VALUATION OF AERONAUTICS AND SPACE TECHNOLOGY AT LAPAN

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Abstract

New challenges arises for government institutions engaged in research and engineering to continuously innovate and develop technologies that have competitive advantages and provide income for the country through royalty from licensed technology. This research carried out to valuate the aeronautics and space technology. The objective of the study is to develop appropriate intellectual property valuation methods. This research is a case study utilizing sequential mix method which is the combination of quantitative and qualitative research. By using intellectual capital theory, this research-broaden the literatures on the technology valuation in the field of aeronautics and space. This study fills research gap on the existing technology valuation method that is still partially conducted by government research and development.

This study discusses the value of intangible assets and licenses from intellectual property that are calculated through three valuation approaches, such as cost-based approach, income-based approach, and market-based approach. The results of the study show that the most appropriate intellectual property valuation method are the cost-based approach and income-based approach.

JEL Classification: O30, O31, O33

Keywords: Cost Based Approach, Income Based Approach, Intellectual Property, Market Based Approach, Sequential Mix Method

1.   INTRODUCTION

Globalization has created challenges as well as opportunities for countries that actively and passively take part in the world economic system. Based on publications published by The Organization for Economic Co-operation and Development Globalization has created challenges as well as opportunities for countries that actively and passively take part in the world economic system. Based on publications published by The Organization for Economic Co-operation and Development (OECD Factbook, Population and Migration, 2013), in 2020 the world population will reach approximately 7 billion people. Based on projections issued by the Statistics Indonesia (BPS, 2017), in 2020 Indonesia will reach more than 271 million people. Knowledge-based economics is based on production, distribution, and the use of knowledge. The biggest contributors to economic growth are human and social resources which are seen as very valuable assets that are able to increase productivity, added value and increase competitive advantage.

The Global Competitiveness Ranking Index issued by the World Economic Forum (Schwab, 2018) show the position of national competitiveness at the global level with indicators: human capital, markets, environment, and innovation, where Indonesia ranks 34 in 2015, 37 in 2016, 47 in 2017, and ranked 36 in 2018. According to data from the World Intellectual Property Organization (WIPO, 2018) showing the ranking of intellectual property ownership, Indonesia ranked 85 in 2013, 87 in 2014, 97 in 2015, 88 in 2016, 87 in 2017 and ranked 85 in 2018.

As a government institution engaged in research and engineering, the Indonesian National Institute of Aeronautics and Space (LAPAN) has the task of conducting research and development in the field of space technology regulated by Presidential Regulation No. 49 of 2015 concerning the Indonesian National Institute Aeronautics

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and Space and Law No.21 of 2013 concerning Space, which became the basis and legal standing in the space management. In the mandate of Government Regulation No. 20 of 2005 concerning Transfer of Intellectual Property Technology as well as Result of Research and Development by Universities and by Research and Development Institute which mentioned the mechanism of technology transfer includes (1) licenses; (2) cooperation; (3) science and technology services; and/or (4) publication, where the value of technology is needed in negotiating license agreement.

Intellectual property is categorized as intangible assets where the valuation involves inventors (researchers) as technology makers and LAPAN as research funding providers. Until now there has been no standard policy in Indonesia to regulate in detail about technology valuation technique or approach used, and benefits of patent appraisal. The formulation of technology/intellectual property valuation is still partial, this is evidenced by every ministry and institution that has a research and development division, formulates its own technology/intellectual property valuation through the regulation of heads of institutions or related ministers.

LAPAN is a non-ministerial government institution that carries out government duties in the field of aerospace research and development and its application, as well as the implementation of space in accordance with the provisions of legislation. As one of the government institutions producing intellectual property, LAPAN needs to make a method to calculating technology valuation that does not only assessing patents value but also calculates the flows of the investments in technology, licensing value, and the value of royalties from utilizing technology. The method of calculating the value of technology is formulated into the guideline to conduct Aeronautics and space technology valuation, in the form of regulations signed by Head of LAPAN. This research will answer the question about how the technical calculation of monetary value (valuation) on technology resulting from space research at LAPAN and determine the most appropriate valuation method to be applied in LAPAN.

In previous studies, technology valuations have been carried out in agriculture, manufacturing and pharmacy. However, until now the valuation of technology in the field of space has never been done in Indonesia. Technology/intellectual property valuation has been carried out by several parties such as: Modeling and Designing of Patent Oriented Technology Valuation Systems in the Bogor Agricultural University (IPB) by (Dharmawan, 2006); "Model for the Evaluation of a Technology Established in a Manufacturing System" by (Schuh et al, 2012); and "Valuation of Compound Real Options for Investments in Innovative Projects in Pharmaceutical Industry" by (Baranov & Muzyko, 2015). This study uses the Intellectual capital theory as described by (Stewart, 1997), and analyzed using Business Process Analysis, SWOT Analysis, and Soft System Management (SSM). The research methodology used is in the form of case studies, where the data sources used are primary and secondary data and data are collected using mixed methods (quantitative and qualitative).

Ellet (2009, p.20) explains that there are four benefits of research from the results of case studies, namely problem solving, decision making process, evaluations, and rule determinations. The research of the case study must have direct benefits for the object of research, so it is expected that this research can be used as a basis for valuating the results of research, development and engineering of aeronautics and space technology at LAPAN and become a reference for other research and development institutions. This research was carried out at Center for Aerospace Innovations and Standards (Pusispan) at LAPAN and limited only to the technology which has been registered in Directorate General of Intellectual Property (DJKI) and had commercialization potential.

The systematics of writing consists of 5 chapters: 1) Background, contains an explanation of the research background; 2) Literature Theory and Study, containing theories and concepts related to research themes; 3) Research methodology used; 4) Findings, which contain discussion and description of research objects; and 5)

Conclusions, containing conclusions from the results of the research and suggestions for what can be given to the government, especially LAPAN.

2. LITERATURE THEORY AND STUDY

Intellectual Capital is all things that are known and given by everyone in the company, which provides competitive advantage, which contains intellectual material (knowledge, information, intellectual property rights, experience), and used to create wealth (Stewart, 1997). Intellectual capital is classified into 3 categories: Human Capital refers to human skills, knowledge and abilities (Harris, 2014); Structural Capital refers to the capabilities possessed by the organization as a whole, such as: technology, inventions, scientific publications, patents, copyright, protection of trade laws (Stewart, 1997); and Customer Capital refers to the most valuable component which is based on the assumption that customers can support the company's operations and provide benefits to the company (Stewart, 1997).

In addition, many studies which use Intellectual property rights theory (HAMI) were influenced by John Locke's in his book Two Treatises of Government concerning property rights. With the emergence of a new theory of Intellectual Property, I. Kant in his book "Von der Unrechtmäßigkeit des Büchernachdrucks" in 1785 emphasized that the inventor has rights that cannot be seen in his work, which is called "ius personalissimus", namely the right of birth from within itself (personality rights) by (Syafrinaldi, 2010).

This study uses business process analysis of managing innovation in LAPAN environment using the approach of input-process-output popularized by (Aguilar-Savén, 2004) "Business process modeling: Review and framework" and and uses SWOT analysis which is defined as the analysis based on logic which not only maximize the strengths and opportunities, but also minimize your weaknesses and threats (Rangkuti, 2013). The researcher also conducted a Soft System Management (SSM) analysis in which a systematic process of questions in the conceptual problem-solving process compared to relevant real-world situations (Checkland & Poulter, 2010).

LAPAN's technology/intellectual property is classified as Intangible Assets which are non-monetary assets that can be identified but do not have physical form and used in producing or delivering goods or services, leased to other parties, or administrative purposes, which are controlled by the institution as due to past events and is expected to generate economic benefits in the future within estimated period of time when the asset utilized by the institution; or the number of production units or the like that is expected to be obtained by the institution from these assets (PSAK 19, IAI, 2015).

Intellectual property is wealth that arises from human intellectual abilities through creativity, taste and intention in the form of work in the fields of technology, science, art and literature (PP No 20 Tahun 2005). According to (WIPO, 2016) in its book "What is Intellectual Property", states that intellectual property refers to the creation of thoughts in the form of discovery; literary and artistic works and symbols; names and images used in trading, and divided into two categories: 1) Industrial property includes patents for inventions, trademarks, industrial designs and geographical indications; and 2) Copyright includes literary works (such as novels, poetry and drama), films, music, artistic works (for example: pictures, paintings, photographs and sculptures) and architectural designs.

Technology valuation methods that can be used, among others: 1) Cost-based method, calculate the historical cost that has been expended in creating and developing an intellectual property, or the cost to reproduce, or the cost of replacement for developing; 2) Market based method, observing the price of the same intellectual property assets purchased and/or sold by an independent party, or comparing the amount of royalties from licenses that give the value of a similar intellectual property asset (European Commission, 2014). This can happen if the market price of similar intellectual property assets can be obtained directly from the active market. According

to (Bader & Rüether, 2011), the market is active if meets the following three conditions: a) goods in a homogeneous market, b) buyers and sellers are willing to enter into an agreement; and c) prices can be known to the public; 3) Income based method, based on the assumption that the value of an intangible asset is seen from the future success of the asset in the form of cash flow (Bader & Rüether, 2011), which is determined as the present value of potential future cash flows that calculated based on a business plan (Menninger et al, 2011). The determination of the present value is applying a risk-adjusted discount rate of the intangible assets during the remaining economic useful life.

There are various technology valuation methods which use cash flow generated by intellectual property and discount rates, including Discount Cash Flow (DCF), Discounted Future Economic Benefits (DFEB), Relief-from-Royalty Method, and others. The DCF and DFEB approach is used to calculate the present value of future cash flows of an intellectual property over its useful life with two main factors: the time value of money and the estimated level of cash flow risk. The relief-from-royalty method is used to determine the amount of royalty that the other party must pay to license an intellectual property.

As a research comparison, the researcher analyzed studies that were carried out by: 1) Budi Dharmawan (2006) entitled " Model of Technology Valuation System of Patent-Oriented Process (Case Study On Composition Of Cajuput Candy As Throat Relief)" using the Ordered Weighted-Averaging (OWA-Operator) analysis method; 2) Schuh et al. (2012) with the research "Model for the Evaluation of a Technology Established in a Manufacturing System", which developed a manufacturing technology value method that is expected to eliminate the complexity of calculating the value of manufacturing technology that continues to evolve using discounted cash flow analysis method; and 3) Baranov & Muzyko (2015) with research on " Valuation of Compound Real Options for Investments in Innovative Projects in Pharmaceutical Industry ", which use real options method (investment valuation method) to calculate the value of investment in innovative projects in Russia.

Based on the previous study above, the valuation of technology especially in the field of space has never been done in Indonesia. The approach taken for valuation of space technology/intellectual property, namely Market Approach, Income Approach, and Cost Approach. The research framework designed to facilitate understanding the research process can be seen figure 1.
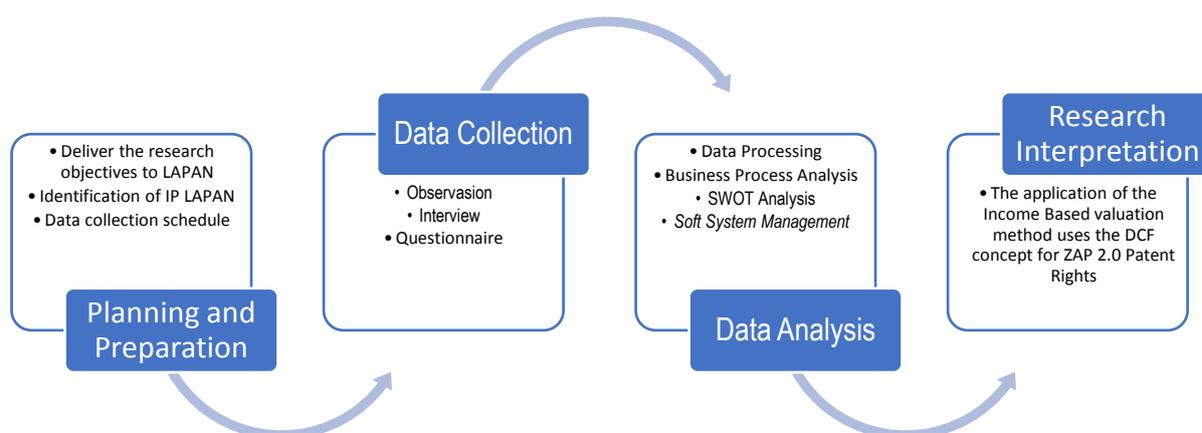

Figure 1 Research Framework
Source: Author

This research is a case study at the Center for Innovation and Space (Pusispan) which is a work unit of the National Aeronautics and Space Institute (LAPAN). The data used in this study are primary data and secondary data. Primary data was obtained from interviewer, namely the head of the center, head of innovation, head of the technology transfer sub-field and several personnel under the innovation field, such as data technology business process data at LAPAN, Pusispan organizational conditions, LAPAN intellectual property data, prospective business partner data, and criteria technology that is ready to be commercialized. Secondary data can be in the form of data from books, journals and scientific works, intellectual property documents, financial planning documents, photos, videos, writings and other information from the internet related to research.

3. RESEARCH METHODOLOGY

This section explains how to build a valuation method for aeronautics and space technology that is appropriate for LAPAN. This research is a case study that can dig deeper into the valuation process of aeronautics and space technology at LAPAN by developing a valuation method that is fit and in accordance with the characteristics of LAPAN technology and organization structure. The method used in data collection is sequential mix-method, which combining qualitative and quantitative methods. Qualitative methods are used to understand the strategic conditions of LAPAN and provide adequate explanations from experts at LAPAN. Quantitative methods are used in the process of data analysis and processing. This qualitative method is quantified through the process of codification (Shauki, 2018).

The data used in this study are primary and secondary, primary data obtained consist of data of technology transfer business process at LAPAN, the condition of the Pusispan organization, data of LAPAN intellectual property, data of prospective business partner, and technology criteria that are ready to be commercialized. Secondary data gathered from books, journals and scientific works, intellectual property documents, financial planning documents, photos, videos, writings and other information from the internet related to research.

The research instruments used in the form of: 1) observations made by observing directly to the activities that occur from business process or object studied; 2) interviews the parties related to process of research, development, and engineering of aeronautics and space technology, such as researchers, head of research center, and other related parties; 3) giving a questionnaire; 4) documentation; 5) corporate website; and 6) document review.

 The analysis used in this study is 1) Process Business Analysis, which is carried out to fully understand the business processes of technology transfer activities and to know the potential areas that can be improved and developed; 2) SWOT analysis, carried out to capture current conditions of LAPAN as a basis for preparing technology transfer strategies; 3) Soft System Management (SSM), used in building working system designs that have human aspects as the main problem. This system is needed to reconstruct a more soft and interpretive methodology to investigate human activities (Bhaskar et al, 2006).

According to (Checkland, 1981), there are seven levels in implementing this SSM, namely: 1) Identification of situations from unstructured problems; 2) Descriptios of existing problems; 3) Formulation of root definitions from relevant system; 4) Building a conceptual model; 5) Comparing models with reality; 6) Establishing appropriate changes; and 7) Take action to correct the situation.
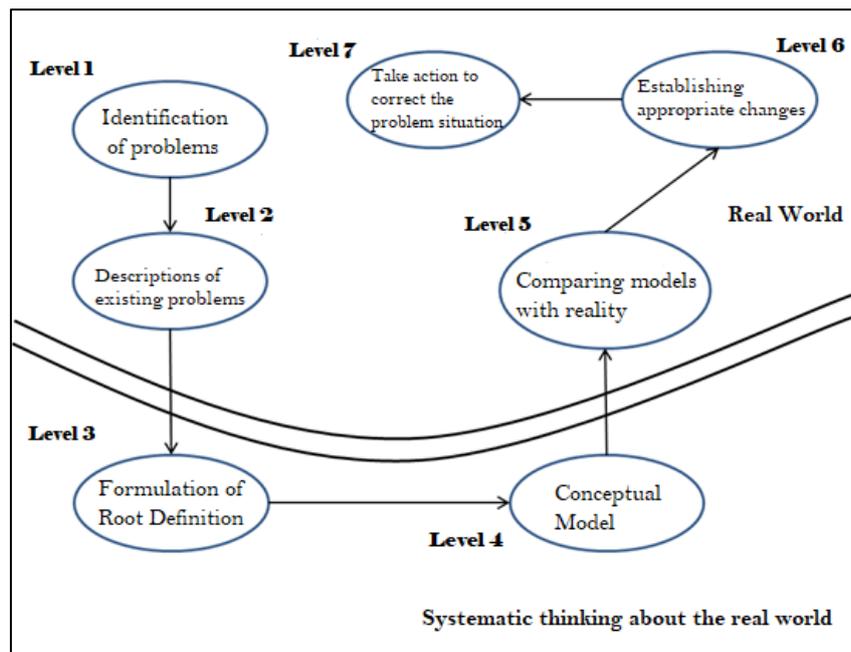
Figure 2 Soft System Methodology
Source: Adapted from the Seven-Stage Model of SSM, (Peter Checkland, 1981)

This research was conducted at LAPAN, LAPAN is responsible directly to the President under coordination minister of research, technology, and higher education, who has mandate to carry out government duties in the field of aerospace research and development and its utilization as well as the implementation of space in accordance with the provisions of legislation. In performing this main task, LAPAN has functions as follows: 1) Preparing national policies in the field of research and development of space and atmosphere science, aeronautics, space technology, remote sensing and their implementations; 2) Conducting research and development on space and atmospheric science, aeronautics and space technology, and remote sensing and their implementations; 3) Space management; 4) Coordinating functional activities in performing LAPAN tasks; 5) Guiding and supporting administratively all units in LAPAN; 6) Conducting aeronautics and space strategic policy studies; 7) Carrying out aeronautics and space technology transfer; 8) Managing aeronautics and space standardization and information systems; 9) Supervising the implementation of LAPAN duties; and 10) Submission of reports, suggestions, and considerations in the field of research and development of space and atmosphere science, aeronautics and space technology, and remote sensing and their implementation.

Pusispan is supporting unit that is functionally under and responsible directly to Head of LAPAN and administratively under and responsible to the Main Secretary. In the context of innovation, Pusispan has task to carry out the assessment and development of innovations and standards in the field of aeronautics and space. It has three pillars: 1) Management of Technology, which has task to trace intellectual property (IP) in LAPAN, IP valuation for determining intangible assets, and IP management; 2) Transfer of Technology, which has task of strengthening technology transfer and implementing technology valuations; and 3) Standard, has the task of formulating, establishing, implementing, monitoring and reviewing aeronautics and space standard (source: www.lapan.go.id).
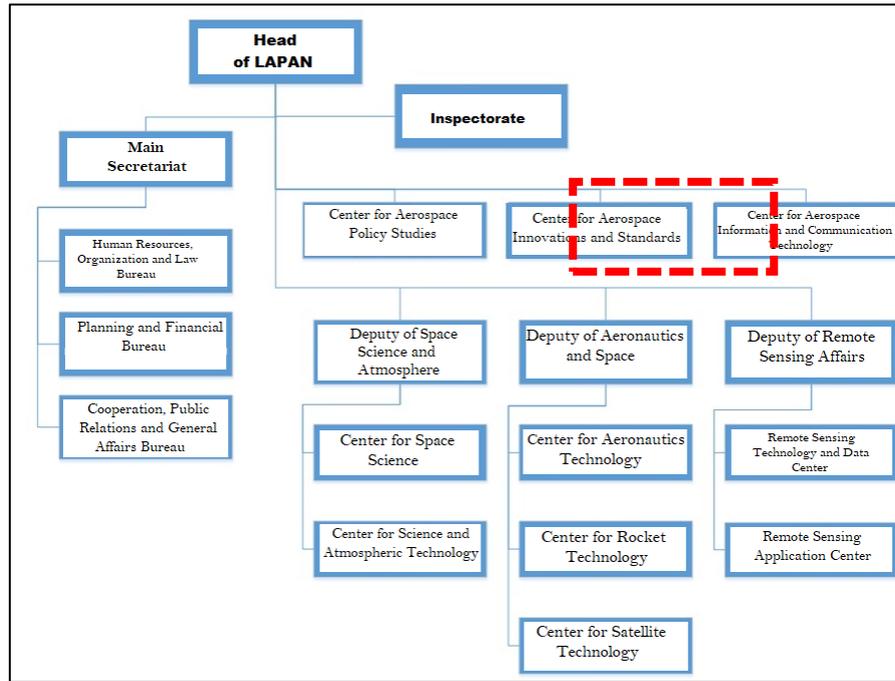
Figure 3 LAPAN Organizational Structure
Source: www.lapan.go.id

4. RESULT

This section explains the analysis of research results including the general description respondents and data acquisition in order to summarize and discuss the research findings. The research instruments used were observation, interviews and questionnaires.

4.1. Findings

The research carried out will answer the problems on intellectual property owned by LAPAN associated with the Intellectual Capital theories and Intellectual Property Rights. LAPAN's intellectual property provides competitive advantages and is categorized as structure capital protected through statutory regulations if it is registered to Directorate General of Intellectual Property (DJKI)

4.1.1. Observation

Observation conducted to systematically obtain data of LAPAN's technology/intellectual property flow. This observation was perfomed at the Pusispan by involving technical units which undertaking research, development and engineering of aeronautics and space technology at LAPAN.

4.1.2. Interview

Semi Structured Inverview performed by asking interviewees 6 open questions then followed-up by deeper questions to get more information about their understanding of technology or intellectual property valuation owned by LAPAN. The target audience are 6 respondents consist of parties related to LAPAN's intellectual property valuation. From the target, the researcher managed to interview 2 respondents. This research instrument has 3 themes: 1) The importance of valuing intellectual property rights of LAPAN; 2) LAPAN intellectual property rights valuation method; and 3) Commercialization of LAPAN intellectual property rights.

4.1.3. Questionnaire

Questionnaire target are the inventors (researchers) at LAPAN who has registered their technology/intellectual property rights to DJKI and ready to be commercialized. From 251 inventors, this research is limited to 26 people based on the Head of the Pusispan Official Memo Number: 172/JT.02/04/2019/Pusispan dated 15 April 2019 with the consideration that 26 respondents already have intellectual

property that has been registered in the DJKI and has investors who are interested in licensing. This questionnaire has 33 questions about LAPAN's intellectual property rights. In table 1. we can see that the target respondents are 26 people. From the target, only 16 people filled out the questionnaire, of which 13 were male and 3 were female. Respondents who filled out questionnaires averaged 35-44 years old and majority of the respondents are researchers at LAPAN.

Table 1 Demographics of Respondents

No.	Description		Amount	Percentage
1.	Target Respondents		26 people	100,00%
2.	Respondents filled out the questionnaire		16 people	61,54%
3.	Gender	Man	13 people	81,25%
		Women	3 people	18,75%
4.	Age	18-24 years old	-	-
		25-34 years old	2 people	12,50%
		35-44 years old	8 people	50,00%
		45-54 years old	4 people	25,00%
		55-64 years old	2 people	12,50%
		65 years and above	-	-
5.	Works	Head of Center/Bureau	2 people	12,5%
		Head of Division/Field	1 people	6,25%
		Head of Sub Division/Field	1 people	6,25%
		Head of Research Group	-	-
		Researcher	9 people	56,25%
		Engineer	2 people	12,5%
		Others	1 people	6,25%

4.2. Discussion
4.2.1. LAPAN Intellectual Property Valuation

Research carried out through observation, interviews, and questionnaires answers the first question of research regarding the importance for LAPAN as a research, development and engineering institution in the field of aeronautics and space to conduct valuations or assessments of technological results or intellectual property. This intellectual property valuation process starts from inventors (researchers) conducted research on LAPAN technology, registered to the DJKI to obtain patent certificate, until intellectual property rights can be utilized and commercialized.

Table 2 List of LAPAN's Intellectual Property

No.	Types of Intellectual Property	Number of DJKI Register Status						Total
		Registered/ Recorded	Certified	Rejected	Publication	Formality	Substantive	
1.	Patent	37	15	3	16	19	2	92
2.	Industrial Design	6	4	-	-	-	-	10
3.	Copyright	8	-	-	-	-	-	8
4.	Brand	1	-	-	-	-	-	1

Of total 92 patents, there are 4 patents that are ready to be commercialized and already have investors including. LAPAN's intellectual property do not have a value that can be used as basis for recording Intangible Assets in LAPAN financial statements and as basis value for licensing intellectual property. For this reason, an appropriate valuation method is needed to calculate the value of LAPAN's intellectual property.

4.2.2. Application of Soft System Management (SSM) in the Development of a Valuation Method

Designed valuation methods must consider needs and perspective of the inventor and prospective business partners. SSM offers series of steps that can be followed in meeting the established criteria

Table 3 Stages of Soft System Management

Stages	Description	Information
Identification and description of problems	There is no proper measurement tool for evaluating the results of research, development and engineering of aviation and space technology at LAPAN	Clear regulations related to technology transfer, recognition of intangible assets in financial reporting
The formulation root definitions of the system are relevant	*Roof definition is a statement that naturally describes the foundation of a system when viewed from a certain perspective* (Checkland, 2002)	Use the CATWOE technique consisting of Client-C, Actors-A, Transformation-T in this case the construction of the valuation method, views on the importance of "T" (Weltanschauung-W), the owner of "T" (Ownership-O), and limitations of the system environment (Environment-E)
Build a conceptual model	The conceptual model of valuations made must have criteria that are relevant to the current condition of Puspanpan LAPAN as a valuator of the results of the LAPAN invention.	Apply the Market Approach, Income Approach, and Cost Approach to LAPAN inventions that will be commercialized
Compare models with reality	The proposed valuation concept model is compared with real world conditions in the context of aviation and space technology and organizational context.	Adjust which valuation approach is the most appropriate and beneficial for inventors, LAPAN, and investors
Set valuation methods and actions to correct the problem situation	This stage encourages the emergence of recommendations for improvements to the concept being built.	Apply the valuation method to all results of the invention that have the same criteria through the Head of the National Aeronautics and Space Agency's Regulation on Valuation Guidelines for Results of Research, Development and Engineering of Aeronautics and Space Technology

Formulation of root definition is a statement that describes the foundation of a system when viewed from a certain angle (Checkland & Poulter, 2010). Following is the CATWOE construction framework of valuation methods for aeronautics and space technology.

Table 4. *Root definition of the LAPAN Valuation Method*

Element	Theoretical	Practice
C (*Customer*)	Who benefits in the system	Intellectual property owner (IP) in terms of the inventors of LAPAN
A (*Actors*)	Who does the valuation	Technology Valuator (Pusispan)
T (*Tranformation*)	From the input process to the output	The valuation process from material collection to valuation reports involving IP owners, prospective business partners, and LAPAN management
W (*Weltanschauung*)	A broad view of valuators	To assist IP owners in conducting licensing negotiations with prospective business partners
O (*Owners*)	Who controls the valuation process	Head of LAPAN through the LAPAN Chief Decree regarding the implementation and revocation of valuation methods
E (*Environment*)	Environmental restrictions that need to be taken into account	Labor relations, understanding of the administrative personnel of the valuation process, the availability of resources, workload valu a tor, knowledge of other sources

4.2.3. LAPAN Intellectual Property Valuation Method

Valuation of LAPAN's IP has benefits, among others, as a basis for recording the acquisition value of intangible assets in LAPAN's financial statements and as a basis for determining the value of licensing. The technical calculation of monetary value (valuation) on technology, from the results of space research at LAPAN can be performed using valuation method, such as:

Cost Based Approach

Kaldos (2009) states that in a cost-based assessment, the cost of developing intellectual property (IP) assets is considered equivalent to the value of the asset. The historical costs incurred by IP owners to develop asset intellectual property are equal to current asset prices. Calculation of technology value/patent using a cost approach can be done by calculating the historical cost that has been incurred in making and developing an intellectual property, or the cost to reproduce IP, or a replacement cost for developing another IP similar.

Based on the interviews conducted, the cost-based approach method is hard to calculate acquisition value of intangible assets as basis for determining the value of patents. LAPAN uses IP calculation methods adapted from LIPI (2017), weighting methods, in which this calculation is based on the output value of IP after deducting the cost of building a prototype and other irrelevant costs coupled with the value of the process of IP protection.

The cost of the process of protecting intellectual property is all costs incurred using the APBN in the context of submitting the protection rights of an intellectual property from registration to receipt of protection rights marked with a certificate. The cost of the protection process can be formed, but not limited to: registration fees, accelerated publication costs, substantive examination fees, certificate issuance costs, and other costs.

Formulation of The Research Cost Weighting cannot be traced (LIPI, 2017)
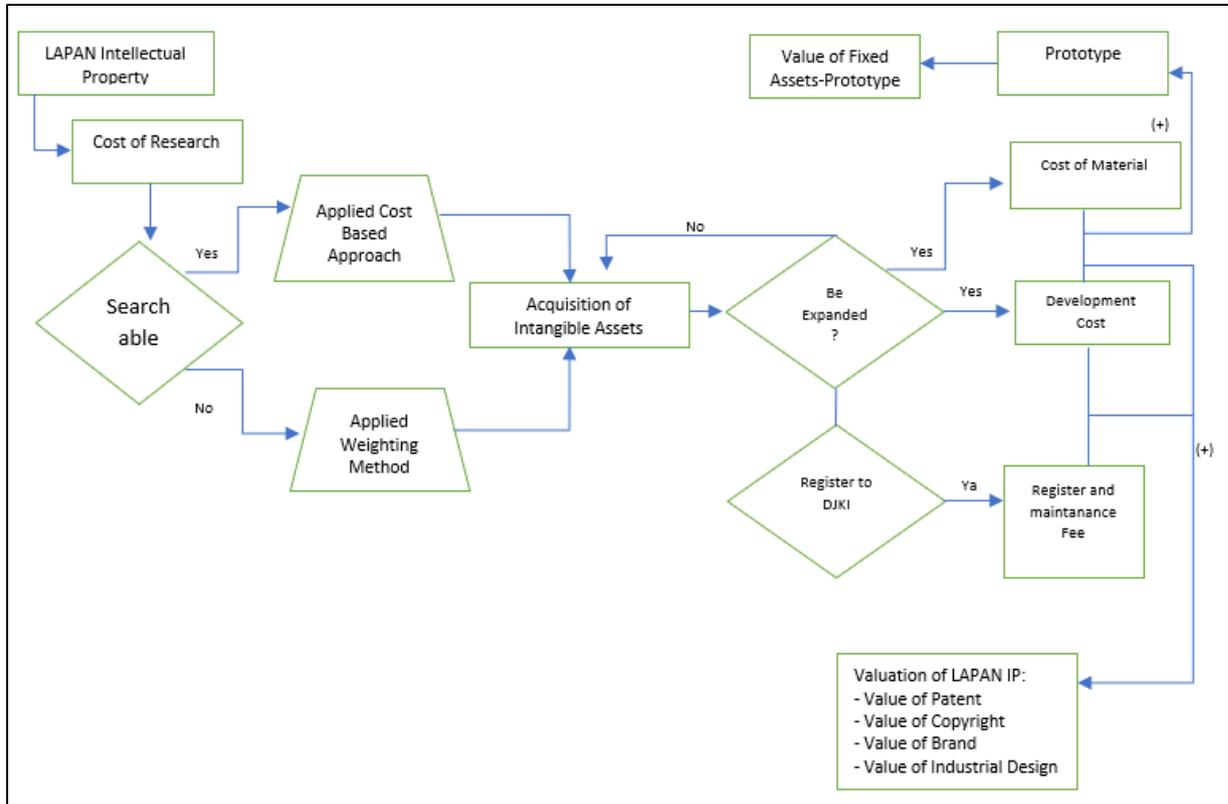
$$nKT = oKT + pKT$$

where:

$$oKT = \frac{Bk}{\sum B} N$$

Information:
nKT : Value of intellectual property/technology
oKT : Intellectual property/technology output
pKT : Intellectual property/technology protection process

Bk : Weight of certain intellectual property
B : Total output weight in one budget ceiling
N : Budget ceiling for research, development and engineering

Figur 4 LAPAN's IP Valuation with Cost-Based Approach Mechanism
Source: Author

Income Based Approach

Based on the results of the interview, this method is the best method to describe the asset value of LAPAN's IP where this method can produce relatively stable or predictable cash flows. The two main factors that must be taken into account in calculating IP asset values are the time value of money and the estimated level of cash flow risk. The researcher uses Discounted Cash Flow (DCF) to evaluate LAPAN's IP which ready to be commercialized. DCF is a method of calculating fair value by valuing net cash flows during the life of a business and discounting the value of accumulated cashflow (Damodaran, 2002).

Formulation of *Discounted Cash Flow*

$$Value = \sum_{t=1}^{t=n} \frac{CF_t}{(1+r)^t} \qquad \text{or} \qquad DCF = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n}$$

Where,

n = the age of the asset
CF_t = cash flow for period t
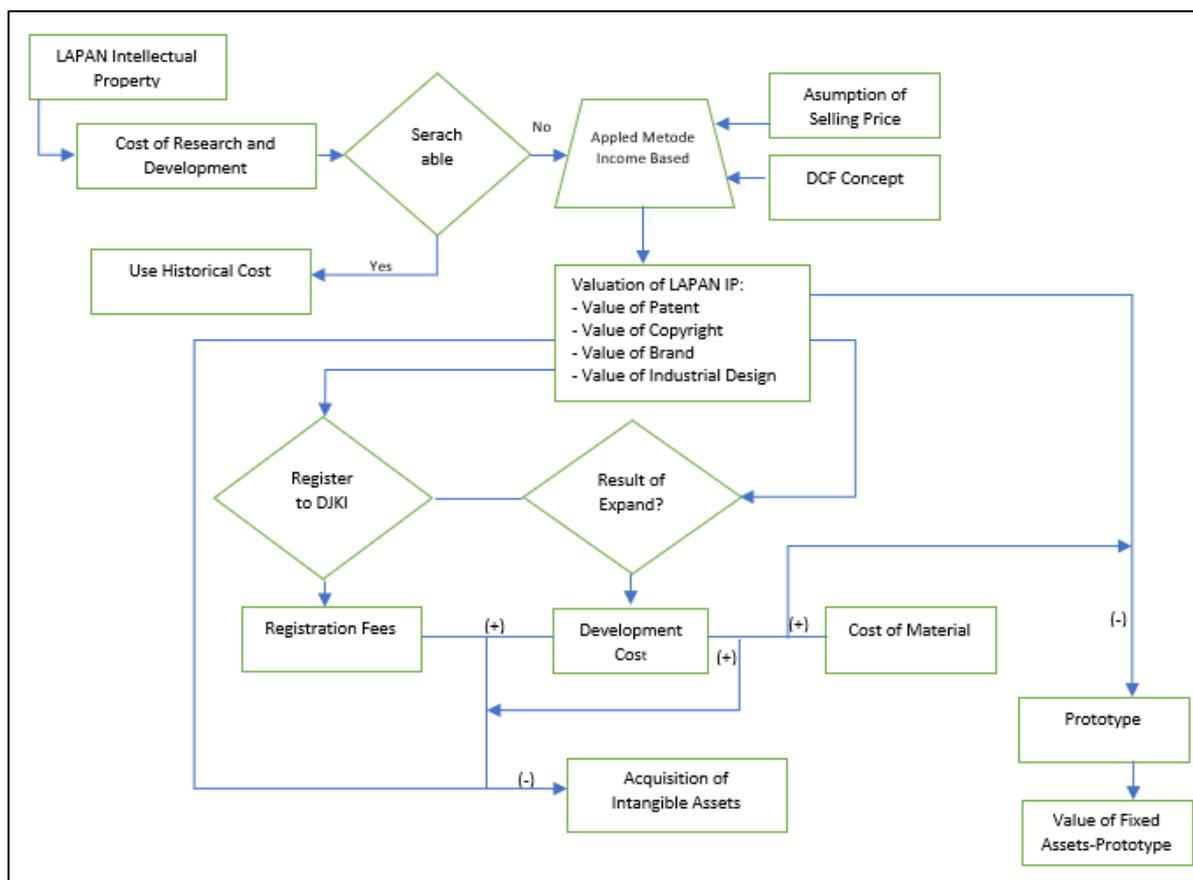r = discount rate risk estimation of cash flow

Figure 5 LAPAN IP Valuation with Income-Based Approach Mechanism
Source: Author

Market Based Approach

The market-based approach is carried out by observing the prices of similar IP assets that are traded by independent parties or comparing the amount of royalties from similar IP asset licenses to serve as the basis for providing the value of an IP asset (Kaldos, 2009). IP assets produced by LAPAN are unique so it is hard to find the exact same technology in the market and if there is any comparative information avalailable it will be contained in confidential legal agreement documents owned by other parties, so that it cannot be used as a basis for valuing LAPAN's IP assets.

Table 5 Valuation Method of LAPAN Intellectual Property Commercialization

Results of the LAPAN Invention	Valuation Method			Consideration
	Market Approach	Income Approach	Cost Approach	
Rain Monitoring System	-	✓	✓	This invention uses a navigation system originating from satellites so that it is not freely traded in the market
Aircraft N219	-	✓	✓	The technology applied in making these aircraft has been widely applied in other countries, such as China, Germany, America, and others
ChargeTest of Rocket Komurindo	-	✓	✓	Rocket technology is the secret technology of each country, so it will be difficult to find this technology on the market
ZPPI Automated Processing (ZAP) 2.0	-	✓	✓	This technology uses satellite weather monitoring technology that is very different from the satellite offered by Nusantara Sea (XL provider) on the market

4.3. Research Interpretation- Valuation ZPPI Automated Processing (ZAP) 2.0

ZPPI stands for Fishing Potential Zone. ZAP is an application processing satellite image data automatically. The result of ZAP is ZPPI information. ZAP had registered in the Directorate General of Intellectual Property in category of patents and type of patents is intangible assets. This Intellectual Property relates to a method for automatically determining potential fishing zones using ZAP 2.0 software. ZPPI information generated is daily information. The input data of ZAP 2.0 software is sea surface temperature (SPL) of Terra/Aqua (T/A) MODIS and SNPP VIIRS satellites. To detect thermal front, the Single Image Edge Detection (SIED) method is used with a threshold value of 0.5C. Results of thermal front detection is a polygon area, which it is partitioned into several polygon sections. The center point of each polygon is the ZPPI coordinar duck. The latest ZPPI information is valid for the next 2 to 3 days with a coverage radius of 3.3 km from its center. ZPPI information is provided in various formats namely: pdf, kmz, shp and Jason. The aim is to accommodate the needs of users in various sectors.

Data obtained from earth station acquisition (satellite image data) are stored in the data bank server owned by the Remote Sensing Application Center, then processed automatically using ZAP 2.0 software. The satellite image will be sent to the prospective business partner server where the prospective business partner has installed ZAP 2.0 software to make data automatically processed into ZPPI, then it will be sent to the Fisher Navigation device. Device is based on Android which has been developed by business partners to display the coordinates of the potential fishing area.
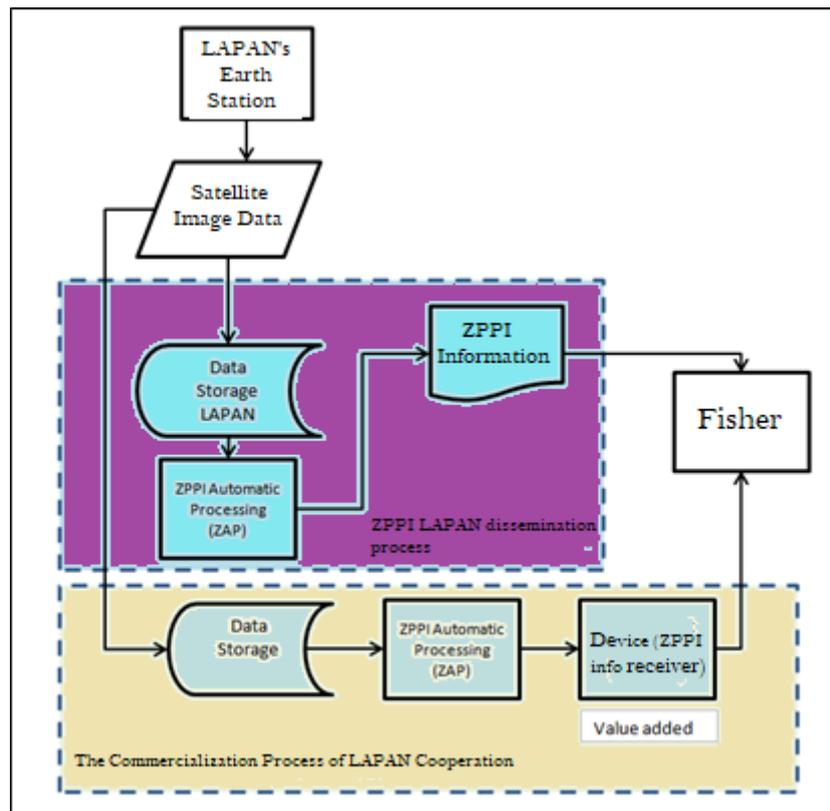

Figure 6 Process Flow of ZPPI Information Production
Source: LAPAN's Document

According to data from the fisheries industry grew by 6.78% in 2017 with a value of Rp169.5 trillion and always above the national GDP growth and agricultural sector GDP since 2014. The fisheries industry still opens a broad avenue for the use of ZPPI information, especially for small and medium fishermen. ZPPI's information allows sea

activities to be more effective and efficient where fishermen can know the location to be visited. Although ZAP has promising market potential, there are several challenges must be faced, namely competition with similar fisheries information products that are available for free and fishermen's literacy rates that are not all high, so reading ZPPI information and operating devices is not easy for some fishing communities.

Simulation Business of ZAP 2.0

ZAP is registered as a patent using remote sensing satellite data to generate ZPPI Information. This patent is proposed by the Remote Sensing Application Center with the application number KI P00201708613. The current status of ZAP is patent pending with the estimated receipt of a patent (patent granted) in 2020 if there are no claims from other parties or other obstacles that slow down the process. In this valuation ZAP assumed to have royalti at a maximum of 5% above the rule-of-thumb of patent royalty rate of 1% based on market growth potential and quality excellence and the continuity of information produced by ZAP compared to similar products on the market.

By calculating using income-based method, the value of the ZAP license is Rp1,701,161,401.00 with the target market being vessel owners with a capacity of 0-30 Gross Ton. According to data Ministry of Maritime Affairs and Fisheries (2018), the number of vessels in the capacity group is 410,000 units and that number can increase with the growth rate of the fishing industry. ZAP products are targeted 10% of the group within 20 years. Furthermore, the information is entered into the DCF formula through the excel application, then we get: Average Earning Before Interest and Tax (EBIT) is 17%; Average After Tax Earning (EAT) of 14%, Return on Investment of 16%, Payback Period in year 4, Net Present Value (NPV) of Rp 9,141,049,845.00, and Present Value of Royalty of Rp3,349,760,184.00.

5. CONCLUSION

This section presents conclusions from the results of the study, the limitations of the study and the proposals for the next study. As a government institution that has missions on research, development and engineering of aerospace technology, LAPAN need to evaluate its intellectual property right and encourage the development of innovation ecosystems to foster innovation productivity in LAPAN research centers. These activities in accordance with PP No. 20 Tahun 2005 on the Transfer of Intellectual Property Technology as well as the Results of Research and Development Activities by Universities and Research and Development Institutions. The technology valuation element consists of system actors and technology valuation factors. System actors are inventors, investors/industries, IP centers, and universities. Technology valuation factors are technological factors, marketing factors and potential marketing factors.

The technical calculation of the monetary value of technology as a result of space research at LAPAN is best using Cost Based Approach and Income Based Approach. This is based on the available information of LAPAN intellectual property. Majority of the technologies produced by LAPAN are classified, using the Market Based Approach will produce a bias value. Information obtained in the market cannot provide definite value for the technology produced by LAPAN because of the costs-components are not likely to be disseminated or usually bound by cooperation agreements.

LAPAN can track research costs and development costs that have been spent to produce patented technology at the Directorate General of Intellectual Property, using the Cost Based Approach valuation method. This method can generate definite value from the acquisition of intangible assets and LAPAN intellectual property license value. LAPAN can apply the Income Based Approach method if these costs are very difficult to trace. By using the discounted cash flow concept based on an assumption on the selling price of the technology produced, LAPAN can determine the expected cash flow of investment with a discount rate in certain period of time. This method will provide information about: Return on Investment, Payback Period, Net Present Value

(NPV) and Present Value of Royalty for each LAPAN intellectual property that is predicted to be commercialized in the near future.

Research limitations is an event that cannot be controlled by the researcher. The researcher has submitted a letter of interview request addressed to the interviewees who has the interest in the valuation mechanism of LAPAN aeronautics and technology. Researchers must follow standard operating procedure at LAPAN regarding research request, so the research cannot be carried out. From 6 targeted interviewees only 2 interviewees can be interviewed. The researcher felt that the results of the interviews from the two interviewees answer the research questions.

Researcher have also distributed questionnaires to LAPAN inventors from targeted 251 inventors to 26 inventors on the basis that this research is specifically for inventors who already have intellectual property certificates in DJKI and are ready to be commercialized. Based on the Head of Pusispan Service Note Number: 172/JT.02/04/2019/Pusispan dated April 15, 2019, it is planned that 26 respondents will fill in the questionnaire, but until the specified time limit, only 16 respondents filled in. The researcher assumed that the 16 respondents were sufficient to meet the required research data.

This research is only limited to the type of intellectual property in the form of patents. It is expected for the next researcher, to perform these valuation methods for other types of intellectual property, such as industrial design, copyright, brands, and so on. This study uses the concept of discounted cash flow where this concept has not produced the value of royalties desired by LAPAN, it is expected that further research can use the concept of relief-from-royalty method to determine the percentage of the amount of royalties paid by other parties to license an intellectual property.

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