Conceptualizing a Seamless Model of Technology Transfer: Evidence from Public Research Institutes and Universities in Indonesia

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Abstract

Technology transfer (TT) is essential in transforming and mobilizing technological knowledge from public research institutes (PRIs) and universities into innovations. The concept of TT has become the center of scholarly attention since implementing the Bayh-Dole Act in 1980. In its progression, TT models and practices varied across organizations. The standard adopted model at Indonesian PRIs and universities is the dissemination model. This classic model is problematic yet suitable for technological knowledge production within these organizations. Consequently, TT performance could be better; only a few technologies were successfully commercialized and became innovations. Meanwhile, most research results ended as publications and new intellectual properties. Therefore, a new model needs to enhance the TT processes. This study uses a multiple-case study approach to conceptualize a "seamless" technology transfer model. This model provides a holistic view of processes and components of technology transfer in the dimensions of knowledge creation, diffusion, and absorption, which are intertwined. The model differs from the existing concept that segregates components in each dimension; it allows actors and determinants to be involved (or utilized) in multiple dimensions to cater to a better TT process.

Keywords: research and development; technology transfer; public research institutes; technology transfer; universities; seamless model of technology transfer

Citation: Hendrix T., Nasution S.Y., Ariyani L., Maulana S., Wicaksono A., Ferianto F. (2024) Conceptualizing a Seamless Model of Technology Transfer: Evidence from Public Research Institutes and Universities in Indonesia. *Foresight and STI Governance*, 18(1), pp. 46–57. DOI: 10.17323/2500-2597.2024.1.46.57

Introduction

Technology transfer (TT) is a peculiar phenomenon among countries, organizations, and individuals. It has drawn scholarly attention since the realization of the Bayh-Dole Act in 1980. At that time, the US government was concerned about the low utilization rate of their patents; among 28,000 patents, less than 5% were licensed to industries (USGAO, 1998). This act became the foundation of funded technology commercialization by universities, not-for-profits, and small businesses. The TT concept evolved into broad discourses in its progression, and scholars agreed that it could substantially benefit nations and organizations (Mansfield, 1975; Mayer, Blaas, 2002; Ramanathan, 2011). Through TT, research institutions can increase economic innovation and productivity, create jobs, and help overcome social problems (Zuniga, Correa, 2013). TT processes push R&D results into industrial innovation and create more value in society (Cohen et al., 2002).

Furthermore, various TT models have been produced over time, yet need more consensus on ideal implementation. The notable models are the Bar-Zakay model (Bar-Zakay, 1970; Ramanathan, 2011; Wahab et al., 2009) model, (2) "the appropriability model" (Devine et al., 1987; Gibson, Smilor, 1991), (3) "the dissemination model" (Rogers, Kincaid, 1981), (4) the "knowledge utilization model," (5) the (Gibson, Smilor, 1991) model, (6) the "contingent model" (Bozeman, 2000; Bozeman et al., 2014), and (7) the "interactive-recursive model" (Eckl, 2012). However, empirical evidence on implementing these models is still being determined.

Furthermore, the TT process focuses on commercializing R&D results from the academic staff and students in the university context. The process encompasses two paths, (1) dropping the discovery off at the technology transfer office (TTO) for acquiring licenses and (2) embarking on the entrepreneurial journey with a spin-off company (Nilsson et al., 2010). Meanwhile, in PRIs, licensing the technology through TTO became the most popular strategy to push the R&D results into innovation (Buenstorf, Geissler, 2012). Although the commercialization options between PRIs and universities differ, both entities have a similar pattern in the TT generic process.

As TT literature evolved, it became rich in the relevant country's characteristics. The production of knowledge regarding TT flows from developed countries into developing ones. The developing countries have different settings and provide vast opportunities to be explored for TT conceptualization. As one of the developing countries in Southeast Asia, Indonesia has some peculiar traits regarding TT processes at the PRIs and universities. Contemporarily, Indonesian PRIs and universities faced the same problem as the US in the 1980s, as most produced patents could not be commercialized. For example, among the 1,226 patents registered with the Indonesian Institute of Sciences (we now call National Research and Innovation Agency - BRIN), less than 2% have been commercialized (until the end of 2021). The most common technology transfer model these organizations adopt is the dissemination model. However, the application involves prominent actors such as the technology transfer office (TTO) and science-techno park (STP). This model relies on the supply push transfer direction, where the technology producer starts the transfer process to push the technology toward the market (Lane, 1999). This classic model needs to be revised as it makes PRIs underperforming in terms of commercialization (Choe, Ji, 2019). It is suitable for the nature of technology production of Indonesian PRIs and universities. Hence, there is an urgent need to renew the current model while adjusting to the nature of existing innovation processes.

Further, Indonesia has enacted Law No. 11 of 2019 concerning the National System of Science and Technology[1]. This law renews the structure of government science and technology-related agencies and integrates several PRIs into a single super body (BRIN). It also regulates the technology transfer process, yet it does less comprehensively. Thus, deficiencies need to be addressed by developing a model and mechanism of technology transfer and this study intends to investigate several models of technology transfer implementation at PRIs.

The Seamless TT model, when connected with many processes in Indonesia today, is one of the references that is based on the processes carried out at each PRI and university. The TT process's essence is based on research and development results. If the Seamless TT model is used, it will be an effective formulation as it considers several descriptions of each process, all of which are needed and interconnected. Generally, the processes carried out at PRIs and universities have various characteristics and factors, each part of an integrated and interdependent process in Indonesia. These TT practices have been repeatedly tested by referring to the characteristics and patterns of the sequence of processes adapted to the implementation in each place, no matter the principles. On the other hand, the TT Seamless model process has been adjusted to the conditions of technology empowerment, human resources, research and development products, product and technology users, and applicable policies and regulations so that the application of this model takes into account the conditions and situation in Indonesia and considers existing market needs.

Literature Study

Technology transfer is a process of the transmission or movement of knowledge (sometimes followed by physical infrastructure). It is intended for the use, further development, or commercialization by other parties, be it

[1] https://ap.fftc.org.tw/article/1589, accessed 17.06.2023.

between parties within the same organization, those at different organizations, or even between parties in different countries (Halili, 2020; Lavoie, Daim, 2020).

Technology transfer has six stages: "technology innovation, technology confirmation, targeting technology consumers, technology marketing, technology application, technology evaluation" (Risdon, 1992). Each stage involves several activities. For example, in technology development, activities begin with finding financial support, conducting research, discovering new technologies, protecting intellectual property, and appraising the technology. In the technology utilization stage, activities are continued with prototyping, finding counterparts, manufacturing, marketing, and others. The final stage, the return of benefits, involves distributing financial benefits (Asmoro, 2017).

Technology Production at PRIs and Universities

Public research institutes have become substantial sources of today's innovations, regardless of their numerous underutilized inventions and R&D results. Among those great inventions, only a few innovations with significant value became widely known. Commercializing these inventions is complex and difficult, as most are not market-ready products (Buenstorf, Geissler, 2012). In addition, developing commercial products from inventions and pushing them onto the marketplace is separate from scientists' regular jobs. Thus, it is common for PRIs to establish a technology licensing office (TLO) or technology transfer office (TTO) to do the job. The TTO has a dynamic relationship with the PRI and firms, acting as an intermediary between these entities (Min et al., 2020).

Conversely, professors and their students are the producers of innovations at universities. Their ideation processes are more fluid than those at PRIs. A university's commercialization path diverges into two streams, (1) outward licensing and (2) establishing spin-off companies. Public-private partnerships, open science initiatives, and entrepreneurial channels, such as student-based start-ups and related financing and mobility schemes, have complemented these paths.

Technology Transfer Model

The need to develop a technology transfer model arises from the recognition among researchers that technology transfer is naturally a complex matter (Garbuz, Topală, 2021; Necoechea-Mondragón et al., 2013). The early development of technology transfer models dates back to the end of World War II (Wahab et al., 2009). The Appropriability Model (AM) was developed from 1945 to the 1950s and stressed the quality of the research or technology and competitive market pressures to ensure the technology transfer (Gibson, Smilor, 1991).

The study of technology transfer models continued to expand along with the development of the Dissemination Model (DM) from 1960 to the 1970s, focusing on the diffusion of a technology from the experts to the willing user (Gibson, Smilor, 1991; Hamdan et al., 2018). According to Gibson and Smilor (1991), the model assumes that the technology transfer will effortlessly occur once the linkages between experts and users are established.

In 1971 another model called The Bar-Zakay Model (BZM) was introduced (Ramanathan, 2011). It describes several stages in technology transfer processes, including search, adaptation, implementation, and maintenance, which require an evaluation and joint decision between the sender and receiver to continue the transfer processes (Bar-Zakay, 1970; Steenhuis, Bruijn, 2005).

The progression continued to the late 1980s during the introduction of the Knowledge Utilization Model (KUM), which was the first to focus on the communication and mechanism of technology transfer (Gibson, Smilor, 1991; Hamdan et al., 2018). It raises two issues as the focal points in managing the technology transfer risks of communication, such as 1) the prominent role of interpersonal communication between researchers and users; and 2) the importance of identifying organizational barriers and facilitators of technology transfer (Lee, Shvetsova, 2019).

Furthermore, Gibson and Smilor's Model (GSM), introduced in 1991, presents the three-level prism to describe the technology transfer processes (Gibson, Smilor, 1991), such as the technological development process, the technology acceptance process, and technology application.

Additionally, Bozeman (2000) first proposed his Contingent Effectiveness Model (CEM) of Technology Transfer, which was further developed in 2015 by Bozeman et al. (2014). It emphasizes two important aspects, including 1) the determinants of technology transfer and 2) the criteria of technology transfer effectiveness (Arenas, González, 2018).

Finally, Eckl (2012) introduced the Interactive-Recursive Model of Knowledge Transfer (IRM), which was developed based on (Gibson, Rogers, 1994; Bozeman, 2000). This model describes knowledge transfer as a complex interactive, non-linear, and possibly recursive process consisting of three fundamental dimensions: knowledge creation; knowledge diffusion; and knowledge absorption (Eckl, 2012). Eckl (2012) structures the respective dimension with the processes, the involved actors, and the determinant factors of technology transfer.

Actors in Technology Transfers

Technology transfer is a process that includes actors from both public and private entities (Van Horne, Dutot, 2017). The interaction between and among the involved actors (Schiavone et al., 2014) and their roles (Flipse et al., 2014) will also determine the success of technology transfers. The actors in technology transfers perform their respective roles to ensure continuity in techonological implementation. Actors involved in the technology transfer process include advisory boards

(Weber, 2017), selectors (Min et al., 2020), intermediaries (Tunca, Kanat, 2019), and regulators (Alaassar et al., 2020). First, the advisory board determines the Key Performance Indicators (KPI). It provides directions that will impact the produced results. Furthermore, the advisory board is one of the important actors in forming an innovation ecosystem and technology transfer process in developing technology-based start-up companies (Weber, 2017). Policies made by the advisory board can be in the form of programs or strategies for technology development, thereby facilitating technology transfer activities (Chen et al., 2010).

Moreover, the role of the selector is to carry out the process of selecting and assessing the readiness of a technology to be developed and applied in the industrial world. This selection process is adjusted to the possibility of achieving the set targets and has to look at the technological and economic aspects. Developing a business and providing economic benefits is feasible (Min et al., 2020). The advisory board and selector actors are the main key actors in achieving the success of the TT process at R&D institutions involving PRIs and universities in Indonesia.

The third actor is the intermediary organization that can facilitate the flow of technology between the research organization or university and industry. The intermediaries are organizations active through all stages of technology transfer and mainly face the challenge of retaining partners (Van Horne, Dutot, 2017). The Technology Transfer Office's (TTO) activities often reflect its role as an intermediary organization in supporting technology transfer from technology-producing agencies to user partners. The TTO plays a vital role in forming an innovation ecosystem and is an actor that accelerates the spin-off process for new companies and the implementation of a technology. The TTO encourages incubation activities and facilitates cooperation agreements on the use of technology as a know-how development process (Tunca, Kanat, 2019).

Furthermore, the regulator is also one of the other actors with a vital role where policies are produced both from the agency and a higher (national) level. The policy made by this regulator will impact the development of the innovation ecosystem and the technology transfer process. The government acts in the policymaking and grant process stage and has to balance the needs of all parties to start the technology transfer (Van Horne, Dutot, 2017). Regulators need to see actual conditions in the field and pay attention to inputs from various parties and experts (social interaction) to determine policies supporting the development of an innovation ecosystem in Indonesia (Alaassar et al., 2020).

These four actors in the technology transfer process will create a non-linear model of innovation based on the relationships between the actors. The linkage between actors is needed so that the technology transfer process follows user needs, not only the interests of certain parties. The actors within each contribution have developed their structure and work cooperatively to facilitate technology transfer (Chen et al., 2010). Each actor does not have to contribute to the performance of other actors but only needs to carry out their duties according to their capacity and authority. The involvement of these parties will later make the innovation ecosystem work properly and be mutually sustainable to build an effective innovation system (Wonglimpiyarat, 2016).

Methodology

This study uses a multiple case study method with a comparative design based on the constructivism paradigm (Eisenhardt, 1989). The case study process includes (1) case selection based on PRIs and universities that have technology transfer offices/units, (2) data collection through in-depth interviews with managers from five PRIs and four universities that have carried out technology licensing, (3) data analysis that includes categorization, preparation of thick descriptions for each case, and the examination of patterns between cases in order to find the emerging trends and synthesize it into a new TT model, (4) validation of findings through triangulation, pattern matching (based on data saturation), and comparing with existing literature. This research uses the interactive-recursive technology transfer model developed by (Eckl, 2012) as the analytical framework. The model describes technology transfer as three related processes, including (1) knowledge creation (KC), (2) knowledge diffusion (KD), and (3) knowledge absorption (KA).

Technology Transfer (TT) in Indonesia: General Overview

TT in Indonesia refers to transferring knowledge, skills, and technology from research institutions to businesses, organizations, and the wider community for commercialization and social benefit. The Indonesian government has recognized the importance of technology transfer and has taken steps to support it.

The concept of TT in Indonesia includes various aspects such as identifying and selecting technologies with potential commercial value, protecting intellectual property rights, negotiating license agreements, providing technical assistance, and supporting commercialization efforts.

The Indonesian government has created several regulations to support technology transfer in Indonesia.[2] The government has issued guidance on patent man-

[2] Including Patent Law No. 13 of 2016 (https://www.wipo.int/wipolex/en/legislation/details/16392, accessed 17.06.2023), Trademark and Geographical Indication Law No. 20 of 2016 (https://www.wipo.int/wipolex/en/legislation/details/16513, accessed 17.06.2023) and Regulation No. 45 of 2016 (https://www.tilleke.com/print-insight/?post_id=36945, accessed 17.06.2023).

agement and trademark rights in the context of TT. In this provision, TT can only be done through a license contract between the technology owner (licensor) and the technology recipient (licensee). The license agreement must be made in writing and registered with the National Office of Intellectual Property.

This policy also stipulates the principles of remuneration in the TT process. The licensee must indemnify the licensor for the use of the technology. Compensation must be in the form of royalties or other payments, and it must be based on the value of the technology. During the know-how transfer, the licensor must transfer the know-how and provide technical support to the licensee to ensure that the technology is properly used and maintained.

Indonesia also has made various efforts to facilitate technology transfer, such as establishing technology incubators and science parks, funding research and development, and promoting partnerships between research institutes, industry, and the government. Overall, the concept of TT in Indonesia focuses on promoting innovation, increasing competitiveness, and generating economic growth through the development and commercialization of new technologies.

Technology Transfer at PRIs

KC Process

The multiple case study results at PRIs indicate two significant patterns in the knowledge creation processes (see Table 1). First, the typical internal knowledge production process derives from top-down research policy at research centers (RCs), resulting in a pool of technology that pushes into the next commercialization phase. Second is R&D collaboration, which rarely occurs due to specific conditions or incentives.

The first pattern starts with determining the research foci in each research center based on national policy. Then, research groups generate ideas based on their expertise and interest. The submitted ideas will be selected based on the quality of the idea and their relevance. Selected ideas will be executed within an annual timeline to generate knowledge in publications and intellectual properties (IP). Researchers drive these processes' key performance indicators (KPI) and funding.

The second pattern only happened in some research centers which conducted applied research and frequently had R&D collaboration. The researchers in these research centers have established a more personal relationship with their industry counterparts. Hence, the collaborative knowledge creation started with informal discussions among them. In some cases, these collaborations lead to a very successful innovation process. On the other side, such collaboration is hard to establish in research centers with basic science and a lack of experience in working with industries.

KD Process

Based on our investigation, the TTO became a standard unit that led the diffusion process at PRIs. The process starts with (1) readiness selection, (2) IP registration, (3) valuation, (4) development, (5) promotion, and ends with a signed (6) contract of license. This process often goes back and forth and can skip between TTO, research centers (or researchers), and industry counterparts. For example, in the process of readiness selection, the TTO will conduct due diligence regarding R&D results that are being 'pushed' from the research centers. They use a readiness selection framework such as technology readiness level (TRL) to assess the R&D results.

KA Process

Absorption concepts involve the actors in Academics-Business-Government (Triple Helix ABG). The absorption of knowledge and technology from existing actors depends on the success rate of the diffusion of existing knowledge and technology. The absorption level of knowledge and technology can accelerate the process of adoption, diffusion, and the achievement of collaboration in technology transfer.

In addition, this absorption rate influences the determination of the potentially applicable technologies, the potential to generate licenses and royalties or other incentives for inventors and innovators, the potential for spin-offs of the new technology-based companies, and the potential for spin-offs of the new technology-based companies' determination of the potential for sustainable collaboration. Regulatory support and competency improvement based on market needs. The process of absorption of knowledge and technology is also strongly influenced by the behavior of the involved actors (Erosa, 2012). The entire process of technology transfer in PRIs has been summarized in Table 1.

Technology Transfer at Universities

KC Process

According to a comparison of four universities' technology transfer cases, several notable results can be highlighted. The knowledge creation processes are mainly based on the lecturers' research interests in line with the university's vision. The submitted research ideas that are successfully selected could continue to the development stage. This development process usually involves lecturers and students across departments or faculties. In some cases, it also involves an industrial partner.

The involvement of partners during the knowledge creation process is relatively minimal. In some cases, it increases the success rate of the invention since the product market has been identified from the beginning. However, we found that one university (UNI-2) started initiating an Ideation Forum to explore the needs of industrial partners as guidance to formulate R&D ideas.

Similar to PRIs' cases, KPIs and funding also play a prominent role in the knowledge creation process within universities. KPIs make the inventor more focused on the invention quantity while paying less attention to quality. Meanwhile, funding availability is crucial for the sustainability of the R&D program, especially for a long-term development project.

KD Process

Similar to PRIs, the TTOs at universities also play a significant role in the diffusion process. At the beginning of the diffusion process, they are responsible for assessing the readiness of the available inventions. This process is usually also carried out together with experts in related fields. The invention with six readiness levels is prepared for the IP protection and promotion stage. The inventions that have obtained partners will continue in the contract management process.

As the processes are facilitated by the TTO, having a qualified TTO is essential for the success of the diffusion process. They should possess sufficient skills and competencies, such as marketing, negotiation, and technology valuation skills.

KA Process

The implementation of the process of absorbing knowledge and technology through formal and informal interactions, both internal and external, where the innovative research and development results have high commercial value and are attached to user needs. The absorption process through several mechanisms, such as licensing, start-ups, and joint operations, takes place as well. This process includes industries, internal business units, and start-ups. The process of technology absorption is characterized by prospective industry partners already involved upstream, from ideas to

Table 1. **Summary of Process TTs Connected to Seamless Models in PRIs**

Samples	Process	Actor	Determinant
	KC		
PRIs-1	Priority Setting, Ideation, Execution, IP Registration, Valuation, Promotion, Contract.	Inventor, Intermediary, Internal Developer, Assessor, Partner.	KPI, Funding, Readiness, IP, Market, Engagement.
PRIs-2	Priority Setting, Ideation, Selection, Pilot Development, Value Capture.	Advisory Board, Inventor, Assessor, Partner.	Policy, KPI, Readiness, Market, Engagement.
PRIs-3	Priority Setting, Ideation, Selection, Readiness Selection, Valuation, Market Discovery.	Selector, Inventor, Intermediary, Internal Developer.	KPI, Readiness, Market, Engagement.
PRIs-4	Ideation, selection, Execution, Valuation, Acquisition, Market Discovery, Value Capture.	Inventor, Intermediary, Partner.	Funding, Readiness, IP, Competence, engagement.
PRIs-5	Priority Setting, Ideation, Acquisition, Value Capture.	Advisory Board, Inventor, Intermediary, Partner.	Readiness, IP, Market, Engagement.
	KD		
PRIs-1	Ideation, Selection, Valuation, Pilot Development, Market Discovery,	Inventor, Intermediary, Partner.	Funding, Readiness, IP, Market, Engagement.
PRIs-2	IP Registration, Execution, Valuation, Co-Development.	Advisory Board, Inventor, Intermediary, Partner.	Readiness, IP, Digital Media, Market, Engagement.
PRIs-3	Selection, Execution, Readiness Selection, IP Registration, Pilot Development, Market Discovery.	Inventor, Intermediary, Internal Developer, Partner.	Readiness, IP, Digital Media, Market, Engagement.
PRIs-4	Ideation, Readiness Selection, Execution, IP Registration, Co-Development, Market Discovery.	Intermediary, Internal Developer, Partner.	Funding, Readiness, Human Resource, Market, Engagement.
PRIs-5	Execution, Readiness Selection, IP Registration, Valuation, Promotion.	Inventor, Intermediary, Partner.	Digital Media, Market, Engagement.
	KA		
PRIs-1	Ideation, Selection, Execution, Pilot Development, Market Discovery.	Inventor, Intermediary, Partner.	Readiness, Human Resource, Competence, Engagement.
PRIs-2	Execution, Readiness Selection, Acquisition, Co-Development,	Selector, Inventor, Intermediary, Internal Developer, Partner.	Market, Competence, Engagement.
PRIs-3	Execution, Readiness Selection, Promotion, Co-Development, Value Capture.	Inventor, Intermediary, Partner.	Policy, Human Resource, Competence, Engagement.
PRIs-4	Valuation, Pilot development, Contract, Acquisition.	Intermediary, Partner.	Readiness, IP, Human Resource, Market.
PRIs-5	Priority Setting, Execution, Pilot Development, Market Discovery.	Intermediary, Partner.	Readiness, Funding, IP, Market.

Source: authors.

the implementation of research. The entire technology transfer process at universities has been summarized in Table 2.

Involvement of Actors and Determining Factors

Based on the elaboration of the aforementioned cases, we identified several important actors and their involvement in every technology transfer process, as shown in Table 3. According to Table 3, each stage of the technology transfer process mostly requires involvement of multiple actors. Therefore, collaborations among these actors are essential to ensure the effectiveness of the technology transfer. Moreover, each should also be involved in several different processes, regardless of its knowledge dimensions and where the process belongs. This finding is relatively dissimilar when compared with the proposition presented by Eckl (2012) in the Interactive-Recursive Technology Transfer Model.

Our contrasting finding shows that actor A3 (inventors), the key actor in the knowledge creation dimension, should also remain involved in the diffusion and absorption processes. Similarly, actor A4 (intermediaries) plays a significant role in knowledge diffusion. Moreover, they need to be involved in processes within other dimensions, such as in the process P2 (ideation), to become partners for inventors to provide input related to technological developments and the latest market needs.

Furthermore, our study also identifies the determining factors that need to be considered in each technology transfer process, as shown in Table 4. Meanwhile, as in the process-actor relationship, the process-determinant mapping also shows findings quite different from those presented in the Interactive-Recursive Model by Eckl (2012). This study found that the determining factors can be essential in different technology transfer processes and knowledge dimensions.

Model Conceptualization

The authors propose the Seamless Technology Transfer Model, which describes the technology transfer models at R&D entities governing the achievement in technology collaboration/licensing utilized by users (stakeholders). This model focuses on the need for special attention by involving various actors in the transition process between (1) the process of knowledge creation toward knowledge diffusion, (2) the process of knowledge diffusion toward knowledge absorption, and (3) the process of knowledge absorption toward the next knowledge creation.

The 'seamless' model holistically explains where the dimensions of knowledge creation, knowledge diffusion, and knowledge absorption are closely related. First, the transition process when assessing applicability after a piece of knowledge/technology is generated requires the direct involvement of researchers, intermediaries, and assessors. That in turn requires researchers to understand field conditions better when their research results are applied by direct users, supported by intermediaries and assessors to assess the possibility/success of the technology being applied. Second, the technology acquisition process after the licensing cooperation agreement is created due to the technology diffusion process. In this transition process, it is necessary to involve inventors, intermediaries, internal developers, and industry partners. The third is the transition process for determining the priorities of subsequent research. After the technology is successfully absorbed and exploited, industry partners may have input for further research as a form of refinement or meeting other new technology needs.

Repetition can occur in every component of the process in each dimension, wherein several stages (at least two) allow for it. After the knowledge absorption process succeeds (or fails), input is generated for iteration in the priority-setting process. The process is described in a streamlined and sequential manner, but a reversal can also occur if a failure or obstacle occurs at a particular stage.

There are 14 processes, nine actors, and ten determinants depicted in this model. In contrast to the Interactive-Recursive Model (Eckl, 2012), which separates the components in each dimension, this model provides flexible constraints on the actor and determinant components. So several actors can play a role in several processes in different dimensions. Likewise, the determinant component can affect several processes in different dimensions. The seamless model of technology transfer is shown in Figure 1.

Discussion

The Comparison Between Eckl's Model and the Seamless Model for Technology Transfer

The new model was developed by translating the stages of implementing technology transfer into either knowledge creation, diffusion, or adsorption, which are adapted to field conditions from each R&D entity. The primary factors of knowledge transfer are determined by the interactions of knowledge creators, knowledge disseminators, and knowledge consumers. Key stakeholder groups in each dimension are critical for the success or failure of knowledge transfer. The outputs or outcomes of their actions in each dimension produce the determinants of knowledge transfer, which center attention on the analysis of the transfer process.

The interpretation of the recursive interactive technology transfer model includes the transformation of the three basic dimensions of knowledge transfer to reveal the related characteristics of the knowledge transfer process. Moreover, it should not be considered a uni-

Table 2. **Summary of Process TT Connected to Seamless Models in Universities**

Samples	Process	Actor	Determinant
KC			
UNI-1	Ideation, Selection, Execution.	Inventor, Intermediary, Internal Developer, Assessor, Partner.	Market, Funding, IP, Engagement.
UNI-2	Ideation, Selection, Execution, Readiness Selection, Valuation, Market Discovery,	Advisory Board, Inventor, Intermediary, Partner.	Policy, Readiness, IP, Market, Engagement.
UNI-3	Priority Setting, Ideation, Execution, Market Discovery.	Advisory Board, Inventor, Intermediary, Partner.	KPI, Funding, Readiness, IP, Market, Engagement.
UNI-4	Ideation, Selection, Execution, Valuation, Promotion.	Advisory Board, Selector, Inventor, Intermediary, Internal Developer, Partner.	KPI, Funding, IP, Market, Competence.
KD			
UNI-1	Readiness selection, IP Registration, Valuation, Pilot Development, Promotion, Contract, Acquisition.	Advisory Board, Selector, Inventor, Intermediary, Assessor, Partner.	Readiness, Human Resource, Market, Competence, Engagement.
UNI-2	Ideation, Execution, IP Registration, Pilot Development, Contract, Acquisition.	Selector, Inventor, Intermediary, Internal Developer, Partner.	KPI, Funding, Readiness, IP, Market, Engagement.
UNI-3	Ideation, Selection, Execution, IP Registration, Contract, Acquisition.	Advisory Board, Selector, Inventor, Intermediary, Assessor, Partner	KPI, Funding, Readiness, IP, Market, Competence, Engagement.
UNI-4	Ideation, Selection, Readiness Selection, IP Registration, Valuation, Promotion, Contract	Advisory Board, Selector, Inventor, Intermediary, Co-developer.	Policy, Funding, Readiness, IP, Market, Competence, Engagement.
KA			
UNI-1	Execution, Readiness Selection, IP Registration, Valuation, Contract, Acquisition.	Inventor, Intermediary, Internal Developer, Assessor, Partner.	Readiness, IP, Market, Engagement
UNI-2	Ideation, Execution, Pilot Development, Acquisition, Value Capture.	Inventor, Intermediary, Internal Developer, Partner.	Funding, Readiness, IP, Market, Competence, Engagement.
UNI-3	Priority Setting, Ideation, Execution, IP Registration, Valuation, Contract, Acquisition.	Inventor, Intermediary, Internal Developer, Assessor, Partner, Co-developer.	Policy, KPI, Funding, Readiness, Human Resource, Market, Engagement.
UNI-4	Priority Setting, Ideation, Selection, Execution, Value Capture.	Inventor, Intermediary, Internal Developer, Partner, Co-developer.	Policy, Funding, Readiness, Human Resource, Market, Engagement.

Source: authors.

directional sequence but should be understood non-linearly and recursively since it has no real beginning or end. It does not begin with knowledge generation or end with its use. It is not be equivalent to a linear motion, as had been prevalent for a long time (Wahab et al., 2009).

From the synthesis and interpretation of the data obtained, several stages can be used as derivative elements of the model proposed by Eckl (2012). Furthermore, it is a new concept generated from field findings by looking in a structured manner at what factors can affect the governance model of technology transfer at R&D entities in Indonesia and used as a reference in the management of technology transfer, especially in Indonesia.

The evolution of this derivative model from Eckl (2012) is a new model that illustrates the stages of technology transfer implementation by looking at the elements of Knowledge Creation, Knowledge Diffusion, and Knowledge Adsorption adapted to the field conditions of each R&D entity. It presents the formation of three fundamental dimensions and has the advantage of combining the benefits of a the now obsolete linear model with the epistemological requirements of a recursive model by describing the process of knowledge transfer without linear biases. The interactions of knowledge creators, knowledge spreaders, and knowledge consumers determine the primary factors of knowledge transfer. The output or outcome of their actions in each dimension determines the factor of knowledge transfer that is at the center of attention in the analysis of the transfer process. For the success or failure of knowledge transfer, a key stakeholder group in each dimension is essential.

The "seamless" model holistically describes where knowledge creation, diffusion, and absorption are closely related. It has several similarities and differences from the model upon which it is based. The seamless model focuses on the need for special attention on the involvement of various actors in the transition process between (1) the process of knowledge creation to the diffusion of knowledge, (2) the process of diffusion toward absorption, and (3) the process of absorption toward creation. Processes can be described in a streamlined manner and sequentially, but there can also be reversals in the event of failure or resistance at some stage. In contrast to the Interactive-Recursive Model, this model removes barriers between dimensions so that actors can have several roles in creating, diffusing, and absorbing knowledge.

Table 3. **Actor's Involvement in Technology Transfer Processes**

Process	Participant								
	A1	A2	A3	A4	A5	A6	A7	A8	A9
P1	√		√						√
P2			√	√			√		
P3		√							
P4			√				√		
P5				√		√			
P6			√	√					
P7				√		√			
P8			√	√	√		√		
P9			√	√					
P10				√			√		
P11			√	√			√		
P12			√	√				√	
P13				√			√		√
P14				√		√			

Source: authors.

Note:

Process

P1 – Priority setting
P2 – Ideation
P3 – Selection
P4 – Execution (collaboration)
P5 – Readiness selection
P6 – IP registration
P7 – Valuation
P8 – Pilot development
P9 – Promotion
P10 – Contract
P11 – Acquisition
P12 – Co-development
P13 – Market discovery
P14 – Value Capture

Participant

A1 – Advisory Board
A2 – Selector
A3 – Inventor
A4 – Intermediarist
A5 – Internal developer
A6 – Assessor
A7 – Partner
A8 – Co-developer
A9 – Regulator

Table 4. **Determinant Factors of Technology Transfer Processes**

Process	Determinant									
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
P1	√	√	√							
P2		√	√							
P3		√	√							
P4		√	√	√	√		√		√	
P5				√	√	√		√	√	
P6					√		√			
P7				√	√	√	√		√	
P8		√	√	√	√		√		√	
P9			√	√	√	√	√		√	
P10				√	√					√
P11			√		√		√		√	
P12		√	√		√		√	√	√	√
P13	√					√	√	√	√	√
P14	√							√		√

Source: authors.

Note:

Determinant

D1 – Policy
D2 – Key Performance Indicators (KPI)
D3 – Funding
D4 – Readiness
D5 – Intellectual Property (IP)
D6 – Digital media
D7 – Human resource
D8 – Market
D9 – Competence
D10 – Engagement

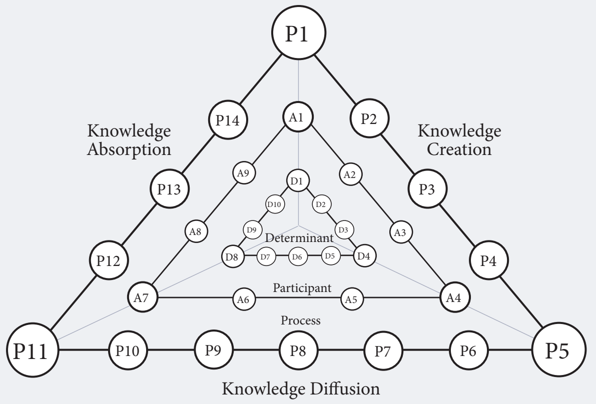
The Comparison between the Seamless Model and Other Models in Technology Transfers

This section compares the seamless technology transfer model with several previous models, mechanisms, processes, actors, and determinants. The technological context in our proposed model corresponds to the idea that technology transfer does not only manifest the physical artifacts of technology as described in most traditional models such as AM, DM, and KUM. However, it also incorporates the movement of know-how and technical knowledge from one organization to another, as in Bozeman (2000) and endorsed by Eckl (2012).

Several possible transfer mechanisms have been revealed in various studies, which Arenas and Gonzalez (2018) have summarized into two categories, i.e., formal and informal. In line with (Arenas, González, 2018; Mendoza, Sanchez, 2018), this research accentuates the formal mechanisms, especially license agreements through which patents or prototypes and joint ventures are created. We do not consider informal mechanisms such as talent recruitment, paper presentations, and informal discussions as do (Arenas, Gonzalez, 2018) in our model. However, such activities might occur across PRIs and universities. Furthermore, according to the Indonesian context, the formal mechanisms still require considerable interventions to yield significant impacts in encouraging national economic development.

Furthermore, the seamless model strives to more clearly illustrate the complex processes within technology transfers compared to the previous traditional models. The traditional models express the technology transfer process as linear, easily understandable, and effortlessly applicable, regardless of the current situation (Bustamante et al., 2021). For example, the AM only emphasizes the need to develop high-quality technology and ensure that the technology transfer will occur spontaneously. Technology transfers can be conducted without deliberate attempts within AM since the suitable technologies sell themselves (Gibson, Smilor, 1991; Hamdan et al., 2018; Wahab et al., 2009). The same is true for DM and KUM. According to Gibson, Smilor (1991), DM and KUM consider technology transfers to be merely simple, unidirectional, and unilateral technology movements from experts to users. There are a series of essential processes to deter-

Figure 1. **Knowledge creation, diffusion, and absorption process in Seamless Technology Transfer Model**



Note:

Process	Participant	Determinant
P1 – Priority setting	A1 – Advisory Board	D1 – Policy
P2 – Ideation	A2 – Selector	D2 – Key Performance Indicators (KPI)
P3 – Selection	A3 – Inventor	D3 – Funding
P4 – Execution (collaboration)	A4 – Intermediarist	D4 – Readiness
P5 – Readiness selection	A5 – Internal developer	D5 – Intellectual Property (IP)
P6 – IP registration	A6 – Assessor	D6 – Digital media
P7 – Valuation	A7 – Partner	D7 – Human resource
P8 – Pilot development	A8 – Co-developer	D8 – Market
P9 – Promotion	A9 – Regulator	D9 – Competence
P10 – Contract		D10 – Engagement
P11 – Acquisition		
P12 – Co-development		
P13 – Market discovery		
P14 – Value Capture		

Source: Author's Interpretation of the Seamless Model for Technology Transfer.

mine the R&D focus according to the user and market needs, protect and promote well-developed technologies, and maintain good relationships with potential users. Therefore, the seamless model attempts to describe the dimensions of KC, KD, and KA in several detailed stages, starting from priority setting activities and encompassing end consumption.

Unlike most traditional models (e.g., AM, DM, and KUM) and BZM, which suggest two key actors (i.e., transferor and transferee), we enrich our model by involving several important actors. We aim to adapt to the complex processes of technology transfer where many stakeholders are involved and are responsible for determining its success.

Furthermore, as their communications are established, the two above actors play a relatively passive role in technology transfers. Even though DM suggests the importance of link between transferors and transferees, this relationship is quite unilateral and lacks user involvement in technological development. AM even puts forward the passive role of the transferors who only need to publish their research results through passive media such as research articles (Gibson, Smilor, 1991). The BZM concept seems different in that the interactions between the two actors already exist. Ramanathan (2011) stated that they should be involved in the collaborative decision process at every stage of the technology transfer.

Meanwhile, the seamless model refers to these actors as inventors and partners. They contrast with the actors described in AM and DM, while in line with BZM, our model suggests that inventors and partners, along with other actors, play an active role as they can be involved and responsible for accomplishing the same stage within the technology transfer process. In addition, the term 'partners' refers to the fact that they are not solely involved in the downstream as the recipients of R&D results but are supposed to be involved in the initial project and the research funding collaboration.

Moreover, several studies have mentioned the need for complementary actors in technology transfer, such as TTOs and policymakers (Arenas, González, 2018). We postulate the role of intermediaries, which have similar responsibilities as a TTO. As for the policymakers, we describe them as the advisory boards responsible impacting the business environment and playing a role at the national level.

Our model also proposes several determining factors for a successful technology transfer. That is in line with the concept of KUM, which was the first model attempting to understand the factors and sub-factors that influence the technology transfer process (Hamdan et al., 2018). Another model, as the CEM, highlights these environmental factors, which Bozeman (2000) refers to as the effectiveness criteria.

Conclusion

Technology plays a significant role in supporting national economic growth. Technology transfers began to impact the performance and productivity of the industrial sector as the commercialization of innovation began to meet market needs. The role of technology transfer in supporting product commercialization depends on sectors that have strategic value derived from equipment, skills, knowledge, processes, and practices. By encouraging technology transfers, national strategies can be reinforced and relationships between key actors and consumers can be developed.

The "Seamless" Technology Transfer Model describes a governance model within R&D. It holistically illustrates how the dimensions of knowledge creation, knowledge diffusion, and knowledge absorption are closely related. This model focuses on the need for particular attention to the involvement of various actors in the transitions between:

1. Knowledge creation moving toward diffusion,
2. Knowledge diffusion toward absorption
3. The move from knowledge absorption toward the creation of new knowledge.

Unlike the Interactive-Recursive Model, this model eliminates the barrier between dimensions so that actors can play several roles in creating, diffusing, and absorbing knowledge. Some key actors (inventors, intermediaries, and industry partners) can be involved in several processes in all three dimensions. As with actors, some determinants can strongly influence technology transfer processes in all three dimensions. To be able to implement this model, a radical enough strategy is needed to be able to strengthen the linkage between technology transfer actors, especially at R&D entities, namely:

1. Changing the concept of inventor KPIs that rely on individual performance to publish or create IP into a more collaborative team KPI concept oriented toward the creation of innovations;
2. Involving inventors and partners (industry partners) in every dimension of technology transfer (knowledge creation, knowledge diffusion, knowledge absorption) so that research and development is determined based on industry- or market-driven needs;
3. Increase the competence of intermediaries to build networks (with inventors, partners, and government institutions) and commercialize knowledge;
4. Provide funding for the development process (internal development and co-development with partners) to increase the preparedness of inventions that still have a high risk of failure so that they can be adopted and mass-produced by industry partners;
5. Digital media is needed to exchange information related to technology development and connect the relevant actors.

In the context of using the seamless technology transfer model in Indonesia, it is highly recommended to accelerate the use of products derived from research and development. This model has been adapted to the TT process patterns and encompasses the best practices carried out by PRIs and universities.

Regarding future research, the role of current and former key actors in technology transfers linking the exploitation and possible commercialization of new knowledge, particularly at PRIs and universities remains unexplored. Acknowledging this role and understanding the driving factors and the main barriers could prove a particularly fruitful direction for future research.

References

Alaassar A., Mention A.L., Aas T.H. (2020) Exploring How Social Interactions Influence Regulators and Innovators: The Case of Regulatory Sandboxes. *Technological Forecasting and Social Change*, 160, 120257. https://doi.org/10.1016/j.techfore.2020.120257

Arenas J.J., González D. (2018) Technology Transfer Models and Elements in the University-Industry Collaboration. *Journal Administrative Sciences*, 8(2), 1–17. https://doi.org/10.3390/admsci8020019

Asmoro P.K. (2017) Technology Transfer in Indonesian State Universities: Do IPRs Play a Significant Role? *Journal Indonesia Law Review,* 7(1), 49–78. https://doi.org/10.15742/ilrev.v7n1.291

Bar-Zakay S.N. (1970) Technology Transfer Model. *Technological Forecasting and Social Change*, 2(3–4), 321–337. https://doi.org/10.1016/0040-1625(71)90009-6

Bozeman B. (2000) Technology Transfer and Public Policy: A Review of Research and Theory. *Research Policy,* 29(4–5), 627–655. https://doi.org/10.1016/S0048-7333(99)00093-1

Bozeman B., Rimes H., Youtie J. (2014) The Evolving State-of-The-Art in Technology Transfer Research: Revisiting the Contingent Effectiveness Model. *Research Policy,* 44(1), 34–49. https://doi.org/10.1016/j.respol.2014.06.008

Buenstorf G., Geissler M. (2012) Not Invented Here: Technology Licensing, Knowledge Transfer and Innovation Based on Public Research. *Journal of Evolutionary Economics*, 22(3), 481–511. https://doi.org/10.1007/978-3-319-01496-8_5

Bustamante A.T., Velasco A.M., Fernández A.M.L. (2021) University–Industry collaboration: A Sustainable Technology Transfer Model. *Journal Administrative Sciences,* 11(4), 1040142. https://doi.org/10.3390/admsci11040142

Chen J.K.C., Chiu W.H., Kong S.F.L., Lin L.Y.T. (2010) Evaluating Global Technology Transfer Research Performance. In: *2010 7th International Conference on Service Systems and Service Management, Proceedings of ICSSSM' 10, July*, pp. 361–366. https://doi.org/10.1109/ICSSSM.2010.5530213

Choe W.J., Ji I. (2019) The Performance of Supply-Push Versus Demand-Pull Technology Transfer and the Role of Technology Marketing Strategies: The Case of A Korean Public Research Institute. *Sustainability,* 11(7), 1–18. https://doi.org/10.3390/su11072005

Cohen W.M., Nelson R.R., Walsh J.P. (2002) Links and Impacts: The Influence of Public Research on Industrial R&D. *Management Science,* 48(1), 1–23. https://doi.org/10.1287/mnsc.48.1.1.14273

Devine M.D., James T.E., Adams T.I. (1987) Government Supported Industry–University Research Centers: Issues for Successful Technology Transfer. *Journal of Technology Transfer,* 12, 27–37. https://doi.org/10.1007/BF02371360

Eckl V.C. (2012) *Creating an Interactive-Recursive Model of Knowledge Transfer*. Paper presented at the DRUID 2012 Conference, June 19-21, Copenhagen, Denmark.

Eisenhardt K. (1989) Agency Theory: An Assessment and Review. *Academy of Management Review,* 14(1), 57–74. http://www.jstor.org/stable/258191

Erosa V.E. (2012) Dealing with Cultural Issues in the Triple Helix Model Implementation: A Comparison Among Government, University and Business Culture. *Procedia — Social and Behavioral Sciences*, 52, 25–34. https://doi.org/10.1016/j.sbspro.2012.09.438

Flipse S.M., van der Sanden M.C.A., Osseweijer P. (2014) Improving Industrial R&D Practices With Social and Ethical Aspects: Aligning Key Performance Indicators With Social and Ethical Aspects in Food Technology R&D. *Technological Forecasting and Social Change,* 85(C), 185–197. https://doi.org/10.1016/j.techfore.2013.08.009

Garbuz V., Topală P. (2021) The Role of Knowledge and Technology Transfer Mechanisms in Stimulating Innovation. *International Journal of Manufacturing Economics and Management*, 1(1), 13–21.

Gibson D.V., Smilor R.W. (1991) Key Variables in Technology Transfer: A Field-Study Based Empirical Analysis. *Journal of Engineering and Technology Management,* 8(3–4), 287–312. https://doi.org/10.1016/0923-4748(91)90015-J

Halili Z. (2020) Identifying and Ranking Appropriate Strategies for Effective Technology Transfer in The Automotive Industry: Evidence from Iran. *Technology in Society,* 62(C), 101264. https://doi.org/10.1016/j.techsoc.2020.101264

Hamdan A.R., Fathi M.S., Mohamed Z. (2018) Evolution of Malaysia's Technology Transfer Model Facilitated by National Policies. *International Journal of Engineering and Technology*, 7(2), 196–202. https://doi.org/10.14419/ijet.v7i2.29.13317

Lane J.P. (1999) Understanding Technology Transfer. *Journal of Assistive Technology*, 11(1), 5–19. https://doi.org/10.1080/10400435.1999.10131981

Lavoie J.R., Daim T. (2020) Towards The Assessment of Technology Transfer Capabilities: An Action Research-Enhanced HDM Model. *Technology in Society,* 60(3–4), 101217. https://doi.org/10.1016/j.techsoc.2019.101217

Lee S., Shvetsova O.A. (2019) Optimization of The Technology Transfer Process Using Gantt Charts and Critical Path Analysis Flow Diagrams: Case Study of The Korean Automobile Industry. *Processes,* 7(12), 1–27. https://doi.org/10.3390/PR7120917

Mansfield E. (1975) International Technology Transfer: Forms, Resource Requirements, and Policies. *American Economic Review*, 65(2), 372–376. https://www.jstor.org/stable/1818878

Mayer S., Blaas W. (2002) Technology Transfer: An Opportunity for Small Open Economies. *Journal of Technology Transfer*, 27(3), 275–289. https://doi.org/10.1023/A:1015652505477

Mendoza X.P.L., Sanchez D.S.M. (2018) A Systematic Literature Review on Technology Transfer from University to Industry. *International Journal of Business and Systems Research,* 12(2), 197–225. https://doi.org/10.1504/IJBSR.2018.090699

Min J.W., Kim Y.J., Vonortas N.S. (2020) Public Technology Transfer, Commercialization and Business Growth. *Journal European Economic Review,* 124, 103407. https://doi.org/10.1016/j.euroecorev.2020.103407

Necoechea-Mondragón H., Pineda-Domínguez D., Soto-Flores R. (2013) A Conceptual Model of Technology Transfer for Public Universities in Mexico. *Journal of Technology Management and Innovation,* 8(4), 24–35. https://doi.org/10.4067/s0718-27242013000500002

Nilsson A., Rickne A., Bengtsson L. (2010) Transfer of Academic Research — Uncovering the Grey Zone Author. *Journal of Technology Transfer,* 35(6), 617–636. http://dx.doi.org/10.1007/s10961-009-9124-4

Ramanathan K. (2011) An Overview of Technology Transfer and Technology Transfer Models. *International Journal of Research and Analytical Reviews,* 6(2), 82–85.

Risdon P. (1992) *Understanding the Technology Transfer Process,* Philadelphia, PA: University of Pennsylvania. https://www.africa.upenn.edu/Comp_Articles/Technology_Transfer_12764.html

Rogers E.M., Kincaid D.L. (1981) *Communication Networks: Toward a New Paradigm for Research,* New York: Free Press.

Schiavone F., Meles A., Verdoliva V., Del Giudice M. (2014) Does location in a science park really matter for firms' intellectual capital performance? *Journal of Intellectual Capital,* 15(4), 497–515. https://doi.org/10.1108/JIC-07-2014-0082

Steenhuis H., Bruijn E. (2005) *International Technology Transfer: Building Theory from a Multiple Case Study in The Aircraft Industry. A New Vision of Management in the 21st Century*. Paper presented at the Academy of Management Annual Meeting, 5–10 August, New York, US.

Tunca F., Kanat Ö.N. (2019) Harmonization and Simplification Roles of Technology Transfer Offices for Effective University-Industry Collaboration Models. *Procedia Computer Science*, 158, 361–365. https://doi.org/10.1016/j.procs.2019.09.063

USGAO (1998) *Technology Transfer: Administration of the Bayh-Dole Act by Research Universities* (Report RCED-98-126), Washington, D.C.: US Government Accountability Office.

Van Horne C., Dutot V. (2017) Challenges in Technology Transfer: An Actor Perspective in A Quadruple Helix Environment. *Journal of Technology Transfer,* 42, 285–301. https://doi.org/10.1007/s10961-016-9503-6

Wahab S.A., Rose R.C., Uli J., Abdullah H. (2009) A Review on The Technology Transfer Models, Knowledge-Based and Organizational Learning Models on Technology Transfer. *European Journal of Social Sciences,* 10(4), 550–564.

Weber E. (2017) *Advisory Boards in Start-ups: Investigating the Roles of Advisory Boards in German Technology-Based Start-ups* (1st ed.), Heidelberg, Dordrecht, London, New York: Springer. https://doi.org/10.1007/978-3-658-15340-3

Wonglimpiyarat J. (2016) The Innovation Incubator, University Business Incubator and Technology Transfer Strategy: The Case of Thailand. *Technology in Society,* 46, 18–27. https://doi.org/10.1016/j.techsoc.2016.04.002

Zuniga P., Correa P. (2013) *Technology Transfer from Public Research Organizations: Concepts, Markets, and Institutional Failures*, Washington, D.C.: World Bank.