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RESEARCH

Patent Valuation of Public R&D Institutions

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Abstract

Patent as Intellectual Property Right (HKI) is the result of research and development (R&D) activity, vital to boost industry development and plays an important role in increasing business competitiveness of a country. Based on Government Regulation No. 6 Year 2006, HKI of public R&D institution as a result of R&D financed by government is public asset; therefore, it must be protected and valuated. The patent containing technology invention is under legal protection and can be commercialized; therefore, its value is affected by factors of technology, law and commercial aspect. The numerous factors influencing patent value makes patent valuation hard to conduct, so there emerge various researches and studies, proposing various methods to determine patent value. Although patent value as public asset must be determined, there has not been any way or method of patent valuation, set or agreed on; thus many R&D institutions encounter trouble in determining the value of a patent. This paper studies various methods published, and recommends Compensation Method as appropriate for patent valuation as a state asset, since this method calculates various fundamental matters affecting patent value, namely the costs in the past and in the future, and potential income if the patent is used commercially. Besides, the calculation process in this method can be conducted quickly by using spreadsheet software commonly known.

Keywords: Method, Patent Valuation, Public R&D Institution Asset.

I. Introduction

A technology protected in a patent grant is a highly valued Intellectual Property Right; it plays a vital role in boosting the science and technology development and industry improvement of a nation. In trading, it is significant both in strengthening competitiveness and protecting business (Chaplisky and Payne 2002). The influence of intellectual property rights on trade has become more prominent mainly after Trade-Related Aspects of Intellectual Property Rights, TRIPS (Maskus, 2000), so that patent is believed to be one of the catalysts of world economy (Chiu and Chen, 2003).

For industry, a patent containing a new technology is an important intangible asset, more valuable than tangible asset, thus its protection and utilization is heavily noted (Smith and Parr, 1998, Scheffer and Zieger, 2005) and becomes a part of company strategy in facing the market (Sullivan, 2000). Therefore, patent valuation in industry has become common and long been practiced (Pitkethly 1997, and Reitzig 2006). In Indonesia, in connection to stock exchange market, Indonesian Capital Market and Financial Institution Supervisory Agency (BAPEPAM) has drafted an intangible asset valuation system for companies taking role in stock exchange (BAPEPAM, 2011).

In Indonesia, apart from its vital value for industry and trading, patents and other intellectual property rights are intangible state asset that must be managed as other state assets (Government Regulation No 6 Year 2006). As a state asset, patent valuation must be conducted by various public R&D institutions owning it. However, unlike in industry, patent valuation in state agency is relatively new, rarely or never been conducted before.

Although it is understood that patent has a vital role in industry and trading, and government regulation has obliged government institution to set the value of intellectual asset as one of intangible assets, the writer's examination shows that there has not been a clear method prearranged for this valuation. This is probably due to the complexity and difficulty in the process of patent valuation (Pitkethly 1997, Gajland 1998), making it hard for

patent creator or owner to set the value of the state intellectual asset.

Studies show that in technology transfer process, the final value of an R&D-generated technology to be used by other party is a product of negotiation between the owner and potential licensee (WIPO 1977, Smith and Parr 1998, and Button and Mirga 2004). The challenge is for the state R&D institution as technology owner to come up with a clear way to set the value of a technology/patent which will be a basis for negotiation in the process of technology transfer. Therefore, one advantage of patent valuation is to support decision makers in the process of technology transfer from R&D institution to user, both by commercial/license agreement and grant.

Considering these matters, patent valuation by public R&D institution must be conducted at least for these two goals, namely a) setting public asset value, and b) estimating the value of technology when the patent is transferred or licensed to potential licensee.

This paper is a review and analysis of things influencing the value of a patent and the methods of patent valuation, and suggests the method that state institutions should employ in setting patent value as state asset. Considering the quite fundamental difference between patent and simple patent known in other countries as utility model (Richards 2010, and Moga 2012), as seen in Law no. 14 year 2001, patent referred to in this paper excludes simple patent.

II. Approaches

This study is conducted employing explorative device by qualitative and quantitative approach. Qualitative approach is conducted since there are lacks of patent data from governmental R&D institution and since patent valuation is still very rarely conducted by governmental R&D institution. Therefore, the study is mainly aimed at viewing various methods of patent valuation published. The challenge is in employing and selecting potential methods according to the present condition, considering the lack of information in governmental R&D institution. Quantitative approach is conducted to show examples of method application, and a calculation is conducted by employing secondary data namely the data of administrative process and patent maintenance cost (Government Regulation No. 38 year 2009), and the cost of research for thematic researches conducted in Indonesian Institute of Science during 2007-2012 period.

In order to get detailed explanation concerning certain method, the writer conducted direct contact with inventor of the method to collect explanation in applying selected method. Selected method can be used by anyone needing it since the method is published under open information principle, providing the source is mentioned properly.

III. Patent Valuation

3.1. Advantage of Patent Valuation for R&D Institution and Industry

The advantage of patent for governmental R&D institution is a little different from that for industry. For R&D institution, the procurement of patent for a technology provides advantages, among others attracting industry to use the technology, showing superiority of research and development conducted by the institution, stimulating activities to generate new inventions, and protecting inventors and owners from illegitimate use of technology by others. Besides, since patent is the most complete technology information source, if regularly observing the development of patent document to certain subject, an R&D institution can (Aiman, 2012):

- compare R&D activities conducted by other R&D institutions,
- learn the tendencies and changes occurred to identify potential obstruction in the efforts of applying the results of the activities by other party,
- identify the development of related technology and technology user,
- avoid reinventing the wheel.

Therefore, the result of patent valuation process, apart from setting the value of state asset, also supports increase of R&D activity quality of the institution and aid in the process of promoting the patent itself.

For industry, patent and other intellectual property rights are used to protect technology owned and increase business strategy, among others by (Chaplisky and Payne 2002, Maskus 2000, and Sullivan 2000):

- maximizing commercial benefit from protection of owned technology, maintaining superiority over competitor,
- defending intellectual property right (to prevent application of technology owned by competitor or other party),
- ensuring superiority of present technology by defeating opponents' technology,
- analyzing technology patented by business rival,
- becoming a device to distinguish quality.

Therefore, valuation of patent as vital asset of industry is conducted to increase the value of industry, support industry life and competitiveness without forgetting that competitors do the same.

3.2. Factors Influencing Patent Value

Patent valuation is not a simple matter and has long

been a subject of study for experts. This is due to the many related factors influencing patent value (Pitkethly 1997, Gajland 1998, Chiu and Chen 2003, Martin and Drews 2010, Collan and Heikkila 2011, Roman et al. 2013).

As explained in Law No.14 Year 2001, patent is a document explaining the invention of a technology protected by law so that the owner can utilize or allow others to utilize the technology commercially. Therefore, the value of a patent is influenced by the variation of three factors, namely the level of technology content, legal status, and commercial potential. The more complete and sophisticated the technology contained, the higher the patent value; the more legally save, the higher the value; and the larger the commercial potential, the higher the value too. Based on the variation of these three factors, there are at least 19 (nineteen) related things influencing the value of a patent (Parr and Smith 1994, Pitkethly 1997, Gibbs 2006, Holloway and Reilly 2012, Anonymous 2013).

For the purpose of setting the patent value as an asset of governmental R&D and patent valuation to push utilization of this intangible asset commercially by other party, this study is aimed at commercial factor, while technology and legal factor will not be examined in details.

Technology Factor

Based on the technology contained, patent value is influenced by 4 (four) of these followings:

1. Technology advancement
2. Technical sophistication.
3. Combinatorial accession.
4. Technology cogency.

Legal Factor

From legal point of view, patent value is influenced by 7 (seven) of these followings:

1. Enforceability.
2. Total relevancy strength.
3. Novelty.
4. Claim scope breadth.
5. Validity confidence.
6. Sustainability in position.
7. Litigation avoidance.

Commercial Factor

In the process of patent valuation as state asset, it should be distinguished between the patent already utilized or licensed and the patent not yet licensed. For technology already utilized, the commercial value can easily be calculated from the size of payment (to be) received from license and royalty until the license expired (Aiman, 2012). For patent not licensed yet, from commercial point of view, the patent value is influenced by these following 8 (eight) factors:

1. Contribution of forward citation value

The patent more cited by others after granted shows that the protected technology is considered important. Economically, it is considered of higher value than the patent less or not cited.

2. Contribution of backward citation value

The number of citation, in the form of other patent as comparison, conducted during composing a patent document shows that the technology contained has a potential wider utilization and market, thus it will influence the value of the patent.

From commercial point of view, the contribution of citation of other existing patent (backward citation), is smaller than the contribution of citation conducted by others after the patent been published (forward citation). The number of citation conducted by patent applicant during document composition shows that similar technology or technology of the same type is quite a lot, so that the technology owned will face many competitions. On the other hand, the number of citation conducted by others (forward citation) of a patent shows that the technology contained has a superiority so that it will be beneficial from commercial point of view.

3. Enforcement licensing potential.

The less patent application in similar field indicating the less competitor of the technology contained, the more potential to get user candidate and the more potential to make profit from the license agreement. From commercial point of view, this kind of patent is valued higher.

4. Partnering licensing potential

As has been explained before, a patent document elaborates invention of a technology for a certain purpose. A production process to produce a product commonly employs more than just a patent. A patent potentially employed together with other patents for the same purpose and owned by the same owner is commercially valued higher than a solitary patent that cannot be joined by other patent.

In other situation, if a patent owned by one owner can be joined or supportive to other patent owned by other owner and have the same purpose, and both the owners potentially cooperate with each other, this kind of patent is commercially valued higher than a patent that cannot be employed together with other patent.

5. Patent group

The number of closely related patents in the same field owned by patent owner influences the value of the patent. Organization or person owning some patents in close fields (patent group), means that wider use of technology protected will make the value of the patent higher. If applicant only has one patent, then the commercial value of the patent will be considered low.

6. Patent group competitive position.

An R&D institution or industry is considered technologically strong if it owns a number of patents as results of its research and development. The more patents owned, the stronger the institution or industry. The patent group competitive position in related fields owned by a person or organization, comparable to other person/organization patent group, depends on the number of patents in the group. More patents group is more competitive than less patents group. Therefore more patents group is commercially valued higher than less patents group.

7. Data of Potential licensees.

The more potential licensees of a patent is that shows the bigger the market of contained technology, the higher are the commercial value.

8. In-licensee opportunity.

A patent potentially in-licensed (meaning a patent potentially employed by organization or industrial group owning the patent itself) is commercially valued higher than a patent that cannot be self used or not appropriate for self usage. Commercially, this in-licensee opportunity is considered more beneficial and legally tends to face less problems.

Valuation of each Factor.

In patent valuation process, the criteria employed to set the value limit of each factor above is determined and prearranged by patent owning organization and applied similarly to all patent valuation process in the organization. This criteria can use patent factor index or the number of each factor (Gibbs, A., 2008, and Anonymous 2013). For example, the criteria for forward citation factor use the number of citations 0-5, 6-10, and above 10. Under 5 citations is considered low and above 10 citations is considered high and the value is set (Table A, Attachment). Each criteria is converted to value transformation, for example 0, 10, 25%, which means that a more cited patent (>10) is valued at 25% (% of total cost) higher than a less cited patent. The setting of value transformation of each criteria is conducted by patent owning organization, and so is the criteria and their influence to patent value for other factors.

Result of statistic analysis of data related to a patent shows that a patent value has no reference limit, depending on the decision and value set by the owner. Meanwhile, the patent selling value depends on the agreement between owner and licensee, so it can happen that a patent is sold/get benefit/royalty much bigger than the owner's investment (Smith and Parr, 1998, and Button and Mirga, 2004). The experience and capacity of an organization, the number of patents owned, and networking between organization and licensees influence the process and result of this analysis.

3.3. Patent Valuation Method.

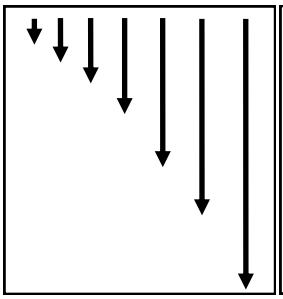
The variation of purpose, condition and factor existed during valuation influence the economic value of a patent, so that individual patent valuation becomes a much studied and discussed area (Pitkethly 1997, Jacquelyn 2004, Kochupillai and Smith 2007, Krattiger 2007, Collan and Heikkila 2011). Patent analysts realize that there is no effective and easy way that can fulfill and cover all factors influential in the valuation (Katz and Olsen 2008, Goldshneider, et al.,2002), therefore, an appropriate method to apply in governmental R&D institution must be studied and arranged.

Patent valuation is not a onetime activity only, but it need to be conducted/renewed regularly considering the development of cost, paid after the patent registered, development of related technology, development of the number of patent owned, and development of index or criteria employed (Anonymous, 2013).

The number of influential factors and complexity of patent valuation pushes the appearance of several thoughts of grouping patent valuation methods (Pitkethly 1997, Chaplisky and Payne 2002, Chiu and Chen 2003, Scheffer and Zieger 2005,

Table 1. Patent Evaluation Method (Roman *et al.*, 2013)

No	Complexity	Approach	Method
1	Low	Cost	Cost History
			Replication Cost
			Exchange (Return) Cost
		Market	Market Transaction
			Industry Standard
		Benefit/Income	Discounted Cash Flow (DCF)
			Present Net Value from Risk
			Present Net Value by Monte Carlo Simulation
2	High	Cost and Benefit Combination	Real Selection and POM (Pay-Off Method) Theories.



a. Cost : Valuation based on cost (Cost Based).
b. Market : Valuation based on market condition (Market Based)
c. Income : Valuation based on projected income (Income Based)
d. Time : Valuation based on money value change (DCF Method)
e. Uncertainty : Valuation based on uncertainty of potential income in the future.
f. Flexibility: (Combined method) Valuation based on money value change and various potential risk analyses (Decision Tree Analysis, DTA, Method).
g. Risk Change : Valuation based on price option theory (Option Pricing Theory,

Source : Pitkethly, 1997

Figure 1. Order of various patent valuation methods based on difficulty level.

1). Cost Based Valuation

Cost based valuation is conducted by calculating all main investments including all costs for research and development activity, costs for document drafting expert, and other costs directly paid until a patent registered. This kind of value calculation is known as Historical Cost Approach (Pitkethly 1997), or Return on R&D Costs (Smith and Parr, 1998).

Considering that patent cost does not end after patent registration, but also needs quite big maintenance cost, this cost calculation is then developed further with the inclusion of future patent administrative cost calculation, which is the cost of maintaining and promoting the technology to be known by potential licensees. This method is known as Total Cost Based Approach (Holloway and Reilly, 2012). Considering that calculating patent value also involves estimation of future cost, and that every year there is money devaluation due to inflation, and all, in this calculation all costs are estimated to Present Value (PV).

Calculation of PV is conducted using common equation known in accounting (Averkamp,2004) namely:

$$PV = FV\,(1 + i)^{-n} \quad \text{..... [1]}$$

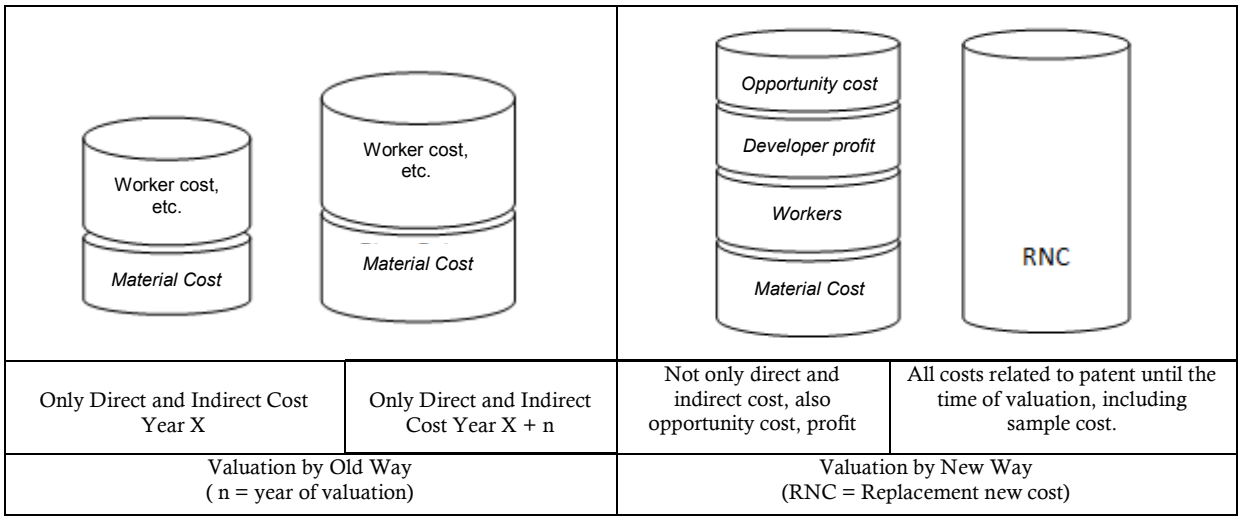
whereas :

PV = Present Value
FV = Future Value
i = Interest, etc (cost of money),
n = Time (year), time difference between present and future.

The example for the use of total cost valuation method is shown in the attachment.

This cost based patent valuation keeps developing, not only calculating direct and indirect cost, but also other costs until a technology is actually ready for industrial application. This kind of approach is distinguished into Replication Cost and Replacement New Costs (Holloway and Reilly, 2012). Schematically, this development of cost based patent valuation is shown in Figure 2.

Replication cost is the cost technology owner or technology licensee industry must pay in order to make product sample, prototype, including cost for failed product sample, prior to mass production. Replacement new cost is all costs paid in producing product sample, prototype, excluding cost for failed product sample. The difference between these two approaches is in the perspective that the cost for



Source : Holloway and Reilly, 2012

Figure 2. Development of Cost Based Valuation.

producing successful product will be returned by the product sold or become industry asset. Both costs, Replication Cost and Replacement New Cost, are important to calculate since it concerns with big investment for pilot scale activity.

Both Replication Cost and Replacement New Cost methods are not really connected to calculation in patent valuation in governmental R&D institution if the R&D institution does not conduct pilot stage process to produce sample products. If replication process is conducted by licensee industry, replication cost is not included in calculation of patent asset value in R&D institution.

The essence of patent valuation is to estimate economic value or benefit in the future if technology contained in the patent is employed. From licensee point of view, patent valuation based on the cost of research paid is not the appropriate approach since patent value does not depend on the cost paid but on potential profit gained in the future from the employment of the technology in producing product (Smith and Parr, 1998). Besides, since the size of cost does not always depict the value of technology contained in patent, the value gained does not depict 'real' value of the patent (Krattiger, 2007). Many technology are produced from relatively small investment but have high economic value, and vice versa, many technology spent large cost, but do not or have not provide economic value to the owner.

Although Cost History approach seems easy, the patent valuation based on this cost approach is not employed much for various reasons, among others is that R&D institution is not good enough in managing the data related to research investment so that the exact cost for R&D is sometimes hard to learned (Pitkethly 1997; Aiman 2012), It used to be often employed in the first patent valuation, but now this method is rarely used by industry (Smith and Parr, 1998).

2). Patent Valuation Based on Market Value (Market Approach).

The value of a patent is best set based on the market value of contained technology by viewing the value of similar technology or technology of the same kind already used in industry (Smith 1998, Parr 1999, Krattiger 2007, Collan and Heikkila 2011).

One example is the patent containing technology for fruit beverage processing. The value of this patent is determined based on the value of other technology for fruit beverage processing already in the market. This method is considered capable of producing 'near actual' patent value and is considered the most realistic method However, the main problem in employing this method is the hardship in learning estimated value of similar technology (Smith 1998), since usually technology value is a secret kept by technology licensee.

This method is much used in industry that has special team and continually observing development of market and advancement of related technology or of technology in the same field with the technology used in production process of their products.

For R&D institutions, since R&D activity varies according to the development and advancement of technology, or follows the need or agreement with licensee, the institution does not have enough information on the value of technology used in industry, so that it is more difficult for R&D institution to use this method in patent valuation. In the future, considering the development of technology, competition and advancement of research in Indonesia, it is better for research and development institutions and universities to have a team continually observing the development of the value of technology available in the market.

3). Patent Value Based on Potential Benefit (Income Approach)

The value of a patent can be estimated through the calculation of future anticipated revenue if the patent is used by other party. This calculation is conducted by estimating the income gained from royalty and license, both calculated by the percentage of product sold by industry using the technology and other potential services, then translated it into present value.

One example of this, a technology is estimated to gain IDR 4 billion in 10 years after license agreement, then the value of the technology at present can be calculated by considering the annual interest for the next 10 years so that present value can be determined.

This method gives a depiction of real income to patent owner; however, the main challenge in employing this method is how to collect data and information for prediction of income for a new technology with no selling of product, no market, and no data of production cost that can be used to predict future revenue yet (Krattiger 2007).

Combination of both approaches, namely market method and revenue method, is known as hybrid approach and the employment of this method faces the challenge and benefit contained in the two methods combined (Kratigger 2007).

Since it is not easy to calculate future income in patent valuation based on this revenue, there emerges Simplistic Rule of Thumb group. This approach can be distinguished into 4 (four) methods namely the 25% Rule, Industry Norms, Return on R&D Costs, and the 5% of Sales Method (Smith and Parr, 1998). In this Simplistic Rule of thumb, patent value is determined by potential royalty received by patent owner.

In 25% Rule, royalty is calculated at 25-33.3% of gross profit, before tax, from selling of products produced based on patent used. In 5% Selling Method, the royalty value is determined at 5% of product selling. Although this 5% Method is widely

applied by many R&D institutions and in various industries, be it food industry, machinery industry, electronic, construction and health devices; why the 5% is used and who started (the inventor) this calculation is not clear (Smith and Parr, 1998). In Return on R&D Costs approach, the royalty during patent use span is calculated based on the size of investment in producing technology patented. In this paper, Industry Norm approach is not elaborated since this approach is only appropriate for the employment of related patent among similar industry.

4). Pay-Off Method (POM).

Considering that patent valuation method based only on cost is not accurate, and it is not easy to collect market data of an available technology, and it is difficult to estimate future income, Mikael Collan suggested Pay-Off Method or POM (Collan and Heikkila, 2011, and Collan 2014). In this study, Pay-Off Method is translated as Compensation Method to estimate the value of a patent.

In this POM method, the value of a patent is calculated by combining calculation of various costs with income potentially gained in the future if the patent is used. Potential income in the future is calculated from potential size of royalty from product selling, but is estimated based on expert judgment. All costs and potential income is calculated based on the present value. It must be emphasized again here that the present value of a patent is the value at the time patent valuation is conducted.

Calculation process is started by drafting potential value distribution created based on three value scenarios, namely Maximum Patent Value (optimism scenario), Most Probable Patent Value (best scenario), and Minimum Patent Value (pessimism scenario). Each value of these three scenario is calculated as follows:

a) Maximum Patent Value scenario is patent value calculated on the basis of:
   i. The lowest cost to manage patent in the future after registration. This cost includes patent maintenance, technology marketing/ promotion cost, and other costs in order to market/promote the patent to potential licensees.
   ii. Most (maximum) income estimated to be gained if the patent is used for several years. This income estimation is based on expert judgment of license and royalty income, and other income from patent usage. One example of other income is consultation cost from licensee to patent owner. This future value estimation based on expert judgment approach is also employed by other researchers (Pitkethly, 1997).

All income gained by patent owner is in unclear (fuzzy) income form. The various incomes are still in possibility type. According to Collan (Collan, 2014), even after the license agreement contract signed, the patent owner income is still contingent since application of new technology in a production process faces high risk, there is still high chance of failure, which will affect the income for both sides. Therefore, good relationship between technology owner and licensee needs to be kept to be able to discuss various developments faced in the application of a patent.

b) Most Probable Patent Value scenario (best scenario) is patent value calculated based on:
   i. the cost most probably provided by patent owner to manage patent in the future after registration.
   ii. the estimation of income most probably gained if a patent is used from certain year. This income is based on the expert judgment, from license and royalty income and other incomes if patent is used.

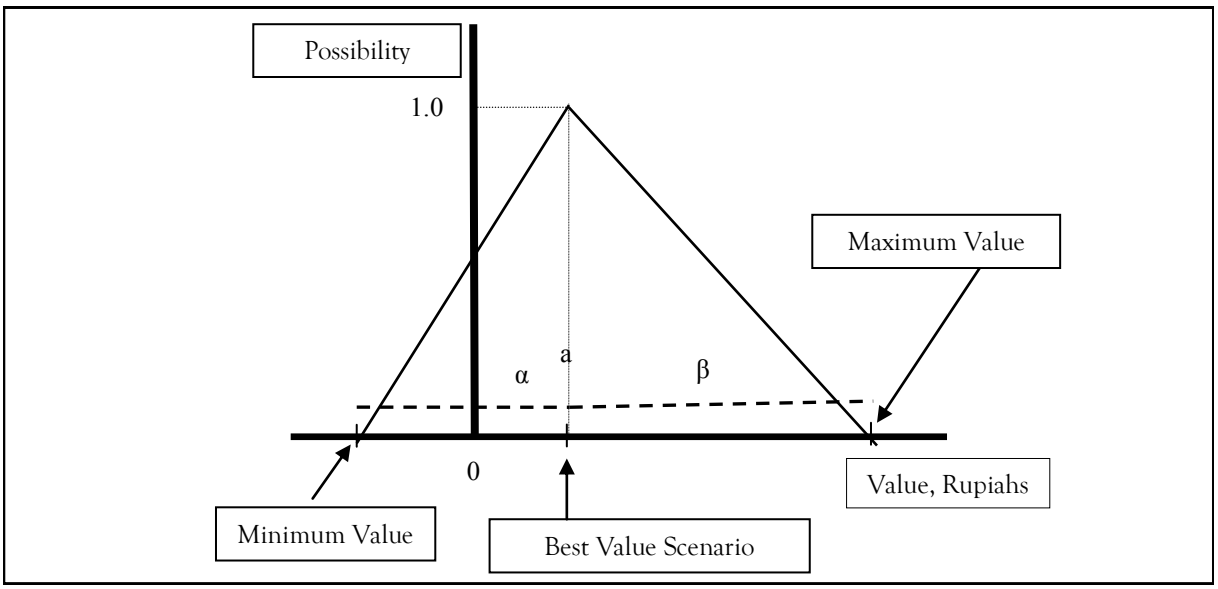
c) Minimum Patent Value scenario (pessimism scenario) is patent value calculated based on:
   i. The biggest cost for management of patent in the future after registration, including big promotion cost.
   ii. Estimation of minimum income from license, royalty and other incomes probably gained if the patent is used from certain year.

Present Value of all these value possibilities, both cost and future income of the three scenarios can be calculated by equation [1].

By determining the (Present) Value, the patent analyzed cannot be higher than the possible Maximum (Present) Value, and cannot be lower than possible Minimum (Present) Value, it means the possibility to get a value below minimum value or above maximum value is zero. So, there will be many possible values between the minimum and maximum values. Possibility to get Most Possible (Present) Value is considered as 1 (one).

The three scenarios is depicted as a triangle as in Figure 3, with the following conditions: a) horizontal axis (abscissa), as Value (in rupiahs) with border points Maximum and Minimum (Present) Values, b) vertical axis (ordinate) as Possible position, whereas smallest possibility is 0 (zero) and biggest possibility is 1 (one), c) values below minimum value estimation and above maximum value estimation should not be noted. So, various value possibilities (Possibility Distribution) from the analyzed patent value will be inside the triangle area. In other word, Real Option Value (ROV), the value sought, will be inside the triangle area.

The Real Option Value is the value closest to Most Possible Patent Value (possibility close to 1),



Source : Collan and Heikkila, 2011

Figure 3. Triangle of possible value distribution.

or close to Best Value, which can be higher or lower than the Most Possible Patent Value.

Since calculation is conducted by using cost data (past data) and also potential income (future data), then patent value is determined by Net Present Value (NPV) that is the difference between present value of income and cost of each scenario. Since there is a possibility that the cost is bigger than income, there is a possibility that the triangle position, fully or partially, is in negative value area of abscissa. Therefore, there are three possible triangle positions, namely all parts of triangle in negative rupiahs value area which means the cost is bigger than income, or a part of triangle is in negative area and other part in positive area, or all parts in positive area.

Arrangement of ROV in a possible area (Probability Distribution) based on Unclear Data Group (fuzzy set) has been widely used to assist in solving calculation for valuation in economic field (Datar and Mathews 2007, Tarrazo 1997), therefore, mathematic decline will not be reviewed in this paper.

To determine location of Real Option Value (ROV) inside the triangle, Mikael Collan employs Fuzzy Set approach (Collan, Fuller and Mezei 2009, Collan and Heikkila 2011, and Collan 2014). A triangle formed from the three scenarios above, can be depicted by using the notations (Figure 3):

- a = location of NPV point for Most Possible Patent Value (best approach) at the bottom of triangle.
- β = distance between a to NPV point for Maximum Patent Value (optimism approach)
- α = distance between a to NPV point for Minimum Patent Value (pessimism approach).
- a + β = position of maximum point.
- a - α = position of minimum point.

Mathematically, ROV in the triangle can be calculated through (Collan, Fuller and Mezei 2009):

$$ROV = \frac{\int_0^{\infty} A(x)\,dx}{\int_{-\infty}^{\infty} A(x)\,dx} \times E(A_+) \quad \text{..... [2]}$$

whereas :

A = NPV fuzzy data

$E(A_+)$ = average fuzzy in positive range of A.

$\int_0^{\infty} A(x)\,dx$ = area width in positive range.

$\int_{-\infty}^{\infty} A(x)\,dx$ = entire area width where A is located.

From equation [2] above, it can be learned that if all value distribution is located in a range bigger than zero, $0 < (a-\alpha)$, then the entire triangle is located in positive range (Collan and Heikkila 2011 and Colan 2014), then :

$$E(A_+) = a + (\beta - \alpha)/6 \quad \text{..... [3]}$$

If value distribution is partially in a range smaller than zero, $(a-\alpha)<0<a$, then part of triangle is located in negative range of abscissa, and a is located above zero, then,

$$E(A_+) = a + [(\beta - \alpha)/6] + [(\alpha - a)^3 / (6\,\alpha^2)]. \quad \text{... [4]}$$

If value distribution partially in a range smaller

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Table 2. Present Value Factor

N (year)	1	2	3	4	5	6	7	8	9	10
Factor, i = 7 %	0.935	0.873	0.816	0.763	0.713	0.666	0.623	0.582	0.544	0.508
Factor , i = 15 %	0.87	0.756	0.658	0.572	0.497	0.432	0.376	0.327	0.284	0.247

Source: Averkamp, 2004

than zero, $(a-\alpha)<0<a$, then a part of triangle is located in negative range of abscissa, and a is located below zero, then,

$$E(A_+) = (a+\beta)^3 / (6 \times \beta^2). \quad \text{..... [5]}$$

If the entire triangle is located in a negative range of abscissa, the calculation does not need to be conducted since $E(A_+) = \text{zero}$.

The way to get and drop various equations above is not a part of this paper since it can be studied from various sources (Collan, Fuller and Mezei 2009, Collan and Heikkila, 2011). The aim of the discussion here is to elaborate how the method is employed for patent valuation in governmental R&D institution.

IV. Example of Patent Valuation by POM Method.

Employment of POM method for patent valuation is epitomized as follows. By using data from Table B and C (Attachment), and determining registration year as 0 (zero), and cost value evaluation from inflation at 7% per year, and devaluation (discounted) of income due to several factors as inflation, interest, and others at 15% per year, and using Present Value Factor as in Table 2, and other costs as in Table 3, then there will be calculation as depicted in Table 4 to 6.

Present Value (PV), and total cost are calculated from adding up of maintenance cost and other costs (Table 3) for each scenario each year, based on equation [1], with the rate of i = 7% (Table 4). For example, in year 1, for best scenario, total cost is IDR 51.2 million, then the Present Value is IDR 47.872 million.

Potential income for patent owner comes from license payment, and other income is calculated as seen in Table 5. In this calculation example, the license payment is assumed as initially received in year 2 after patent registration in optimism scenario and best scenario, but in year 3 for pessimism scenario. Income value in Table 5 is calculated based on the estimation whereas the income is relatively small at the beginning of license, then increases according to market development until year seven. After 7 years of using technology, it is assumed that licensee's income has become stable, that after year 7, income of patent owner from royalty and other income are considered constant. For pessimism scenario, it is assumed that income

Table 3. Patent Maintenance Cost and other Cost each year (IDR 000)

Time (th) Type	0	1	2	3	4	5	6	7	8	9	10
Maintenance cost and 10 claim cost (a)	3,225 (b)	1,200	1,200	1,200	2,000	2,000	3,000	4,000	4,000	5,000	6,000
Other cost: Optimism scenario (c)		30,000	30,000	25,000	20,000	20,000	5,000	5,000	3,000	3,000	2,000
Other cost: Best scenario (d)		50,000	50,000	50,000	40,000	40,000	10,000	10,000	5,000	5,000	5,000
Other cost: pessimism scenario (e)		75,000	60,000	60,000	50,000	50,000	20,000	20,000	10,000	10,000	10,000

Explanation:

(a) Patent maintenance cost is calculated based on Government Regulation No. 38, year 2009 on PNBP Department of Law and Human Right (Table A, Attachment 2).

(b) 10 claim applicant cost, substance examination cost and certificate publication cost (if granted) is calculated concurrently at year zero. At this year zero, Patent valuation is also conducted.

(c, d, e). This cost is the cost patent owner needs to pay for marketing and promotion of related technology, both in form of exhibition, brochure, seminar, and others. This cost depends heavily on the program and competency of patent owner in promoting. This other costs can be drafted based on expert judgment. For example, the cost at best scenario (d) is calculated based on: the cost for 2 exhibitions per year, IDR 15 million each, and promotion cost IDR 20 million per year for the first 3 years. This cost provided by patent owner declines in the next year. By the 5th year, exhibition is considered unnecessary; promotion is only conducted in other form. Cost at c) is set lower than at d) and in pessimism scenario (e) is set as such that the cost for promotion is big, while the income is small.

Table 4. Present Value from Total Cost in Table 3 (IDR 000)

Time Type	0	1	2	3	4	5	6	7	8	9	10	Total
Maintenance cost and 10 claim cost.	3,225											
Other cost: Optimism scenario		29172	27237.6	21379.2	16786	15686	5328	4984	3492	4352	4064	132480.8
Other cost: Best scenario		47872	44697.6	41779.2	32046	29946	8658	8099	4656	5440	5588	228781.8
Other cost: Pessimism scenario		71247	53427.6	49939.2	39676	37076	15318	14329	7566	8160	8128	304866.8

keeps increasing.

Net Present Value (NPV) is the difference between income and cost from Table 4 and 5 as shown in Table 6.

From Table 6, a triangle can be drawn as in Figure 4. Since the location of Value Minimum point is below zero, some of the triangle is located in negative range, and "a" is above zero, then to determine Real Option Value (ROV) equation [4] is used. From the calculation, ROV for year 0 (2014), is at IDR 388,960,000 with possibility rate at 0.87.

It should be noted that this ROV value excludes the research cost at IDR 1.062 billion (Table C, Attachment). If research cost is calculated, then value of a patent with data mentioned above, in 2014, is IDR 1,450,960,000,-. This value is the value of the patent stated as value of public asset or value that becomes the basis for negotiation with potential licensee when technology is transferred/licensed to other party.

Benefit and Challenge of Using POM Method.

Understanding the hardship of collecting data of a technology value, this POM method is considered appropriate to apply in governmental R&D institution since:

a. The data required to calculate the value of a patent is the data available, namely research cost, patent administrative cost based on transpired regulation, and data of potential income determined based on expert judgment. This expert judgment is used to overcome troubles in collecting market data of a technology. Thus, market data survey or other primary data collection can be avoided.
b. The value of a patent can be determined anytime needed, both for old and new registered patent.
c. The potential income that can affect patent value can be estimated based on how long the patent will be licensed. The longer the license period, the bigger the revenue to be received. In this matter, technology protection age for maximum of 20 years (Law No. 14/2001) can be used as reference for license period.
d. This method can be combined with other method, market value calculation (market approach) or income estimation (income approach), if data is available.
e. The calculation can be conducted quickly and

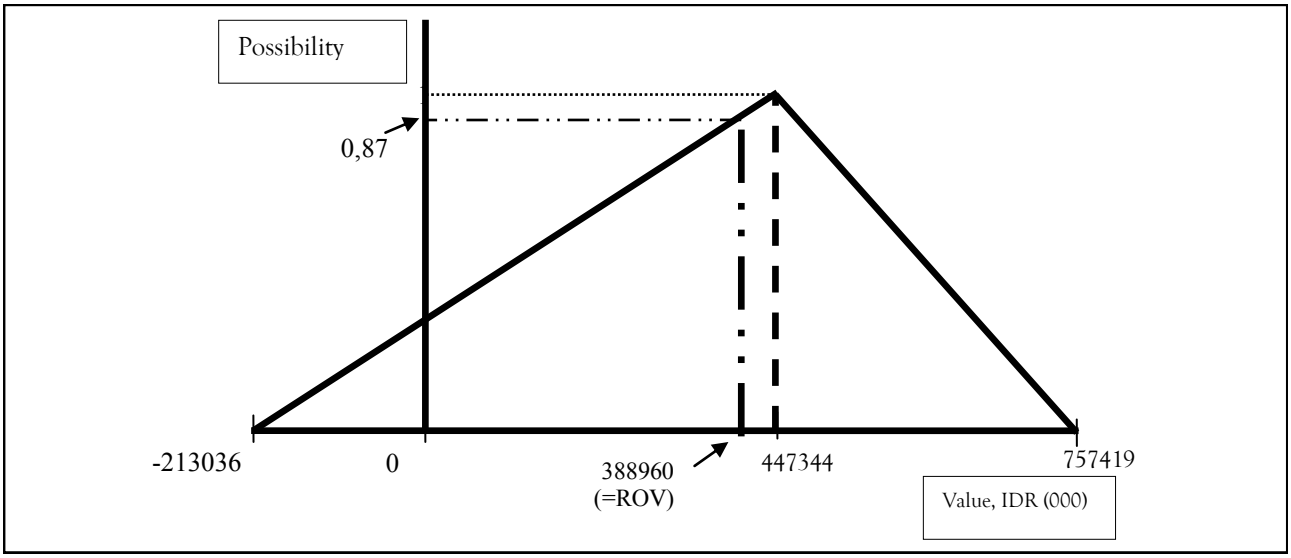

Figure 4. Example of Calculation Result (not scaled)

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Table 5. Calculation of Annual Income and Present Value of Total Income

Year	0	1	2	3	4	5	6	7	8	9	10	Total
License and Royalty Income												
Optimism	0	0	50000	75000	150000	150000	300000	350000	350000	350000	350000	
Best Scenario	0	0	30000	50000	100000	150000	200000	300000	300000	300000	300000	
Pessimism	0	0	0	10000	20000	20000	30000	30000	40000	50000	50000	
Income/Other Competitive Revenue, a)												
Optimism	0	0	5000	7500	15000	15000	30000	35000	35000	35000	35000	
Best scenario	0	0	1500	2500	5000	7500	10000	15000	15000	15000	15000	
Pessimism	0	0	0	0	0	0	0	0	0	0	0	
Present Value (PV) from Income, i = 15 %, b)												
Optimism	0	0	41580	54285	94380	82005	142560	144760	125895	109340	95095	889900
Best Scenario	0	0	23814 0	34545	60060	78277.5	90720	118440	103005	89460	77805	676126.5
Pessimism				6580	11440	9940	12960	11280	13080	14200	12350	91830

Explanation:

a Income/Other Revenue can be consultation and analysis services during license agreement period.

b Present Value of Income, is from Present Value (PV) of Total Income (License, Royalty + Other Revenue) each year in each scenario calculated with equation [1], with discounted rate, i = 15 %. For example, total income of year 3 in optimism scenario is IDR 82.5 million, for i=15 % factor is 0.658 (Table 2), so that the present value is IDR 54.285 million.

Table 6. Calculation of Net Present Value (NPV) in each scenario

No	Component	Sum of Value (10 year) Table 4 and 5	NPV (Income – cost) Each Scenario	Border point
	Total Cost 10 Year (Present Value) :			
1	Optimism Scenario	132480.8		
2	Best Scenario	228781.8		
3	Pessimism Scenario	304866.8		
	Total Income 10 Year (Present Value) :			
4	Optimism Scenario	889900	757419.2	β = 757419.2 – 447344.7 = 310074.5
5	Best Scenario	676126.5	447344.7	= a
6	Pessimism Scenario	91830	-213036.8	α = 447344.7 - (-213036.8) = 660381.5

relatively easy with the assistance of spreadsheet software like Excel or others, so that calculation can be repaired or revised quickly if new data that is more supportive is collected.

The challenge in employing POM method is the estimation of income of the three scenarios, therefore, experience and expert competency in estimating this data will affect the result of calculation.

V. Conclusion and Suggestion

5.1. Conclusion

Patent valuation, as a state asset, is an obligation of R&D institutions and universities owning the patent. This patent valuation needs to be conducted as such that it a) can show most probable value of a patent as a product of R&D financed by the government, and b) can be used as a basis for negotiation with potential licensee if the patent is used by other party commercially. If patent of R&D institutions and universities is employed by other party incapable of paying royalty, for example small business, then this patent valuation will be beneficial in calculating the state support in helping the development of small business.

The value of a patent is affected by how big the investment and revenue, as well as commercial value, that can be generated from the implementation of technology contained. Commercial value is affected by 8 factors, and the criteria to determine the influence of each factor on patent value is determined by the patent owner.

The problem in patent valuation as a state asset generated by R&D institution is the limitation of data to calculate the income/commercial value of technology patented. To solve this problem, then Compensation method (POM method) can be employed since it can surpass the limitation of information through value estimation by experts. With this method, calculation can be conducted quickly with the assistance of common software, and can be easily revised according to development of data available for valuation.

Other benefit of POM Method is that it can be used anytime needed, both for patent long or newly registered, although the time of valuation is long after the research is conducted.

This method is a device for R&D institution owning patent for patent valuation, but can also be used by technology potential licensee in order to find equality in valuation process in a negotiation process to determine the value of patent to be licensed.

5.2. Suggestion

There are many methods available to assist in patent valuation process; therefore, there is a need to select method appropriate to condition and goal of valuation. For R&D institution never conducted patent valuation, it is suggested to use historical cost approach first, and for perfection, use this POM Method. For R&D institution not used to estimating benefit, and estimating potential income from license agreement, it is suggested to conduct calculation based on "rule of thumb". By employing this approach, the minimum value of a patent as a state asset is obtained as much as the research investment value and other cost the governmental institution as patent owner should pay, thus, if this asset is used by other party, the state investment can be returned at least as much as the cost paid.

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Attachment:

A. Example of Criteria and Value of Each Commercial Factor.

Table A. Example of valuation at each commercial factor

Factor		Influence to Value		
		Low	Medium	High
Forward citation value contribution	a	0-5	6-10	>10
	b	0%	10 %	25 %
Backward citation value contribution	a	0-10	11-20	>20
	b	0 %	5 %	15 %
Enforcement licensing potential	a	0-1	2-3	>4
	b	0 %	5 %	15 %
Partnering licensing potential	a	0-1	2-3	>4
	b	0 %	15 %	50 %
Patent group	a	1-2	3-5	>5
	b	5 %	15 %	25 %
Patent group competitive position	a	1	2	3
	b	5 %	10 %	25 %
Potential licensees	a	0-2	3-5	>5
	b	0 %	5 %	10 %
In-licensee opportunity	a	0	1	2
	b	0	25 %	50 %

Explanation : a = Criteria, b) Influence to Patent Value, % from Total investment.

Criteria and Value in Table A is determined by patent owner. If owner does not have experience and experts to set criteria, assistance from patent valuating consultant can be requested.

B. Example of patent valuation based on Total Cost Approach, with DCF.

Suppose a research is conducted for 5 years (2007 - 2011) and produces a patent with 10 (ten) claims. Patent is registered in 2012. In year 2014, patent is valuated since it has to be recorded as public asset or will be licensed to licensee. Value of the patent in year 2014, is total costs for producing technology until 2011, and other costs such as registration cost, patent maintenance, etc. until year 2014. All these costs are then calculated to value in year 2014.

Suppose 5 years of research activities spent the cost (material, worker fee, etc.) of IDR 150 million each year. This cost exclude employee fee if the actor is Civil Servant. Registration cost, patent examination, maintenance cost, and others, based on transpired regulation (Government Regulation No. 38/2009 on PNBP Department of Law and Human Rights), table B. Then, patent value in year 2014 can be calculated by using common equation PV [1].

No	Cost	(thousand rupiahs)	Explanation
1	Patent applicant	575	
2	Cost of each claim	40	
3	Substance examination	2000	
4	Certificate	250	(if granted)
5	Registration of license agreement recording	1000	(after license agreement)
6	Maintenance : Year 1to 3 (10 claims) per year	1200	For 10 claims
	Year 4 to 5	2000	
	Year 6	3000	
	Year 7 and 8	4000	
	Year 9	5000	
	Year 10	6000	

By using equation [1], with calculation of cost value change at 7% per year, and registration and maintenance cost, for a patent with 10 claims, patent value in year 2014, can be calculated quickly by using spreadsheet, will generate results as in Table C.

Table C. Example of patent valuation based on Cost Approach

No	Activity Cost	Value in related year (IDR million)	Value in 2014 (IDR million)
1	Research Cost in 2007	150	240.86 (a)
	Research Cost in 2008	150	225.11
	Research Cost in 2009	150	210.38
	Research Cost in 2010	150	196.62
	Research Cost in 2011	150	183.75
2	Adm. patent registration in 2012	2.975	3.41
3	Maintenance cost in 2013 and 2014	2.4	2.48
4	Total cost until 2014	755.375	
5	Patent Value in 2014		1,062.61 (b)

(a) Present money value from investment in 2007 at IDR 150 mil, based on equation [1]: $150(1+0.07)^7$, whereas n=7, seven years from 2007 to 2014.
(b) Present Value from total investment.

From Table C, it can be comprehended that total investment to generate patent since 2007 is IDR 755,375,000 and value of the patent in 2014, based on research cost and patent administrative cost alone, becomes as big as IDR 1.062 billion.

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