DOI : 10.18843/rwjasc/v9i4/12
DOI URL : http://dx.doi.org/10.18843/rwjasc/v9i4/12

Measuring the Space Economy: Space in International Classifications and Measurement Obstacles

Shinta Rahma Diana,

Center for Aerospace Policy Studies,
LAPAN, Jakarta, Indonesia.

ABSTRACT

Space economy has scope from companies that create, launch and run space assets like satellites, to other layer of companies that use signals and data supplied by these space assets to develop value-added applications. Space economy also includes extended groups of companies that are not included in the space industry but earn income from indirect activities. The definition of the space economy is very broad; many of the obstacles or challenges lie in its measurement, because the space economy also takes into account and disclose the impacts of the activity of space. The formulation of the problem in this research is how to measure the space economy in the international classification along with the obstacles faced in the measurement. Method used to answer the problem formulation is descriptive method. Results show the identification of obstacles or challenges in measuring space activity in international classification. Although there have been official domestic space data according to the International Standard Industrial Classification (ISIC) but this is considered less detailed. There is also US trade statistics data where this data is used more frequently than ISIC data, but countries still have to adapt it to the character of their respective national space sector activities.

Keywords: space economy, measurement of space economy, international classification, obstacles of measurement.

INTRODUCTION:

Background of Study:

Economy is a broad science and is related to everyday life. Our daily life includes activities of resource use for R&D needs and production, to its distribution, which in turn can be used by people in many sectors. Economy is also one critical tool to measure whether a country is developed or not. One of indicators to see the good or bad of welfare level in one country is to look at its economy.

Mubyarto (2002) writes that economics is taught and applied worldwide since World War II, it was first pioneered by Paul Samuelson's book, 'Economics an Introductory Analysis' (MIT, 1946). His theory is popular as neo-classical economic theory, which synthesizes between classical free competition economic theory (homo economicus and invisible hand, Adam Smith), and marginal utility with general neo-classical balance. Santosa (2008) sums up that there is a supression in neo-classical economic lecture that free competition market, with certain assumptions, always goes towards an optimal balance and efficiency for everyone. There would be an optimal achievement of common good (Pareto Optimal) if we let the market free. Samuelson stated that every efficient activity is the best, meanwhile inefficient activities should be eliminated (Santosa, 2008).

"Samuelson believes that using this science to control the economy is the right way to achieve the highest possible efficiency, and this is what Nelson labels the gospel of efficiency. The goal of Economics, in short, is progress; the means is an efficient economic system…." (Hellestveit, 2014). Economics is the branch of science which examines how to satisfy unlimited human needs with scarce resources in the best way. So, this definition tells us that we should examine human needs in order to find out the level of the economy (Ozdaglar, 2015).

From what is written briefly about economy, essentially, it is every activity that uses economic resources, which

further can be utilized by people. Activities in space sector exist within the scope of limited economic resource use by human for research and development programs, as well as production activity that involve industrial sectors, which later people of all sectors can utilize the outcome. It is also stated in OECD report (2012) that the space sector includes all actors involved in the systematic application of engineering and scientific disciplines to the exploration and utilization of outer space, an area that extends beyond the earth's atmosphere.

Characteristics of aerospace is considerably broad, including how to measure and recognize aerospace, both its products and activities. Moreover, many space activities also extend to various science and technology disciplines. Manual Frascati gives details of science and technology disciplines related to aerospace, some of which are astronomy (includes astro-physics, aerospace science); aerospace engineering; mechanical engineering; applied mechanics; thermo-dynamics; meteorology and atmospheric science; climate research, and so on (OECD, 2007b). The expanding aerospace activities and there are some structural difficulties inherent to the space sector, causing a plenty of debates in definition and measuring aerospace activities using international classification. Especially, there is no research related to aerospace economy in Indonesia. Research problems of this study include how to measure space in international classification with so many obstacles in doing so?

METHODOLOGY:

The type of research in this study is associative research. It is a research aiming to find a connection between two or more variables (Sugiyono, 2008). Data collection in this research is using documentation method and also the use of secondary data. Mardalis (2002) argues that, descriptive method is a method that describes what currently prevails in which there is an attempt to describe, record, analyze and interpret the current conditions.

This research considered as descriptive research, describes a phenomenon, event, incident that currently happens. Descriptive research focuses on actual problems; it starts with collecting data, analyzing and then interpretingit. Library research is used to collect data. It is a collecting data technique done by using study on literature or learning the relevant books, and journals related to the research. The stages in problem solving in this study are:

a. Literature review about space economy. Due to the extent of space activities, so before measuring space economy activities, clarity about space economy scope should be clear first, including space economy definition. After formulating the definition of space economy from author view based on several references, this study make a formula to answer how is its application in Indonesia.
b. Recognition stage of economic measurement is performed by using International Classification in measuring space activitiees applied in countries with obstacles to deal with.

RESULTS AND DISCUSSION:

Definition of Space Economy and Its Application in Indonesia:

The term ' aerospace' describes "all the regions beyond the Earth's surface" (OECD, 2012). Definition of space in accordance to the space law No. 21 of 2013 Chapter 1 General Provisions Article 1 paragraph 1, Outer Space means a space including its all material that beyond the Airspace, and paragraph 2 stated that Space related aspects mean anything related to Outer Space that associated with the exploration and use of Space. Related to space sector in space law 21 of 2013 Chapter I General Provisions Article 1 paragraph 4, Space Related Activities mean exploration and utilization of Space which is conducted in or from the Earth, and in the Airspace as well as in the Outer Space. Based on space activity specification, one definition agreed generally about aerospace sector is "the space sector includes all actors involved in the systematic application of engineering and scientific disciplines to the exploration and utilization of outer space, an area which extends beyond the earth's atmosphere" (OECD, 2012).

Meanwhile, people can use the economic terms covering all activities by using economic resources. Economic resources are everything that can be used to generate value for people. By knowing aerospace and economy, several experts try to define what space economy is in many references. Some definitions related to space economy written by NASA (2007) which is a summary of several sources, stated that "the space economy: the full range of activities and the use of resources that create and provide value and benefits to human beings in the course of exploring, understanding and utilizing space" (Foust, 2007). A more narrow definition developed by OECD secretariat that is more focused on value chains is "the space economy includes all public and private actors involved in developing and providing space-enabled products and services. It comprises a long value-added chain, starting with research and development actors and manufacturers of space hardware (e.g. launch vehicles, satellites, ground stations) and ending with providers of space-enabled products (e.g. navigation

equipment, satellite phone) and services (e.g. satellite-based meteorological services or direct-to-home video services) to final users" (OECD, 2007c).

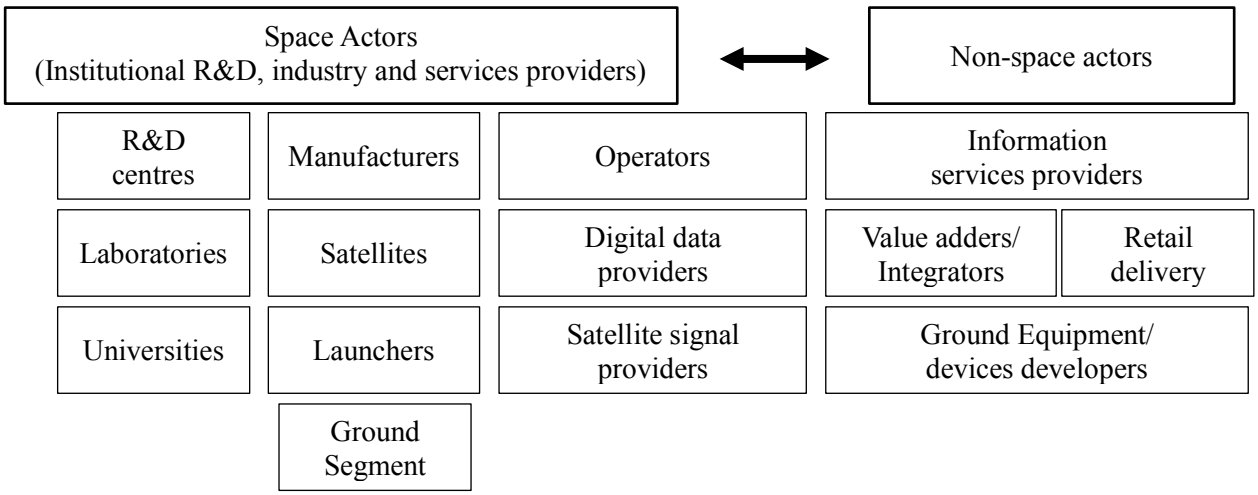
Currently, the amount of public and private stakeholders involved in world space activities are rising significantly and aerospace application absorbs many economic sectors. As space activities have widely broadened to other fields and sectors that involve plenty of stakeholders, defining the space sector as mentioned above has become too restrictive. Such restrictions, especially when trying to cover these new activities derived from space applications. The influence of space expands even beyond direct applications, as companies in non‐space sectors benefit directly from space enabled services, and indirectly via knowledge and technological spillovers (London Economics, 2015).

Recognition of space economics measurement as mentioned in the paragraph above to the stakeholders in the non-space sector. Stakeholders of non-space sectors in Indonesia one example is as written in space law No. 21 of 2013, Article 24 goes about space technology mastery, one of which includes spinning technology (spin off). Spin off is all activities related to space technology utilization for activities in other sectors, such as remote health services, remote education, and teleconference. Other stakeholders of non-space sector in Indonesia is a company or industry engaged in business lines expanding from space products, such as cellphones, broadcasting using satellites, GPS derivative products, etc.

OECD Space Forum Participants specify that space economy needs no limitation only to several characteristics, for space application development is easily expanding in many daily activities (meteorology, telecommunication, etc). Learning from other sectors, broad definition about space economy has been appropriate in covering the different dimensions found in programs, services, and stakeholders. Therefore, from all definitions and explanations above, it can be written that the definition of space economy is very broad, which includes measuring and recognizing the impact of space activities. Because basically, economy is all activities that have a purpose and have an impact on society. Related to industrial sectors, space economy has scope ranging from companies that create, launch, and run space assets such as satellites, then to another layer which is company that using signal and data provided by space assets to develop an application. This last group is clearly not in the space industry, but earns revenue from tools such as satellite navigation equipment and / or services such as maps, direct satellite broadcasts) which depend on advances operations of the space industry. This is then defined as the space economy.

Formulation of space economy definition above, more clearly depicted in both activity process and stakeholders from each space activities, starts from the upstream to downstream as follows:

Figure 1: The Space Economy's Stakeholders/ Actors



Source: Adapted from OECD (2011), The Space Economy at a Glance 2011, OECD Publishing, http://dx.doi.org/10.1787/9789264111790-en, hal.15.

The chart above shows the scope of space economy in the view of space's stakeholders. In accordance to definition formulation, Space Econoomy admit and measure all stakeholders, both space or non-space stakeholders. Other charts show that space economy scope can be seen from classification of three activities group before the generated product from the last group are distributed to users. The three activity process classified into 3 groups is a systematic process, namely, space manufacturing, space operation, and space applications (London Economics, 2015)

Indonesian space economy application is in accordance with the definition above and based on space law number 21 of 2013 and Presidential Regulation of Indonesian Republic Number 45 of 2017, is as follows:

- Space manufacturing includes all group responsible for finished product of space asset (rocket, satellite, launch rides), including technology mastery (R&D) to the manufacture of space hardware and space launching service provider. Space manufacturing stakeholders is the goverenment institution, which duty and function is to develop aerospace independency in Indonesia (LAPAN) which coordinating with other governmental institutions related to mastery and/or space product development, universities, and private R&D.
- Space Operation includes satellite operation and active space product and service provider. After space product is ready and succesfully produced, then the next stage is space product operation. Space service stage uses special satellite capacity, such as bandwidth or image data, as an inpit to provide service on consumers business. Stakeholders is company that uses signal and data provided by space asset, so it has value added, satellite operator and product provider, as well as active space service. Several groups of Indonesian companies that belong to this group are PT. Waindo, PT. Citra Bhumi Indonesia, PT. Integrasia Utama, PT. Bhumi Prasaja, etc.
- Space Application includes all stakeholders that received indirect revenue from space product. This group does not exist in space industry in making space finished good product, but receiving profit from space product. This group depends on advanced operstional of space industry. Government or more global reatil groups belong to this group. Divided into 3 big application domains, namely tellecommunication, earth observation (remote sensing) and navigation.

Measuring Space Economy in International Classification and Its Measurement Resistance:

Economics is a science, which is very broad in scope. Many measuring tools can be used as proxies to economic size of an activity. Although there is no standardized measurement setting for space activities, there is an international standard industry classification. In OECD 2012 written that there are number of international and national classification systems used to measure space economy. Both of them compile industrial and economic activities by facilitating comparison of national economic data from year to year, or evaluating comparison across countries. “Classification is a set of observations that are different, comprehensive, and independent which can be given to one or more variables to be measured " (OECD, 2007a). The terms “classification” and “naming” often used interchangeably, even though “naming” definition is more narrow than “classification”. Hierarchical classification ranging from the broadest level (division) to detailed level (class). Example of classification includes United Nations International Standard Industrial Classification for all economic activities (ISIC, Revision 4), statistics classification of economic activities in European community (NACE, Rev 2), and International Standard Classification of Occupations (ISCO-88).

There is no special “space activities” classification in ISIC, and outlining space sector from wider space and defense sector is still a challenge for most countries. This truth also applied in other international classifications, such as Central Product Classification (version 2) or Harmonized Commodity Description and Coding System (HS) for World Custom Organization. “space” category is also unidentified in System of National Account (SNA).

In national and regional level, several countries identify further on space products and services as a space economy by adding more numbers in international common code (i.e. France, America). However, this leads to difference when trying to compare data internationally. This classificaiton problem is not new; it has often happened along with the rise of economic sectors. Already in the late 1960s, at the beginning of the space age, the general “missiles and spacecraft” statistical categoru was identified as causing methodological difficulties in the United States when trying to assess aerospace prices over time because of the heterogeneity of the products covered in the single category (Campbell, 1970).

The International Standard Industrial Classification (ISIC) regulates a classification of coherent and consistent economic activities, which is based on a set of concepts, definitions, principles and classification rules that are internationally approved. Economic activities in ISIC are divided hierarchically 4-levels structure. Current edition of ISIC (rev.4) covers most of the space sector under different aggregate categories. In fact, there is no certain “space activities” category in ISIC, and outlines space sector from wider space sector. Therefore, this is still a challenge in most countries. The following is classification table of space economy from ISIC:

Table 1: A Closer Look at ISIC Class 3030: Manufacture of Air and Spacecraft and Related Machinery

Section: C-Manufacturing **Division:** 30 – Manufacture of other transport equipment **Group:** 303 – Manufacture of air and spacecraft and related machinery

Class: 3030 – Manufacture of air and spacecraft and related machinery

This class includes:

- Manufacture of airplanes for the transport of goods or passengers, for use by the defence forces, for sport or other purposes
- Manufacture of helicopters
- Manufacture of gliders, hang-gliders
- Manufacture of dirigibles and hot air balloons
- Manufacture of parts and accessories of the aircraft of this class
  - Major assemblies such as fuselages, wings, doors, control surfaces, landing gear, fuel tanks, nacelles, etc
  - Airscrews, helicopter rotors and propelled rotor blades
  - Motors and engines of a kind typically found on aircraft
  - Parts of turbojets and turboprops for aircraft
- Manufacture of ground flying trainers
- Manufacture of spacecraft and launch vehicles, satellites, planetary probes, orbital stations, shuttles
- Manufacture of intercontinental ballistic missiles (ICBM)

This class also includes:

- Overhaul and conversion of aircraft engines
- Manufacture of aircraft seats

This class excludes:

- Manufacture of telecommunication equipment for satellites (class 2630)
- Manufacture of aircraft instrumentation and aeronautical instruments (class 2651)
- Manufacture of air navigation systems (class 2651)
- Manufacture of lighting equipment for aircraft (class 2740)
- Manufacture of ignition parts and other electrical parts for internal combustion engines (class 2790)
- Manufacture of pistons, piston rings and carburetors (class 2811)

Manufacture of aircraft launching gear, aircraft carrier catapults and related equipment (class 2829).

Source: United Nations (2010), International Standard Industrial Classification (ISIC) Rev.4, United Nations, New York, http://unstats.un.org/uned/cr/registry/isic-4.asp

Other than the setting on classificaiton of space economy activities by ISIC, the North American Industry Classification System (NAICS) provides a consistent system to analyze economics among its 3 trading partners namely Canada, Mexico and America. Moreover, there are several others of industrial groupings classification from some countries such as NACE system (Nomenclature statistique des activites economiques dans la communaute europeenne) from Europe, and NAF (Nomenclature d'Activites Francaise) from France (Madinier, 2009).

In accordance with ISIC industrial classification, a number of special classificaiton are used to track down international trading data, including the Central Product Classification (CPC, version 2) and Harmonized Commodity Descrption and Coding System (HS). CPG is a comprehensive classification of all product and service, describing output of every economic activities by using products. HS is an international naming regulated by World Custom Organization in classifying products to facilitate customs objectives with some descriptions of 5,300 products. The following table contains the chosen space activities in international classification (the classifications codes usually all include more than just the space products and services indicated):

Table 2: Selected Space Activities in International Classification

ACTIVITY	CPC Ver. 2	ISIC 4*	SITC Rev. 4	HS 2007
Manufacturing and launch services	49630 Launch vehicles for satellites	3030	792.5	8802.60
	65320 Space transport services, freight (i.e. Launching of satellites into space	5120	792.5	-
	64250 Space transport services of passengers	5110	792.5	-
	67640 Supporting services for space transport	5223	792.5	-
	88824 Air and spacecraft manufacturing services	3030	792.5	-

ACTIVITY	CPC Ver. 2	ISIC 4*	SITC Rev. 4	HS 2007
Insurance	71332 Marine, aviation, and other transport insurance services (includes "satellite launching insurance policies, underwriting of")	6512	-	-
Earth observation and navigation	83430 Weather forecasting and meteorological services (more than satellite data activities)	7490	-	-
	83421 Surface surveying (includes surveying by satellite)	7110	-	-
	84190 Other telecommunications services (includes Satellite tracking services)	6110	-	-
Telecommunications	48220 Radar apparatus, radio navigational aid apparatus and radio remote control apparatus (includes "satellite linked auto security device used to send signals via satellite to a specific vehicle to carry out electromechanical commands on that vehicle based on an encoded signal)	2651	764.83	8526
	49630 Satellites, telecommunications			8802.60
	54614 Residential antenna installation services (includes installation of satellite dishes)	3030	792.5	-
	84131 Mobile telecommunication services – access and use (includes satellite telephone services)	4321	-	-
	84150 Data transmission services (includes satellite space segment, occasional use feeds, broadcast applications, VSAT satellite service, occasional use, broadcast or two-way applications)	6120	-	-
	84634 Home programme distribution services, pay per view (includes pay per view television program, by satellite (i.e. Video-on-demand, by satellite)	6110	-	-
	91134 Public administrative services related to transport and communications (includes administrative services related to satellite communications)	6010	-	-
		6020	-	
	Subclass: 47223 – Other telephone sets and apparatus for transmission or reception of voice, images or other data, including apparatus for communication in a wired or wireless network (such as a local or wide area network) (includes: Field telephones (military))	8413	-	-
				8517.18
		2610	764.11	8517.18
		2630		8517.18
				8517.18

Source: Adapted from United Nations (2010), International Standard Industrial Classification (ISIC) Rev. 4, United Nations, New York, http://unstats.un.org/uned/cr/registry/isic-4.asp.

Official data for domestic space industry (according to ISIC classification) is considered blunt, and may not be in line with trading statistics due to slightly wider coverage. In that context, industrial associations (US Aerospace Industry Association, Satellite Industry Association) tend to use several definitions and data from US Department of Trade, but mainly use their own estimation in aerospace sector (AIA, 2011).

The discussion above shows that there is no international dealing related to measurement, classification, or international coding. This happened because space activities scope are expanding throughout various sectors. Moreover, space activities are integrated with non-space commercial activities and each countries have their own industrial characteristics and system related to its space activities. Furthermore, space activity is unique in the sense of nature characteristic of goods and services components of different space with a non-space goods and services. For example, component to develop a rocket where there is an the Misssile Technology Control Regime (MTCR) regime, which more or less affect how international standardize classification is agreed, used,

and adopted by other countries so, a classification should function specifically for some countries that regulate strategic commodity trading for the sake of national security and international security settings. At any time, the state is required to prepare a "Munitions List" and a special "list of dual-use items" as in America, France, or Canada. The use of common naming contribute to control international sensitive technology transfer. Space technologies, being dual by nature, are often included in these restrictive trade regimes. We can explore about space technologies the MTCR and annex MTCR (MTCR, 2011). Space technology with dual use, one that explains why space commercial products are sometimes misunderstood in official trade statistics.

Another structural challenge in measuring, identifying, and evaluating the impact of socio-economic of space activity becomes difficult to be explained by Bruston (2014). One of the challenges is a divisive structure of recording and reporting economic data. Space is not recognized as a category in international industrial classification standards (for example, UK SIC 2007). A regular collecting and reporting space sector data, which can be used by space community to measure socio-economic impact is hard to be done, due to identification of space sector needs cannot be determined in real time. The population of small and new companies are great. Downstream market for space application is still under development, driven by the development of micro and SME applications. For all companies that are above the threshold are usually given one year of pauses in the publication of annual report.

By looking at many restrictions and unique characteristics of space scope including its products and services character, even though there is a regulation concerning the classification of economic activities that are coherent and consistent based on a set of consepts, definition, principles, and international classification rules, yet it still could not accommodate the needs in countries. This shows various space systems and applications, explain the difficulties in determining space sector in the existing industrial classification.

CONCLUSION:

Definition of space economy is consideably broad, which also includes measure and recognize the impacts of space activities. Related to the industry, space economy has several scope from companies that create, launch, and run space assets such as satellite, to other level of companies that use the signal and data provided by space assets to develop value-added application. The group that does not belong to the space industry, but generate revenue from space activities indirectly; that in turn forms the core of space economy. The Indonesian space economy application is in accordance to the definition formula and is based on space law number 21 of 2013 and Presidential Regulation of Indonesian Republic Number 45 of 2017.

The extent of the space scope and activities leads to many challenges in measuring space economy. However, there is international coding classifications that can be adopted, for example, the American International Trade Administration provides categorical details. Even several countries have made classificaion code of space activity. They use their own estimation when using it in space sector. Even though there is official data for domestic space according to ISIC classification, but it is considered less detailed, and there is statistics data of AS trading that is more frequently used. However, countries need to adjust it with their own space sector activity characteristics.

ACKNOWLEDGEMENTS:

The author is very grateful to Mr. Agus Hidayat as a Chairman of the Center for Aerospace Policy Studies, National Institute of Aeronautics and Space who has contributed to this research. Also, thank you to the reviewers of this article.

REFERENCES:

AIA (Aerospace Industry Association). (2011). *US Aerospace Statistics, Website*. Washington DC. Available: www.aia-aerospace.org/economics/aerospace_statistics.

Bruston, J. (2014). Space: the Last Frontier for Sosio-Economic Impact Evaluation?. Yearbook on Space Policy 2011/2012 – *Space in Times of Financial Crisis.* pp. 183-191. DG's Office for EU Relations. European Space Agency.

Campbell, H.G. (1970). *Aerospace Price Indexes. RAND Corporation. Report Prepared for the US Air Force.* Washington, DC. December.

Hellestveit, Anders (2014). Economy as Religion Master's Thesis-Sociology Trondheim/Oslo. October 2014. Norwegian University of Science and Technology. *Faculty of Social Sciences and Technology Management. Department of Sociology.*

London Economics. (2015). The Case for Space 2015. The impact of space on the UK economy. A study for the Satellite Applications Catapult, Innovate UK. *UK space and the UK Space Agency.*

Mardalis. (2002). *Metode Penelitian Suatu Pendekatan Proposal.* Jakarta: Bumi Aksara.

Madinier, C. (2009). The Aggregated Classifications of NAF Rev. 21. Courrier des statistiques. *English series*. No. 15.

Mubyarto. (2002). Meninjau Kembali Ekonomika Neoklasik. *Jurnal Ekonomi dan Bisnis Indonesia.* Vol 17. No.2. 119129.

Foust, Jeff. (2007). The Space Review. *NASA's new outreach plan.* http://www.thespacereview.com/article/899/1.

OECD. (2007a). *OECD Glossary of Statistical Terms.* Webpage. Paris. France.

OECD. (2007b). Revised Field of Science and Technology (FOS) Classification in the Frascati Manual. Directorate for Science. Technology and Industry. Committee for Scientific and Technological Policy. Working Party of National Experts on Science and Technology Indicators. OECD. DSTI/EAS? STP/NESTI (2006)19/FINAL. Paris.

OECD. (2007c). *The Space Economy at a Glance.* OECD Publishing.

OECD. (2011). The Space Economy at a Glance 2011, Penerbit OECD: http://dx.doi.org/10.1787 /9789264111790-en, hal.15.

OECD. (2012). OECD handbook on measuring the space economy. http://browse.oecdbookshop.org/ oecd/pdfs/free/9212011e.pdf.

Ozdaglar, Mehmet (2015). Economic development and Maslow's hierarchy of needs. The Journal of Turkish Weekly. http://foreignpolicynews.org/2015/07/26/economic-development-and-maslows-hierarchy-of needs/

Presidential Decree Number 45. (2017). Indonesia Space Activities Implementation Master Plan 2016-2040.

Republic of Indonesia. (2013). Indonesia Legislation Number 21 of Space in 2013. https://lapan.go.id/ files_arsip/UU_no.21-2013_keantariksaan_(English-Version).pdf.

Santosa, Purbayu Budi. (2008). Fakultas Ekonomi Universitas Diponegoro Semarang. Jawa Tengah. Relevansi dan Aplikasi Aliran Ekonomi Kelembagaan. *Jurnal Ekonomi Pembangunan* Vol. 9. No.1. Juni 2008. hal. 46 – 60.

Sugiyono. (2008). *Metode Penelitian Bisnis.* Alfabeta: Bandung.

The Missile Technology Control Regime (MTCR). (2011). *MTCR website.* Washington, DC. Available: www.mtcr.info/English/FAQ-E.html.

United Nations. (2010). *International Standard Industrial Classification (ISIC)* Rev.4. United Nations. New York. http://unstats.un.org/uned/cr/registry/isic-4.asp.
