D flow process. It means that research products generated by the R&D-C institute are used for the researcher as input for the next research on the R&D flow process.

Supporting factors:

1. Regulation and policy support
   Development of policy and regulation that supports research product commercialization.
2. External factor support
   External factors development that supports research product commercialization environment.

This research product commercialization model gives a rule of the flow of research product commercialization, which improved with a list of solutions. It is started with research mapping and selection until the commercialization performance indicator process. A loop flow system was generated through the research idea source box that gathering ideas inspiration through field problems or commercialized products. This idea source then fed to the R&D flow box, in this system is summarized just only in one box.

R&D-C institute model also generated some commercialization institution models. It is developed in the case of commercialization task limitation on academics, R&D institute, R&D regulator, or research-based company. Due to that problem, this institute was developed on this model then. This institute should be separated from those institutes and should be established independently.

In the literature review, it is mentioned that there is also a technology park model in the framework of technology commercialization. The technology park is developing an interconnection between stakeholders in the process of technology commercialization. It is mentioned that STP as a center of excellence and as a space for collaboration among academics as an innovator, business, government as a policymaker, and community (Kusharsanto & Pradita, 2016; Soenarso et al., 2013). Instead of building technology commercialization interconnection and space framework as technology park did, this R&D-C bridge model gives the technology commercialization flow process on interconnection among them. Technology parks and university incubators have a role in accelerating commercialization through some tasks: property development, market networking, R&D, university involvement, firm's clustering, equipment advancement policy, managerial support, students and faculty, and institute reputation (Jamil et al., 2015). There is no clear technology commercialization process flow on that, and

technology parks are still doing R&D activity too. R&D-C institute gives clear research product commercialization flow and also commercialization tasks division. This is what of research positioning on the result generated from this research.

R&D-C bridge model has its standing position compare with another technology commercialization model. The Goldsmith Commercialization Model has three phases with six stages in modeling technology investigation, feasibility, development, introduction, growth, and maturity (Atikah et al., 2014), while the Stage-Gate model used as a mechanism on ideas to product launch process. They are using five stages that started from ideas discovery until launch commercialization and gates on each stage for the decision process between each stage organization (Edgett, 2015). The Goldsmith Commercialization Model is a tool in commercialization steps that can be used by every institute on developing a new product, while the Stage-Gate model is ideas to product launch mechanism that mostly used by private companies. R&D-C bridge model gives a research product commercialization flow, a commercialization mechanism for each research product category, and commercialization tasks division. That is what this R&D-C bridge model has its standing point and position.

5. Conclusion

Exploration process resulting in some findings that technology commercialization processes in R&D institutions are conducted in several ways: business incubation, community services, commercialization partnership, and policy paper implementation. It varies on each stakeholder domain.

Based on the hierarchical networking process, then a framework of research product commercialization was developed. Networking resources were generated from qualitative data that has been collected through an in-depth interview. The framework shows the process, constraints, mechanism, and product of technology commercialization. Those frameworks are generating a research product commercialization flow that is showing gaps/problems in the commercialization process.

An improved commercialization flow was generated through gaps and solutions arrangement. A new model of research product commercialization was built. Because this commercialization flow is bridging research into commercialization, the model is named with Research and Development Commercialization bridge (R&D-C Bridge) model then. As an improved bridge by filling holes in the existing process with solutions, this model can answer challenges and constraints on the technology commercialization process.

R&D-C bridge model is a research product commercialization flow model. The whole R&D-C flow process is mainly run by the R&D-C institute. It is an independent institute that developed on the R&D-C bridge model with the primary task on research product commercialization, and also as research to commercialization bridge. R&D-C institute act as a hub between the technology provider and technology receiver. Four commercialization models can be run by R&D-C institute: as a business incubator that producing technology for business, as community technology transfer institute that is producing technology for the community, as industrial/private partnership institute that is producing technology for industry/private, and government policy facilitator that generating technology for policy. Research idea source as a feedback point for the R&D flow process on research idea inspirations that come from commercialized product or customer problems generated in commercialization flow.

R&D-C bridge as a research product commercialization model has its position with other technology commercialization

concept. In the literature review, the technology park model is developing interconnection between stakeholders in the process of technology commercialization, or as a center of excellence and as a space for collaboration among academics, business, government, and community. R&D-C bridge model gives the technology commercialization flow process on interconnection among them, which was not mentioned in the technology park model. Technology parks and university incubators have a role in accelerating commercialization through some tasks. There is no explicit technology commercialization process flow on that, and technology parks are still conducting R&D activity too. R&D-C institute gives clear research product commercialization flow and also commercialization tasks division. This is what of research positioning on the result generated from this research. Comparing with another technology commercialization model, the R&D-C bridge model has its standing position.

The Goldsmith Commercialization Model is a tool in commercialization steps that can be used by every institute on developing a new product, while the Stage-Gate model is ideas to product launch mechanisms that mostly used by private companies. R&D-C bridge model gives a research product commercialization flow, a commercialization mechanism for each research product category, and commercialization tasks division. That is R&D-C bridge model has its standing point and position. It is found that the R&D-C bridge model is different from the existing technology commercialization model (Goldsmith and Stage-Gate). R&D-C bridge not only provides the guidance process like Goldsmith or Stage-Gate but also makes an integration relationship between institutes that related to research commercialization.

As the world is still developing research product commercialization through some concept and model, this research gives some insight into developing a new research product commercialization model. There is a lot of technology transfer institute that has already established in the world. Indonesia is using a technology park concept or commonly called as science and technology park (STP). An implementation of the R&D-C bridge model on the STP concept in Indonesia would help answer its constraints and challenges. R&D-C bridge model development and R&D-C institute concept implementation on Indonesia STP are expected can optimizing research product commercialization on stakeholder interconnection that has already developed in STP.

The development of the next research for R&D-C bridge model optimization is needed. Of course, this model needs to be tested. Action research would be fit for testing and developing this new model. Soft system methodology can be used to test this model and giving a picture before it is implemented. Action research in some STP cases is the best one on R&D-C bridge model implementation.

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