How Hedging Accelerates Development and Commercialization of Technology

Bagaimana Lindung Nilai Mengakselekrasi Pengembangan dan Komersialisasi Teknologi

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A B S T R A C T

Technological innovation has been widely recognized as a very important factor in strengthening firms' competitiveness. Continuous launching of newly technology-based product by firms is aimed at keeping the firms staying competitive in the market. Large firms have capacity to evaluate and access technology they need from various sources besides developed them internally. These firms have the capacity to take risk through experimentation of even untested technology yet have good commercial potential. On the other hand, most SMEs do not have such this capacity due to high risk of such this undertaking. To address this challenge, a new strategy needs to be considered, that is, through hedging normally practiced the financial and commodity markets. Through this strategy a firm will only need to invest a very small fraction of the total value of a contract to secure its right to execute the contract if the contract will deliver benefit. Hence, the potential loss that may occur for the firm that hedges the contract is minimized. Firms can also adopt this hedging type strategy to access technology from various R&D institutes. Such this strategy has been successfully implemented in Taiwan. This paper will elaborate why and how hedging strategy can help firms to improve its capacity to access and adopt technology and help R&D institutes to accelerate its technology transfer to firms. Hedging strategy seems to be a new concept and practice that can also be adapted in the field of management of innovation technology.

Kata Kunci:
Lindung nilai litbang,
pengembangan teknologi,
komersialisasi teknollogi,
usaha pemula berbasis teknologi,
pembiayaan inovasi

S A R I K A R A N G A N

Inovasi teknologi telah diakui secara luas sebagai suatu faktor yang sangat penting dalam penguatan daya saing perusahaann. Peluncuran produk-produk baru berbasis inovasi teknologi dimaksudkan agar perusahaan tetap unggul bersaing di pasar. Perusahaan-perusahaan besa mempunyai kapasitas mengevaluasi dan mengakses teknologi yang mereka butuhkan dari berbagai sumber disamping yang dikembangkan secara internal; mempunyai kapasitas mengambil resiko teknologi melalui eksperimentasi teknologi yang bahkan beleum terbukti namun mempunyai potensi komersial yang baik. Di sisi lain, UKM atau perorangan pada umumnya tidak mempunyai kedua kapasitas tersebut. Utuk mengatasi tantangan ini, suatu strategi baru perlu dipertimbangkan, yaitu, melalui *hedging* (lindung nilai) yang biasanya diterapkan pada pasar modal atau komoditas. Melalui strategi ini suatu perusahaan atau seseorang hanya perlu menginvestasikan bagian sangat kecil dari jumlah nilai suau kontrak atau proyek untuk menjamin haknya untuk melaksanakan kontrak tersebut *di kemudian hari* jika kontrak dipandang akan menghasilkan suatu manfaat. Dengan demikian, potensi kehilangan atau kerugian yang munkin timbul bagi perusahaan atau orang yang melakukan lindung nilai atas kontrak dapat diminimalisir. Perusahaan juga dapat mengadopsi jenis strategi lindung nilai ini untuk mengakses teknologi dari berbagai lembaga-lembaga penelitian dan pengembangan.Strategi ini telah berhasil dipraktekkan di Taiwann. Makalah ini mengelaborasi mengapa dan bagaimana strategi lindung nilai dapat membantu perusahaan meningkatkan kapasitasnya mengakses dan mengadopsi teknologi dan juga dapat membantu lembaga-lembaga penelitian dan pengembangan mengakselerasi alih teknologi ke perusahaan. Strategi lindung nilai tampaknya menjadi suatu konsep dan praktek baru yang dapat diadaptasi dalam bidang manajemen inovasi teknologi.

INTRODUCTION

Technology innovation has been widely recognized as a very important factor in strengthening firms' or industry competitiveness. This, for example, can be seen through continuous new product launching to the market by firms in its attempts not only in providing solution to its customers or market but also to stay competitive. Many of new products launched to the market generally are based on technology resulted from research and development (R&D) activities. The firms might source its technology from its own internal R&D activities and/or from external sources such including R&D institutes.

Whether the technology obtained from internal and/or external sources the costs of its acquisition normally is also very expensive. Besides, when a firm sources its technology from external sources it requires a capacity to assess the risks and benefit of such undertaking. Based on this assessment, in many cases, a firm would be required to conduct further experiments to prove technical and commercial viability of a newly tech-base product with specific application and market. This would incur risk for the firm. Therefore, developing and/or accessing technology from external sources normally is done by large firms and mostly done in a more developed countries.

In developing countries, like Indonesia, this approach has not become a common practice. Firms have a tendency to adopt a new technology or new product which have bee proven elsewhere—there is no need to undertake experimentations to prove its technical and commercial viability. In other words, besides state-of-the art of research results from R&D institution in developing countries still contain high risk; the industry culture also tend to be more risk aversion. This creates a situation where adoption of technological innovation by local firms, both large and SMES, from local R&D institutions and also from foreign market takes place in a very slow phase—insignificant.

It is therefore necessary to find a strategy on how to accelerate innovation adoption from R&D institutions by local firms, given the high risk nature of such undertaking. ***Hedging*** can become one of the alternatives for industry to minimize the risk that might occur in the technology development process in collaboration with R&D institutions. Through hedging, a firm can reduce technological development risk level which in turn can enhance its ability to adopt technology innovation. This is so as the firm can set its investment in the technology development to a minimum amount and only when the opportunity becoming more visible the firm can make further investment in the technology development collaboration.

However, an R&D institute needs to have an appropriate form of organization to enable it to adopt hedging strategy in its research collaboration schemes. R&D institute will have to be able to conduct collaboration in a flexible and professional manner. In the absence of such organizational requirement, the presence of intermediaries can help such R&D institute to accelerate its R&D results utilization through, amongst other, hedging strategy.

This paper briefly reviews how hedging concept which commonly used in financial, investment, and commodities business can be applied in technology innovation development; what type of institutional form is required so as to be able to implement hedging strategy; and how firms can use hedging in its technology investment.

The purpose of this paper is to introduce a commonly known concept in the financial and commodity sector, i.e., hedging as a new concept in the technology innovation management. This concept can be practiced by firm, individuals, and R&D intitutes to accelerate commercialization of technology.

CONCEPTUAL REVIEW

Risk Management, Hedging, and Technologi Commercialization

Risk Management

Risk management can be defined as "a general management function to idendity, assess, and addess causes and effects of uncertainty and risk in an organisation" (Williams, Smith, dan Young, 2001:27). The purpose of rist management is to enable an organization to achieve its mission and objective in a most efective, efficience, and direct way.

This definition entails two key words, i.e. (a) uncertainty and (b) risk. Uncertainty is a doubtfu condition of our ability to predict outcome in the future from currect activity. While a risk presents on every thing the human does. When a risk exist, outcome cannot be forecasted accurately. The existence of this risk increase uncertainty. On the other hand, exposure toward risk is created when an action increase and unpredicted gain or loss. As such risk is an objective concept which can be measured.

What is risk

There are various types of risks such as financial risk, economic risk, political risk, social risk, technology risk, etc. For the purpose of this review, two types of risk, technology and economic risk is briefly elaborated.

Technology risk. Technological risk exists when technology, at a proposed project scale, might not perform in accordance with specification or become obsolete prematurely (Finnerty, 1996:42). If technological deficiency caused the project fail to reach completion testing, risk element can be categorized as completion risk. But, it the project can meet completion of general requirement, yet not perform in accordance with technical specification, this failure is categorized as equity risk.

Technical obsolescence risk in completion becomes particularly important when a project state of the art coverage in an industry where technology evolve quite fast. Generally, such this type of technical risk will be out of financing consideration. Nonetheless, probably sponsor still can fund this project although in the existence of such risk if technology provider has good reputation and there is an instrument to protect investor from such risk.

Economic risk. In certain cases, although a project technically can be accepted and can be completed and operated successfully or reach its near capacity, there is a risk that demand for such product or services might not be sufficient to generate revenue required to return its investment or project cost and provide appropriate return on investment to the investor. Such development, for example, can take place due to the decrease of the project output or production caused by the price of raw materials. Depending on the economics of certain project, it can occur a result of a very small profit. If this occurred, it might not be able to cover all its investment.

One of the important elements of economic risk is efficiency with which project facility operated. A technology development project, for example, does not have records on financial feasibility or credit before operation started. The investor, funder, and/or loan provider cannot see previous operating records for them to assess so they can evaluate the economic risk of a project. Hence, these funders need guarantee from related parties or instruments that can be counted on in order to convince funding/investment requirement to be met.

The above elaboration suggests that whatever commodity and/or product including technology uncertainty level of quantity and price will continuously fluctuate. Technology 'commodity' will entail a much higher risk level; besides the level of quantity and price which cannot be guaranteed its delivery; also technical risk level and its completion contain a high uncertainty level. Without appropriate strategy, this makes technology development collaboration between firms and R&D institute underway in a less intense level.

It is true that R&D institutes open collaboration opportunity with industry in every technology development level. There is no any policy which prohibits firms or industry or investor or businesses to undertake research collaboration with R&D institute. However, much more common in developing countries, there is a view of the firms or investors that research collaboration with an R&D institute will always require a costly investment or expenditure. This can be done, for example, through research contract where business partner or firm or investor will have to fund 100% of the cost of the research. Or in certain cases, it might also occur the fund provided by the firm or investor is 50% of the total cost of the research cost (equal contribution). It is very rare that the funder or firm can provide a small fraction of the total cost of the research. In other words, the risk of technology development collaboration with R&D institute in developing countries is very high; while the success of such development has yet to be seen in high uncertainty level. The result is that technology development between firms, not only large firms but also SMEs, with R&D institute in Indonesia become very low.

Therefore it can be inferred that there are two kinds of uncertainties in R&D investment: technological and market uncertainties. According to Macmillan and MacGrath, "*technological uncertainty usually occurs when firms do not know whether the new technology will work, whether the complementary technology will be ready in time, and what technological standards will be formulated. Market uncertainty involves determining whether there will be enough potential buyers, or whether the market demand is likely to change in the future*" (2008:52). These two kinds of uncertainty factors would also create uncertainty of outcome associated with an investment in R&D projects and technology commercialization, directly or indirectly. In other words, these uncertainties would create risk that influences the firm decision to collaborate in R&D project or technology development and technology commercialization. As such these risk needs to be managed through certain strategy. Hedging is one of the strategies that can be considered.

Hedging

The basic idea of a hedge is that the party or firm or investor/individual enters into a contract to purchase ***some portion*** of a 'commodity' at a predetermined price. This strategy entails some benefits for the firm or investor if the price or value of the commodity increases. But this can also create losses for the firm or investor or hedger if the price of the value of the 'commodity' decreases or fall below the predetermined price. Let's see an example of hedging a 'commodity.' A firm, say for example Garuda Airline, make a hedging on jet fuel price. With this strategy, Garuda can get a profit for when the price of jet fuel sky rocketed; while other airline which does not hedge its jet fuel will incur a huge loss. However, if the jet fuel price decreases, Garuda will incur a loss because the price of the jet fuel as set in the contract is higher than prevailing prices at that time. However, the loss incurred to Garuda will be limited to the size of the hedging fee as stipulated in the contract. It can be seen from this example, that the benefit for the hedger might not be unlimited; and the risk is limited.

Therefore, the risk level to the hedger can be minimized; while the level of expected benefit or profit can be unlimited in line with the price level during the validity of the contract. In other words, benefit obtained from hedging will depend on the on the quantity and price difference favourable to the hedger; while the risk or loss that might be assumed by the hedger can be limited up to the cost of the fee hedging (because of the option to execute hedging by the hedger)

Yet, according to Irvin (in Savage,, 2011) there is a possibility of hedging would not be of value for the firm as to enter into a hedging unless such commodity to be hedged is the top five up to top three of the firm's budget. In other words, if a firm have R&D budget is in the top five up to top three therefore hedging technology would probably create big advantage or benefit; and the other way around applies.

Hedging Instruments: Future and/or Options

Futures and/or Options are two types of instrument of hedging. Somehow, there is a significant different between the two. *Futures* is a contract which obliged to purchase or to sell a quantity that has been determined—goods or security—at a determined price and on a determined date without considering every change that influence on price or environment (Sefton, 1996:78). *Futures*, like *options*, enable investor to take big risk for an advance small payment. But, not like *options*, potential loss generally is unlimited that is, depend on the price level that apply when the contract end. It is worth noting that *futures* contract can be used for hedging purposes with speculative purpose.

The following example can explain in a simple manner the mechanics of a *futures* contract. For instance, an investor wants to speculate on the future price of pure gold without actually purchase the gold. He expects the price of gold, say on 21 October 2014, buy a contract of 100 gram at the price of Rp. 500,000 per gram to be executed on 31 March 2015. The total value of the contract is Rp. 50 million. He pays part of the actual price on the contract, say 10% or Rp. 5 million. The price of gold before the end of the contract, say, is Rp. 650,000.-. The hedger or investor sell its contract before the end of the contract and make a profit of Rp. 10 million, i.e. Rp. 15 million –Rp. 5 million or 200% profit although the price of the gold has increased only 30%. But, if the condition is the opposite, say the price of gold become Rp. 350.000 per gram, so the investor or hedger will incur a loss of Rp. 10 million or 200%.

Options is a ***right*** to do a transaction to occur some time in the future which have been determined at terms and conditions decided when the *option* is made (Peirson at al., 1991:622). Or, it can also be said that *options* is right, but not an obligation, to purchase of to sell something at the price and time that have been determined. A *put option* gives right to sell while a *call option* give right to purchase (Sefton, 1996:161). For example, purchaser of a *call option* on a stock or certain goods or commodity has the right to purchase the stock or certain goods in the future from the seller of the *call option* at the price determined when the contract made. The purchaser of the call option can execute its right to get the stock or goods at the price that already determined before, without considering whatever price of the stock or goods that prevail at that time of execution. While in the *put option*, the purchaser of has the right to sell stock or certain goods in the future to the seller of the *put option* at the price that has been determined when the contract made, without considering the price of the stock at the time of execution. The fee for the right to purchase (*call option*) and the right to sell (*put option*) must be paid by the buyer of the *option* when the *option* is made or purchased.

The Difference between Option and Futures Contract

It is important to differentiate between option contract and futures contract because it is often misinterpreted that there is only minor difference between the two. Yes, there is a prominent similarity. For example, both contracts can cover the delivery of the asset that based the transactions in the future at the predetermined price. Somewhow, there is a very significant difference between the two.

A *futures* contract require the delivery of the asset as agree in the transaction; while such delivery on an *option* contract is an option for the purchase of the *option* to decide. The purchaser of *futures* contract has the obligation to buy; while the purchase of an option has the right to purchase (*call option*) or to sell (*put option*) if she/he decides so. Therefore, if the purchase of a future contract does not take action to cancel his position, he will be obliged to purchase the asset that as agreed in the contract at the end of the contract. While if the purchaser of a *call* or *put option* do not take action to cancel his position, so the *option* will be ended without further transaction. Other difference related to the payment. When future contract made, payment from the future prices is not required until the date ended, but when option contract made, the purchaser must immediately pay to the seller (writer) the price of the *option*. If *option* is exercised, there will be further transaction when the prevailing prices paid by the hedger (*option* buyer).

Why Hedging the Technology?

The essential of hedging can be simply described as managing risk to obtain certain commodity, be it good, services, or technology with a minimum costs yet with potential unlimited benefit due to the existence of high level of uncertainty. Generally, 'hedgers; want to lock at the time of the contact made the price of 'commodity' where they want transaction in the future, so that transaction will not be influence by changes in the future of the price of the commodity or product.

A *forward* contract obliges the contract seller to deliver to the contract buyer (a) a quantity that has been determined, (2) from a commodity, currency, or other certain items, (3) on a certain date in the future, (4) on a price that has already agreed by both parties when they entered into the contract. While *future* contract is identical to *forward contract* except that (1) a future contract is traded on an organized exchange (where *future contract* traded *over-the-counter*) and (2) a *future contract* standardized (while *forward contract* is customized with coverage items or delivery time).

Forwards and futures enable project sponsor to sell the output to be delivered some time in the future. This instrument, at least, guarantee the quantity and the price of the items (including, for example, output of research result) which can be sold or delivered on this basis. This principle can also be adapted and implemented in the technology development collaboration by considering the needs of the related parties. The basic principles that need to be considered are benefits and risk to the parties involved in the technology development collaborations. It is therefore critical to identify optimal benefits that can be obtained by the parties. It can, then, be inferred that the potential benefit that might be incurred if such collaboration do not take place. Further, parties that entered into the technology development collaboration contract should be able to understand potential risk that might occur for the parties.

Example of technology development collaboration model that have implemented this hedging strategy is Industrial Technology Research Institute (ITRI) in Taiwan as will be elaborated further in later section. This hedging strategy can reduce risk and accelerate technology innovation adoption. More importantly, in many cases hedging strategy can bridge the gap of the valley of death in the technology commercialization (Simamora, 2008). Availability of the financing at the early stage will help to bring the technology further to the later stages.

Table 1. LIPI's IPR as of December 2003

No.	Type of IP	Total
1.	Patent Registered/Pending	273
2.	Certified patent	17
3.	Copy right	26
4	Industrial design	7
5.	Protected Plant Variety	2

Source: Center for Innovation-LIPI, 2014

Take for example the case of technology development in Indonesian Institute of Sciences (LIPI). From 273 patent pending it already registered (Table 1) almost all of these IPR are funded by government funding. Only one of them developed in collaboration with a firm. As such, it is not surprise to find the existence of asymmetric information. The impact of this type of technology development wholly relied on government funding is that the information on the technology, such as its

technical advantage and commercial potential is only owned and understood by the technology provider; while firms that might need the technology do not have sufficient information. In other words, strategy in involving potential users in the early phases of technology development has not taken place. This can also be inferred that the approach used in technology development activities in this way is carried mostly through supply push. The implication is that when research has been completed, the efforts to introduce the result to potential users or firm have just begun! In many cases, with this approach, most of the research result will not meet the user requirements be it technical requirement and/or economic feasibility.

METHODOLOGY

The method used in this study is literature review and case study. A brief review on how hedging can minimize risks in the financial and commodity sector will help in explaining how it can also be used to reduce risks in the development and commercialization of technology by firms and technology providers. This conceptual review will be useful to comprehend *hedging* strategy in the development and commercialization of technology as described in the case study.

CASE STUDY:

Hedging Technology Collaboration Models between R&D Institutes and Industry

The above elaboration suggests that the essence of a hedging is to reduce risk, and hedging can also deliver benefit or profit. This risk reduction especially in the investor's side is a very important factor in developing technology development collaboration with R&D institute. This risk is due to the existence of uncertainty in the output of such collaboration. It has also been discussed that generally firms in developing countries like Indonesia tend to adopt a risk aversion culture in adopting technology innovation (laggard). This can be seen in the firm's capacity in carrying out experimentation to prove technical and commercial of new technology-based products.

Even in such developed countries, like Taiwan, risk aversion culture can also be found. While R&D institutes and firm in Indonesia have not adopted an appropriate strategy to address this challenge; Taiwan has come up with a strategy through which firms can participate in the technology development at almost every stage of development—from very early stage up down latter stages as implemented in ITRI.

Technology collaboration model: Early stage participation

Technology collaboration model as in Table 2.shows that a firm can participate in research projects being carried out in ITRI with relatively very small costs, that is, below 10% from the total costs of the research financed by ITRI. In this model, participating firms ***have the right to know*** the research activities, so when the participating firm sees that there is a business prospect of such research the firm can make further negotiation on further collaboration. With financial contribution below 10% of the total cost of the research project ITRI remain the owner of the IP resulted from the research. However, during the research project conducted the participating firm has the right to express its intention in the collaboration if it sees it would benefit the firm.

In Indonesia, this practice is still rare or almost never occurred. The consequence is that more than 80% of the funding of research projects at R&D institutes is government appropriation. Research collaboration between research institute and firm tends to take a ***'take it or leave it'*** approach. Research collaboration costs offered to the firms in general are in the range of 50% up to 100% of the total costs of the research project. This scheme exposes a very high financial risk for the firm. Practically, this scheme makes it almost impossible for SMEs to participate.

Table 2. Technology Collaboration Model Industry Participation at Early Stage and R&D Collaboration

Model	A. Early Stage Participation	B. Collaborated R&D
Target	Current MOEA projects and potential IP	Current MOEA projects and potential IP
Funding	Less than 10% of MOEA funding from each participating companies	Higher than 10% of MOEA funding from each participating company
IP	Belong to ITRI	Shared based on funding percentage
Benefit	• No need to go through R&D topic screening • Lower R&D risk and lower cost in technology feasibility evaluation	• R&D topics can be adjusted to meet participants' needs • Participating companies can send researchers to join the R&D activities • Exclusive right to participants and ITRI
Note	ITRI has the whole licensing right	Need to be approved by MOEA

Source: Wang, 2011

With technology collaboration model in early stage Industry participation as implemented in Taiwan, both research institute (ITRI) and participating firm obtain some benefits such as:

Benefit to ITRI:

- The process of determining research topics can be done fast;
- Obtaining input from the participating firm during the research underway; not after the research completed. This can reduce technical and financial risk for ITRI
- R&D risk decreases and evaluation of technology feasibility become more effective as it is done during the research; not after the research completed.
- Obtaining additional revenues from research projects that is being underway (not only before the research conducted and after the research completed) from more than one firms. This can create a competitive climate for the participating firm to adopt the research result.
- Accelerating innovation by the participating firms because ITRI has provided information on the technical and commercial advantages for the participating firm during the research project underway.

Benefit to the firms:

- Technical and financial risks can be reduced to a minimum (below 10% of the total cost of the research project);
- Obtain real time information in the development and/or research result so it can take appropriate action immediately in negotiating further involvement in the project;
- Provide opportunity to SMEs to participate in the research project in big R&D research institute such as ITRI with a small research investment[1].
- Create a culture of development of technology-based products for participating firms. Firms' participation in such this collaboration indirectly provides learning for firm staff or researchers[2]. At the same time interaction between the staff or researchers of participating firm and ITRI can create linkages between the organization which is an essence of an innovation system strengthening at the industry or micro level.

The above technology collaboration model shows that firms can participate at the very early stage of technology development but the participating firms do not have the right of the IPR generated from the research project. These firms, however, have the ***option*** to invest or to participate in a more intense level if the firm sees the good commercial prospects. In other words, firm with a small size investment (research costs) or very low risk, i.e., below 10% or the total cost of research project can participate in the research project. The firm can decide or take option to increase its investment and have quick and real information on the output of the research.

This model of technology development collaboration is similar to hedging strategy in the category of *call options*. Furthermore, this model also can become one of the strategies in addressing the challenges of linking research into the market—bridging the gap between technology provider and technology users (asymmetric information). Through firm early participation, the needs or expectation of the firm can be communicated to the research team in the R&D institute. At the completion of the research project, there is a big chance that the expectation of the user and/or participating firm can be accommodated.

Technology Collaboration Model: Exclusive,non-exlusive licening and Contract Service

Technology collaboration model as can be seen in Figure 3.B. gives opportunity for firms to participate in the research projects in ITRI still with a limited amount of investment, i.e., above 10%. If on the first model as in Figure 2.A. the participating firm do not have the right over the IPR resulted from the research project; in this model of technology collaboration (where the firm invests above 10% in the research project) the participating firm will have the right to the IPR resulted from the research project in proportion of its investment size.

[1] Generally in Indonesia, with a conventional technology collaboration model where firms as if obliged to provide financial contribution either all of the research costs or 50% or the total costs, practically close opportunity for SMEs to participate in such research. The consequence is that many SMEs expect grant from the government to support them to participate in the research project conducted by large R&D institutes such as LIPI, BPPT, LAPAN, BATAN, and universities.

[2] And also for the researcher in the R&D institute

In this model of technology collaboration, the participating firm has the opportunity to provide input in determining research topics that might be of interest to the firm. In addition, the participating firm can also send its researchers to participate in the research. Interaction of these experts or researchers from firm and R&D Institute (ITRI) would further improve the intensity of networking amongst the scientists from industry and R&D Institute (ITRI). This type of interaction could develop trust amongst the players of the innovation system. Furthermore, because firm is involved in determining the research topic and participate in carrying out the research, so there is a high probability the result of the research to be adopted by the participating firm.

Table 3. Technology Collaboration Model: Exclusive- and Non-Licensing and Contract Service

Model	A. Exclusive Licensing	B. Contract Service and Non Exclusive Licensing
Target	Certified or pending Patent	Specifif R&D Target or Intellectual property
Funding	From interested firm through bidding process	From interested firms
IPR	**ITRI keeps the IP ownership; the licensee may relicense the IP**	**Funding company has the IP rights; Co-sharing can be negotiated**
Benefit	• **Licensee share the IP right** • **Licensee can use the IP right to relicense, cross license, use on negotiation and litigation etc**	• **Target specific and shorter R&D duration** • **Lower risk and cost due to possible stepwise R&D investment**
Note	**Need to be approved by MOEA panel**	**Follow ITRI's existing procedures**

Source: Wang, 2011

The model of technology collaboration in ITRI as in Table 3 is a conventional technology development strategy. The collaboration is aimed at developing a technology that of interest to both parties. The right to the intellectual propertu will depend on the pre-determined arrangement. This can be in the forms of exclusive technology licensing, non-exclusive technology licensing, and/or just limited to a contract service.

Technology collaboration model through exclusive licensing and service contract and non-exclusive licensing are technology transfer strategy commonly implemented both at public research institute and research centers at private companies. Important note that can be made from this model is that exclusive licensing can be done for intellectual property other than certified patent; but also on pending patent; and more interestingly that the licensing recipient can be obtained through a bidding process. This approach can only be done if there is more than one companies interested in a technology. Through bidding process, so there is a high probability that the selected companies are those who have high commitment to commercialize the technology.

Technology Collaboration Model: New Business and Others

The next two models of technology collaboration practiced in ITRI are (a) New Business Investment and (b) Other categories (See Table 4). In general, the most common technology commercialization models done by(public) R&D institutes is mainly through technology licensing and various other forms such as cooperation, profit sharing, and creation of spin off companies. Some public R&D institutes including universities in developed and developing countries, may create new spin off companies as a vehicle to commercialie certain prospective technologies.

The new business investment model introduced by ITRI, however, is quite different with spin off mechanism. In this case, ITRI technology, protected or unprotected ones, can be treated as pas of its initial investment in a new business investment initiative. At the outset, this approach seems to be common. Yet, a deeper observation suggests that this approach can contribute in accelerating the technology commercialization. Through this approach, ITRI business partner does not have to pay cash or direct payment of the

Tabel 4. Technology Collaboration Model: New Business Investment and Others

Model	A. New Business Investment	B. Others
Target	**Using IP or know-how to invest in new business/company**	1. **Consulting service** 2. **Contract experiments** 3. **Analysis and certification**
Funding	**Usually, IP and /or know-how is below 20% of the initial capital**	**From interested companies**
IP	**In form of right transfer and exclusive or non-exclusive licensing**	**In principle, ITRI has the IP rights; Co-sharing can be negotiated**
Benefits	• **Both IP/know-how and technical experts can be transferred** • **Provide best use of capital** • **Quick team formation**	• **High flexibility** • **Simple process**
Note	**Need to be approved by MOEA panel**	**Follow ITRI's existing procedures**
Source:Wang, 2011		

technology licensing fee and royalty; but it can convert that value into ITRI's stock ownership in the new company with the proportion below 20% from the total stocks of the company when it was established.

The new business investment model in transfer technology acceleration can be done by publicly owned R&D institute if it is supported by supporting regulation and policies. A public R&D institute in Indonesia, for example, cannot adopt this new business investment model because the regulation does now allow public institute to own any stock in a firm. As such, in order to be able to adapt this technology collaboration model, transformation of institutional setting is required. For example, an R&D institute can create an quasi private organization to represent its interest with its business partner such as through new business investment model. In other words, there is a need for a new organizational design to enable public R&D in Indonesia to adopt the new business investment model. Innovation adoption in the area of aviation technology by PT. Industri Penerbangan Teknology Nurtanio (PT. IPTN) now known as PT. Dirgantara Indonesia (PT. DI) also took this type of technology transfer model. When CASA Spain transferred its technology to PT. IPTN it converted its licensing technology fee into some stocks ownership of the PT. IPTN. As such PT. IPTN did not have to pay licensing fee to the owner of technology in the form of cash.

Institutional setting and Technology Commercialization

Hedging strategy as elaborated above besides has become an important way to minimize risk level of the research project investment for R&D institutes and also for firms. Through this strategy, research activities in R&D institute become more inclusive. This is so because firms (especially local firms) can participate in research project in R&D institutes without having to make large or risky investment. Likewise, the policy of allowing firm to participate below or above 10% of the total value of research project carries out by R&D institute (ITRI) not only provide opportunity for local firms to participate it also give a kind of certainty on the existence of (potential) adopter of the technology resulted from the research in R&D institute. Furthermore, new business investment model which allowing licensing and royalty fee to be converted into a portion stock ownership for the technology owner with the limit 20%, besides give clear guidance to the member of the R&D institute of the existence of such policy but also ease the financial burden that the firm might face if it has to pay the licensing and royalty fee at the very early age of the new business.

Considering many benefits can be gained by adopting various technology collaboration business model innovations as practiced by ITRI, it is interesting to question whether this approach can be implemented in other developing countries like Indonesia. Or, put it in another way. To be able to implement these news technology collaboration business model what prerequisite that needs to be met?

Implementation of hedging strategy and those various technology collaboration models as implemented in ITRI required a certain institutional status with which can adopt organization governance like a corporation. For example, an R&D institute should be able to accept companies to participate in the research projects it carries out—whether the participating companies can contribute below or above 10% of the total costs of the research project. Such R&D institute should also be able to utilize its revenue to further strengthening institution capacity without necessitate to make first revision of the utilization of the revenues in a long process.

Indonesia has created a policy where a public R&D institute or R&D center can have a certain type of institutional status to enable them to adopt a business practice *ala* corporation. Through a government regulation, an R&D center now can get permit or certain status from the government so they can manage their financial plan in a more flexible manner *ala* corporation. For this purpose, the R&D center has to change its financial management as Public Service Agency (Badan Layanan Umum-BLU). Yet, even with this status the news business investment model in technology collaboration as implemented in ITRI cannot be applied as BLU is still a government institution—not allowed to have share in a firm unless it becomes a State Own Enterprise.

Experiences from China, Taiwan, Korea, and India, show that there is a need for an organizational to adopt a responsive business practices so an R&D institute or an R&D center can serve or respond to its customers or business partners with commonly business principles. The introduction of BLU in Indonesia by the government for example can help an R&D institute to manage its revenues in a more flexible way—as agreed by the parties involved. However, this type of organizational design (BLU) cannot adopt the new business investment

technology collaboration model as practiced in ITRI Taiwan. ITRI in Taiwan, for instance, is an R&D institute initially established by the government but later become an independent institute managed by professionals. Currently, ITRI obtain its research fund from companies using its services through various technology collaboration models as discussed above; and around 50% of its research fund still comes from the government sources on a competitive bases. It is interesting to find that in Taiwan, the government can provide research fund to a non-government institution. ITRI can use this fund to mobilize fund from companies through various type of technology collaboration models

Likewise, in Korea similar practice also occurs. In order local companies especially SMEs can adopt technological innovation from various sources the government establish Small Business Corporation (SBC). This organization is funded by the government but it is not a government institution. SBC is managed by professional to fund technology development projects by companies that meet certain criteria. SBC can provide fund for new companies adopting new technologies. When a company financially supported by SBC succeeds to exploit technological innovation in the market so SBC will get a return from its investment in that company; however, if the firm fails to exploit such technology so such financial support can be treated as grant. In other words, SBC in some respect take some risk from the companies it supports. Or course, to be able to participate is such a program a company has to go through a competitive and tight selection process. To enable SBC can play this role its organizational setting has been designed for that purpose.

The experience of those countries shows that there is a need to have organizational innovation so as to be able to support the acceleration of technology collaboration and technology transfer between R&D institute and firms. Therefore, it is necessary to R&D institutes or centers to have a proper institutional support to better develop collaboration with its customers. For example, the existence of intermediaries in an R&D institute such as Technology Licensing Office (TLO), center for innovation, and technology business incubator can help represent its business interests in developing various technology collaboration models. Likewise, Science and Technology Park (ST) can also create a conducive environment in accelerating technological innovation diffusion. One of very important factors that has to exist for an intermediary institution to perform its role in accelerating technological innovation diffusion is that the intermediary has to be managed by professional and adopted common business principles in its operation.

In other workds, strengthening intermediary institution, besides it is amied at improving its organizational setting also has to consider the need for a new form of intermediary. Such this intermediary can be established and initially funded by the government but it should be independent and probably not in the form of a government organiztion. Its fund can come from the government but on a competitive base and more importantly from companies with various technology collaboration models. With this new type of organization, the hedging strategy can also be adopted.

DISCUSSION

Hedging is one of important instruments to reduce or minimize risk level due to the existence of uncertainty in the future. This instrument has commonly been practiced in the business world such is in the financial and/or commodity market. Some hedging instruments are available to be considered, namely, *forwards*, *futures*, and *options*. Hedging through *option call*, for instance, a firm can manage its investment or expenditure to a minimum, say 10% of the total value of a contract, for a certain quantity with determined price to be delivered sometimes in the future to the hedger. With this scheme, the hedger can have opportunity to get (potentially unlimited) benefit with relatively low level of risk (e.g., the risk maximum to the hedging fee).

Hedging instrument in fact can also be applied in accelerating the technology innovation adoption of R&D institute by firms. Technology collaboration model implemented in ITRI, Taiwan, for instance, provide opportunity for firms to participate in the technology development and/or commercialization through various collaboration models. This includes the *options* for the firm to participate in the technology development and/or commercialization in various stages of innovation process.

ITRI policy to allow firm to participate in such collaborations by allowing the firms to contribute below or above 10% from the total value of a research projects is a business model breakthrough. By providing this *option*, large, medium, and even small firms can participate or access technology from R&D institute with a minimum investment.

This type hedging strategy practically can also significantly reduce the existence of asymmetric information commonly occurred in a conventionally managed R&D institute where research plan is often done in isolation and promotion of the research results started only when the research project has already been completed.

It is worth noting that implementation of hedging strategy by a public R&D institute, universities, and higher education in Indonesia requires appropriate institutional setting. Such institutional setting should allow R&D Institutes to adopt a flexible and professional management style so as to enable it to respond to various type business partners requirement such as technology collaboration models preferred by firms like those implemented in ITRI, Taiwan. ITRI technology collaboration business model gives insight for public R&D institutes in developing countries including Indonesia of the importance of the existence of various *options* including hedging strategy for firm to participate in the technology development and/or technology commercialization.

Challenges. The adoption and adaption of hedging strategy by public R&D institutions including universities in Indonesia, however, faces some challenge. Institutional setting of public R&D institutions in Indonesia has yet to develop an appropriate forms of organization to enable them to adopt hedging strategy in the development and commercialization of technology. Likewise, most public R&D institutions in Indonesia have not had the practice of bidding its technology development and/or commercialization project to potential funder, especially investors or priviate companies to get funded. Public R&D institute, including universities, in Indonesia commonly compete for funding from goverment sources.

To address this challenge, public R&D Institutes and universities in Indonesia can considers suitable organizational status to enable them to adopt a business friendly management—flexible, responsive, and proactive. This can, for example, in the form of a public service agency (BLU), State Owned Legal Entity (Badan Hukum Milik Negar-BHMN), etc. An R&D innstitute can transform itself into a new BLU or BHMN. Or, it can also consider to create an independent institution or organization (can be from part of the organization or a new one) with the main task to develop partnership with potential partners both in the development and/or commercialization of technology. Technology Licensing Office (TLO) in Japan with the main task to commercialize a university technology or Yissum a private company set up by Hebrew Jerusalem University in Israel to commercialize its technology to global market are just two examples of organization that can help publicly owned research institute to commercialize or even to develop technology. This types of institution can consider management tool like hedging in its business operation.

CONCLUSIONS

Technology development and technology commercialization by definitionn entails high risk. An environment where the culture of an industry or society in actively exploring the commercial potential of technology at the early stage of its development and commercialization to improve its competitiveness is not a common practice, will need a strategy to minimize the risk.

Hedging instrument can help technology providers and technology users to enter into a collaboration by committing limited size of investment in a technology development or technology commercialization from very early stage. This approach has been successfully practiced in ITRI Taiwan. Through hedging, many technology development and technology commercialization are jointly initiated and conducted by technology provider and technology users. As such asymmetrical information commonly existed in technology development process can be addressed through hedging strategy as the potential users of the technology are involved from the very early stage. In the end, this will contribute to the high success rate in its commercialization.

Policy implication. Hedging practice in technology development and technology commercialization seems to be a new concept in Indonesia For this concept to be adopted by public R&D institute in Indonesia ***there is a need to adjust or to transform its institutional setting*** so as to be not only more responsive but also more proactive to "market" its research plan or projects to potential partners (investors and technology users). However, privately owned R&D centers of institutes or even NGO doing R&D can consider hedging strategy to encourage participation of the partner (investors, users, funders) from the very early stage of the technology development and commercialization. This will siginificantly increase its success rate.

Practical implication. R&D Centers or R&D Institutes need to have a strategy on how to

convince or demonstrate to potential partners a sound investment on technology development and technology commercialization. This can be done by showing in a simple way of the potential risk and benefit to the partners. As such management competence on risk management including hedging strategy needs to be integrated into an R&D institution managemen practice. It is therefore necessary fo public R&D Institutes or public R&D to prepare and to train its human resource in the are of risk management, hedging R&D in particular in the development and/or commercialization of technology.

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