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Strategy and Evaluation of Bilateral Agreement on Telemetry, Tracking, and Control Activities in Indonesia

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ABSTRACT

India and Indonesia propose a bilateral cooperation to develop and operate telemetry, tracking, and control (TCC) ground stations to support satellite missions on geostationary orbits with the use of Geostationary Satellite Launch Vehicle (GSLV) since 1997, in order to master and commercialize space technology. This cooperation needs to be assessed in order to identify how it will affect Indonesia and India and to establish an improvement strategy for improved business and ways to integrate. The objectives of this paper are to (i) evaluate the benefits and cost of this cooperation, (ii) map the business model of the telemetry, tracking and command ground station in Biak, and (iii) design a new strategy to get competitiveness. Descriptive analysis with canvas mapping and transaction cost perspective is the approach utilized. The article's results highlight that (i) Indonesia and India have mutual benefits from tangible and intangible side, (ii) Indonesia has a competitive advantage due to its geographic location and commercialization of Biak Ground Station, so its potential to Telemetry, Tracking, and Command (TT&C) commercial businesses in the future, not only to domestic, but also international market, and (iii) Indonesia needs collaborate with commercial entities and making optimum diplomation with G2B schema to get beneficially among parties to maximize TT&C infrastructure in Biak Island.

Keywords: Bilateral cooperation; Biak Ground Station; Indonesia; Evaluation; Strategy.

INTRODUCTION

India and Indonesia have bilateral cooperation, particularly in the field of space. India is a developing country like Indonesia; it began with space activities in the 1960s but has since achieved technological mastery that now surpasses Indonesia in the field of space technology. India has a space agency, the Indian Space Research Organization (ISRO), which has successfully conducted commercial rocket launches as well as a navigation satellite, the Indian Regional Navigation Satellite System (IRNSS), etc. Communication between space and ground segments is very crucial to the operating satellite and launch industry. Today, the technology and service telemetry and tracking (Telemetry, Tracking, and Command [TT&C]) market is rising and developing with constellation satellite issues. The position of technology at the ground station becomes important for the development of satellite technology and rocket launch technology, including for India and Indonesia themselves. According to Prasad and Pal (2003), TT&C systems

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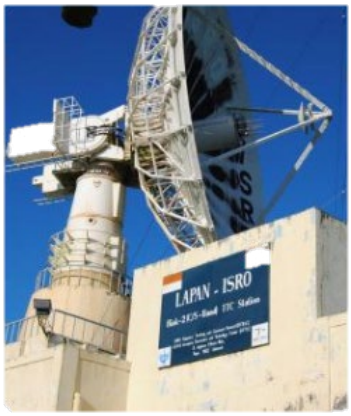
provide the most critical telecommunication link between a satellite and ground station, providing the uplink for commands and the downlink for monitoring the various health parameters for the satellite's position in orbit. Lembaga Penerbangan dan Antariksa Nasional (LAPAN) operates ground stations in Rancabungur, Bogor, and Biak Island. More countries have bilateral agreements on the space sector, such as the operation of ground stations, to master and commercialize space technology. Since 1997, India has proposed bilateral cooperation with Indonesia to build and operate TT&C ground stations to support satellite missions in geostationary orbits using the Geostationary Satellite Launch Vehicle (GSLV). On April 25, 1997, in Jakarta, LAPAN (the national space agency) and ISRO signed a Memorandum of Understanding between the National Institute of Aeronautics and Space of the Republic of Indonesia and the ISRO of the Republic of India for Cooperation in the Establishment of Telemetry, Tracking, and Command Station for Satellites and Launch Vehicles as a precursor to the bilateral agreement between Indonesia and India in the field of space technology (LAPAN 2019). The agreement marks the start of the construction of India's ISRO 1 and ISRO 2 ground stations on Biak Island (Fig. 1). The main antenna's size is 10-11 meters and transmits in the S and C bands.



Source: Elaborated by the author.

Figure 1. Biak Ground Station.

Since 1997, India has built two telemetry and tracking system (TT&C) stations on Biak Island. India also has ground stations in a number of countries, including Vietnam, Brunei Darussalam, and Indonesia. According to LAPAN (2019), there are provisions in the 1997 agreement document and the updated MoU of 2018 regarding the transfer of ownership status to TT&C. The agreement has been modified and ends in 2019. There have been few studies that show the benefits of such collaboration or cooperation during its 22-year implementation. The issue in this study is what motivates India to construct the TT&C ground station on Biak Island. What were the factors that contributed to the selection of the Biak Islands as a strategic location for TT&C? One of the competitive advantages in the field of technology is the regional or geographic advantage (Zuhal 2010). The transfer of the TT&C ground station in Biak will be an interesting matter to see how competitive Indonesia will be in terms of technology mastery and commercialization activities. The bilateral cooperation agreement, which has a validity period, explains Indonesia's strategy in the face of potential global commercialization of the TT&C station business. Benchmark from a private actor, KSAT operators, a commercial satellite hub owned equally by Kongsberg and the Department of Trade and Industry through Space Norway. KSAT operators operate ground stations in the Polar Regions, specifically in the Arctic (Svalbard) and Antarctica, and they have contract business worth $43.8 million. (Kongsberg 2017). This illustrates or example that TT&C is valuable for commercialization and profitability in the supply chain for space technologies. How can the business possibility of the TT&C Biak Ground Station become something to do? This is demonstrated by the expanding ground station's role in assisting Indian space endeavors.

The purpose of this study is to (i) identify the benefit and cost of this cooperation, (ii) analyze Indonesia's potential for growth in terms of commercialization of Biak Ground Station, and (iii) develop a plan to gain a competitive advantage. The scope of the study is ex post policy analysis to evaluate bilateral agreements before 2019 and benchmarking with G2G and private practice in the TT&C program. According to Rainaldo (2017), the canvas business method is one suitable method for determining business potential. This method has the benefit of describing overall business conditions and is able to identify weaknesses and improvements

that need to be made to increase competitiveness for future business planning (Herawati, 2019; Solihah, 2014). It was used in this study to set a strategy for Indonesia in the future for operating TT&C ground stations.

METHODS

This research uses a mixed method of qualitative and quantitative analysis, including an overview of the literature, a cost-benefit analysis, and the canvas model. In the context of strategic management decision-making, business design evaluation, and cost-benefit analysis, the canvas model and transaction cost perspective are utilized. There is both primary and secondary data in this study. Primary data was acquired through meetings, interviews, surveys, and focus group discussions (FGD) that were used to gather information. Secondary data is gathered from books, articles, publications, and other secondary sources. TT&C's business model can be mapped using a canvas model. In this model, an organization's business model is broken down into nine interconnected components, including customer value proposition segments, customer relationships, channels, key resources, key activities, partners, costs, and revenues. According to Osterwalder and Pigneur's (2010) model canvas, business models are defined as "the rationale of how an organization creates, delivers, and captures value." Although employing it might assist users in balancing gain and goal to promote greater sustainability to make the canvas model, the identification stage of transaction costs during the operation of this TT&C ground station becomes important. Transaction cost is understood as an alternative mode of organizing transactions (governance structures, i.e., markets, bureaus) that minimize transactions (Williamson 1979). Defining transaction costs based on Furubotn and Richert (2000) are costs for using the market (market transaction cost) and the cost of exercising the right to give orders within the company (managerial transaction cost). From identification transaction cost, it can be measure to cost-benefit to space program, like co-operation. Cost-benefit analysis is a tool to assist in decision making or the use of space technology (Hein *et al.* 1976; Hockley 2014). Transaction cost its uses to identify all cost and benefit include management cost (lobby, etc.) and operational cost during implementation partnership. In the economic institutional, is very useful to explain to social cost at least in governmental.

ANALYSIS

Scope of LAPAN-ISRO cooperation

International collaboration is one method for mastering space technology. The Indonesia Space Act is regulated in a special article on the implementation of commercialization through international cooperation. The items of cooperation arranged between the LAPAN and ISRO are included (LAPAN 2019): (i) space science, space exploration, use of space technology, monitoring the earth's environment from space and remote sensing of the earth; (ii) develop forms of multidisciplinary cooperation in the practical use of space technology and use the spin-off benefits of space technology; (iii) operation, maintenance, addition, improvement, and use of the Integrated Biak TT&C Ground station for the mutual benefit of both parties; (iv) joint research and development activities in the field of space technology; (v) exchange of technical and scientific personnel appointed to participate in cooperation programs; (vi) organizing training, workshops, and seminar programs in areas of mutual interest, etc. TT&C is a program of bilateral cooperation between LAPAN and ISRO and has run for at least 22 years. This relationship of cooperation is highly beneficial to both parties.

Impact

The bilateral cooperation between LAPAN and India in the operation of the TT&C Biak 1 and 2 Ground Stations has an impact on both parties in terms of benefit and cost.

Indonesia

LAPAN (2019) mentions the following benefits to Indonesia:

- Transfer of knowledge in data utilization and operation of the Biak TT&C Ground Station;

- Transfer of ownership and further use of the integrated Earth TT&C Biak Station;
- Launching of two satellites owned by LAPAN by Indian launchers at a cost of return (in kind);
- Capacity building in the mastery of space technology in fields including:
  - Radio frequency (RF);
  - Safety features, construction, control of movement of ground station (GS);
  - Networking coordination GS to GS;
  - GS trouble shooting software engineering in data and interactive;
  - Installation of redundancy power by ups and battery switch hold; and
  - Installation of lightning system.

Benefits and costs are divided into tangible and intangible values. In Table 1, it can be shown that the cost is greater than the benefit from the tangible side. It is related to the business process of this cooperation that there is no revenue or tariff as income. Besides that, Indonesia has bigger direct and indirect intangible benefits that are not included in the state revenue component (Table 1). To support this, LAPAN must prepare a unit and teams to support this ground station. The direct benefit of this cooperation is that LAPAN can monitor (command and track) the satellite itself and got indirect benefits, such as capacity building, training, and others.

Table 1. Estimation intangible and tangible benefit cost for Indonesia.

Tangible revenue ($)	Tangible cost ($)
TT&C service 20.000,	Operational 25.600,
Sum	Sum
Total R-C	(5.600)
Intangible benefit	Intangible cost
Capacity building Support satellite LAPAN A2, at S band Freq Satellite piggy back (launching cost)	AIS Data

Source: Elaborated by the authors.

India

The benefits of operating the TT&C Biak Ground Station directly are for satellite monitoring activities owned and launched by India. India has one of the largest constellations of remote sensing satellites in the world today and needs support with the Indian Data Relay Satellite System (IDRS) (PraveenReddy *et al.* 2018). The beginning of the TT&C Biak 1 operation, according to Tanoemihardja *et al.* (2002), was operated to monitor the launch of PSLV and GSLV that were launching sites in Shriharikota. It was confirmed by interviews with operator staff during a visit to the Biak TT&C, where the Biak TT&C has the function to support the IDRS to provide tracking and data acquisition support for all types, including supporting the launch and reception of remote sensing and telecommunications satellite TT&C data. TC Biak is known to track 23 satellites. Some of the satellites monitored are located in Low Earth Orbit (LEO) via geostationary relays, according to Praveen Reddy *et al.* (2018), namely Cartosat 1, SARAL 2, Resourcesat, Cartosat 2, and Oceansat. Biak has an important value among the four ground stations that India has, which, according to Kasturiranjan (2001) in "Competition Science Vision", telemetry confirmation had been received from Biak Ground Station that the spacecraft all systems were functioning well (Table 2).

Table 2. Estimation revenue and cost TT&C Biak Ground Station for ISRO/tear.

Revenue ($)	Cost ($)
TT&C service: uplink 1.200.000 Downlink 9.600.000	Operational and maintenance: (141.866)
Sum 10.800.000	Sum (141.866)
Benefit	10.658.133

Source: Elaborated by the authors.

The calculation in Table 2 is based on using a pessimistic scenario of the benefits or benefits obtained by the ISRO of 159.777 billion/years in Rupiah or equivalent with 10.658.133 in Dollar (assume 1 $ = Rp. 15.000,) from the potential commercialization of Biak TT&C.

Potential of commercialization Biak Ground Station

From the perspective of the foreign developing situation, commercial TT&C is the trend of the times (Xu *et al.* 2018). With canvas mapping, the potential for commercialization of the operation of the TT&C Biak managed by LAPAN itself is revenue from the state at a minimum of 159,872 billion Rupiah, with segmentation of users spread from within and outside the country. AWS (2019) said that customer must buy or lease ground antennas to communication with satellite, must build business rules, and workflows to organize, structure, and route the data to employees or customers before it can be used to deliver data. Therefore, it need significant capital investment and operational cost to build. The market price for (X Band-S Band) antennas is about $ 200 to $ 400 per pass, and trend to future will seek to offer lower prices to create a competitive advantage (Henry 2017). The business potential of the future TT&C Biak in the canvas model is mapping as Fig. 1.

According to Hasbi (2019) in Forum Group Discussion for commercialization space issues, the push demand or commercialization of equatorial TT&C ground station services on Biak Island are:

- Supporting the low orbit satellite constellation program;
- Supporting the spaceport on Biak Island;
- Supporting the most recent TT&C ground station in Bogor;
- The availability of ISRO's satellite control facility, which has a strategic position on Biak Island;
- Establishing a partnership with the commercialization industry entity for the development of the ground station;
- Increasing demand for low-orbit satellite launches, which will require ground stations for operations.

To get benefits of cooperation, from institutional economic, identify transaction cost is needs to be included in the term bilateral cooperation. There are need to be arrange fixed and variable transaction costs that maybe arise from the cooperation in the certain period time, and both in terms of revenue and costs. To achieve and develop TT&C market, there are need identify several cost includes search and information cost, supervision, managerial, and political cost. There are very important to get cooperation and optimum negotiation. The low cost of political costs and managerial that there are reflect transaction costs may affect to performance of not optimally their functions of organization (Perwitasari 2019a). To joint in international commercial TT&C market, Indonesia must learn from existing G2G practices and private industry. India is a partner and potential user to this.

Figure 2 show scenario of business model of TT&C Biak before LAPAN merger into BRIN (Badan Riset dan Inovasi Nasional). This mapping is based on discussion and in-depth interviews with keyperson. LAPAN has mandatory from Space Act Number 23 Year 2013 to build commercial space activity, including ground segment. Biak Ground Station 1 and 2 will be Indonesia asset, so there are huge potential to develop. India and or other space entities maybe joint on this business model with Business of Business (B2B), Government-to-Government (G2G), or Business to Government (B2G). The customer or user of TT&C market are domestic and international. The operational of ground station will be on online and offline format. The utilization and spin off satellite technology on Indonesia and satellite will be launch (small satellite) and commercial spaceport in Biak is high value proportion. According Perwitasari (2019a), the first determination Biak selected to spaceport based technical criteria (location, safety, security) and its need support a TT&C service from Indonesia ground station. LAPAN needs partners likes India and other potential players in the satellite communication industry to share space capacity of ground station to get profit and scale economies.

Since 2021, LAPAN mergers into BRIN and this canvas model was change. The transformation organization with BRIN structure has consequence with business model (canvas mapping). Under BRIN structure, space infrastructure facilities including TT&C ground segment is operated under Deputy of Infrastructure, Research and Innovation (DIRI). Research Organization for Space and Aeronautics (ORPA) concerns with research and space activity. Key partner (actor) were changing, they are DIRI, ORPA, DFRI, Sestama, and others. This has consequent on space e-government in Indonesia. Structure organization was change and still progress until now.

<table>
<tr>
<td rowspan="2">Key partner
Defense (safety)
Operator (Pusteksat, Pustekroket LAPAN)
Remote Sensing Data Centre (Pusdata, Pusfatja, LAPAN)
International operator
National operator
Supplier
Ministry of Communication (frequency)</td>
<td>Activities
Communication data relay satellite/Tracking
R&D
Support launch mission
RF interference</td>
<td rowspan="2">Value proposition
To monitoring and support space segment (satellite)
To support launch mission</td>
<td>Customer relationship
Long term contract with G2G, G2B, B2B
Maintenance support</td>
<td rowspan="2">Customer segmentation
LAPAN
University
Governance
Defense
Commercial (private, international parties)</td>
</tr>
<tr>
<td>Resources
Human resource
Control room (building)
Funding</td>
<td>Channels
Online
Offline</td>
</tr>
<tr>
<td colspan="3">Structure cost
Investment: antenna
Operational cost (fix and variable cost)
Depreciation technology
Maintenance, service cost
Construction cost, land utilization
Cost learning</td>
<td colspan="2">Revenue
Tracking pass service
Downlink data service
Rental cost</td>
</tr>
</table>

Source: Elaborated by the authors.

Figure 2. Business canvas model of TT&C Biak by LAPAN (consent before merger into BRIN).

Strategy to create competiveness advantage

Prasad and Pal (2003), said that development, testing, and fabrication of these systems are quite involved, tricky and difficult, and required a lot of expertise to develop it. Miau and Holdaway (2000) mention that for country who lag behind in space technology but want to build up their capacity to develop their own space in the future, the fastest way is to take advantage of the opportunity when procuring ground system from firm advanced country by requiring technology transfer. Therefore, by looking at the business potential of mapping the canvas model, the strategy that must be carried out by LAPAN (now BRIN) by looking at the benefits of commercialization of TT&C Biak for India and the benefits is not optimum for Indonesia during the collaboration. Several strategies according the information obtained from the FGD discussion results and interview are:

- Evaluating existing bilateral co-operation ;
- Supporting technical aspect needs to operation of spaceport in Biak (Perwitasari 2019), with competitiveness of TT&C Biak with commercial schemes going forward by paying attention to safety and security aspects;
- Promoting local industry to support and join in TT&C business and research and development in the long term.

Countries or international partners are very interested in the excellence of the Biak region as a competitive advantage. The position of Biak is strategic for Indonesia as well as space faring nations. This is one of the reasons Indonesia's geographical location benefits from the growth of ground-segment enterprises through the commercialization of TT&C. A number of nations use the bilateral agreement as the centerpiece of their efforts to commercialize space, particularly with regard to the operation of spaceports.

In order to take advantage of the chances for involvement and collaboration provided by the partnership, Perwitasari (2019b) argues that national coordination is necessary, involving academia, business, and government or triple helix network. Due to the absence of numerous parties in this ISRO-LAPAN cooperation in the TT&C operation in Biak, the benefits are only felt by the two parties involved, with India reaping the majority of the benefit. In order to maximize benefits between India, BRIN, and other national stakeholders, BRIN must build a commercial model incorporating industry and other players from the opportunity of partners in the canvas model discussed above. Indonesia currently has an SBSN initiative that will create TT&C and launch a commercial business landscape. Construction was completed in 2022, with an anticipated opening in 2023.

CONCLUSION

In global or regional cooperation, bilateral cooperation is a part or method of the space collaboration strategy. Due to the global space value chain, an evaluation of international partnerships is required to accelerate space technological mastery. Using ex-post institutional economic evaluation and learning from current practice from international can be used to see input, activities, and impacts from bilateral activities, especially TT&C between Indonesia and India. Indonesia and India have mutual benefits. Indonesia have tangible and intangible benefits like piggyback satellite (on the launch of its own satellite experiments, such as LAPAN A1, LAPAN A2, and LAPAN A3 and next A4) and capability building for TT&C scientific research, etc. According to CBA analysis, India has bigger benefit, because they have mature commercial industry for example spaceport, satellite and use support TT&C from Biak. India can monitor and communicate with its satellite and the space industry and operations have a significant economic impact (multiplier effect). Indonesia is still progress to build space industry especially promoting private local actor on TT&C program.

Indonesia has a competitive advantage due to its geographic location and the operation of the Biak Ground Station for both domestic and foreign users. A crucial piece of technology for the Biak spaceport's functioning is the TT&C Biak Ground Station. In order to get scale economies, bilateral cooperation with new model businesses is being evaluated. In order to develop an efficient space business and use offset to obtain technology transfer based on the canvas model, Indonesia needs collaborate with commercial entities and making optimum diplomation with G2G, G2B schema to get beneficially among parties.

Because the limitation in this evaluation research did until 2019, from this conclusion, there is need next research to ongoing evaluate bilateral agreement with new space government structure in Indonesia.

CONFLICT OF INTEREST

Nothing to declare.

AUTHORS' CONTRIBUTION

Conceptualization: Intan P; **Validation Data:** Intan P; **Methodology and Analysis:** Intan P and Firmansyah; **Writing:** Intan P and Firmansyah; **Investigation & data curation**: Intan P; **Review and editing:** Intan and Firmansyah; **Final approval:** Intan P.

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Data sharing is not applicable.

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REFERENCES

[AWS] Amazon Web Services (2019) Announcing general availability of AWS Ground Station. [accessed May 23 2019]. https://aws.amazon.com/about-aws/whats-new/2019/05/announcing-general-availability-of-aws-ground-station-/?nc1=h_ls

[Kongsberg] (2017) Kongsberg Satellite Service will deliver services to NASA. [accessed Feb 25 2020). https://www.kongsberg.com/newsandmedia/news-archive/2017/kongsberg-satellite-services-will-deliver-services-to-nasa/#:~:text=Kongsberg%20Satellite%20Services%20(KSAT)%20has,and%20Space%20Administration%20(NASA).&text=KSAT%20will%20deliver%20operations%20support,satellites%20S%2DNPP%20and%20JPSS

Furubotn, G, Richer R (2000). Institutions and economics theory: the contribution of the new institutional economics. Ann Arbor: University of Michigan.

Hasbi, Wahyudi (2019), Aspek Komersial Operasi Satelit Konumikasi orbit Rendah LAPAN & Layanan TT&C di Wilayah Khatulistiwa. Unpublished. Presented in FGD RPP Tata Cara Kegiatan Komersialisasi KeantariksaaN, Lembaga Penerbangan dan Antariksa Nasional, Jakarta, 24 Pebruari 2020

Hein GF, Stevemson SM, Sivo JN (1976) Cost benefit analysis of space technology. Cleveland: NASA.

Henry C (2017) Japanese starup raises $7.3 million for smallsat antenna sharing servisse. Spacenews. [accessed Sep 13 2017]. https://spacenews.com/japanese-startup-raises-7-3-million-for-smallsat-antenna-sharing-service/

Herawati N, Lindriati T, Suryaningrat IB (2019) [Aplicação do modelo de negócios canvas na determinação do plano de manejo do negócio de soja frita Edamame]. J Agro 13(1);42-51. https://doi.org/10.19184/j-agt.v13i01.8554

Hockley N (2014) Cost-benefit analysis: a decision- support tool or a venue for contesting ecosystem knowledge? Environ Plann C Gov Policy 32.2:283-300. https://doi.org/10.1068/c1384j

Kasturiranjan (2001). Competition Science Vision (2001) MCQ in physic: pratiyogita darpan https://books.google.co.id/books?id=TugDAAAAMBAJ&printsec=frontcover&dq=Kasturiranjan±(2001)±in±Competition±Science±Vision±(2001)±Jun±2001&hl=id&sa=X&ved=2ahUKEwiByr37o5mDAxXTTGwGHcghBCwQ6AF6BAgEEAI#v=onepage&q&f=false

LAPAN, (2019). Naskah Urgensi Pengesahan Kerangka Persetujuan antara Pemerintah Republik Indonesia dan Pemerintah Republik India Tentang Kerja Sama Eksplorasi dan Penggunaan Antariksa untuk Misi Damai. (Framework Agreement Between The Government Of The Republic Of Indonesia And The Government Of The Republic Of India On Cooperation In The Exploration And Uses Of Outer Space For Peaceful Purposes}. Policy Paper (Unpublished): Jakarta

Miau J-J, Holdaway R (2000) Reducing the cost of spacecraft ground systems and operations. Dordrecht: Kluwer Academic Publishers.

Mustari, Nuryanti (2015) Pemahaman KEBIJAKAN PUBLIK Formulasi, Implementasi dan Evaluasi Kebijakan Publik, Jogjakarta : Leutika Nouvalitera

Osterwalder A, Pigneur Y (2010) Business model generation: a handbook for visionaries, game changers, and challengers. Hoboken: John Wiley & Sons.

Perwitasari I (2019) Indonesia spaceport selection based on multicriteria analysis: a study on relative importance and priority regarding spaceport selection location attributes utilizing AHP. 3rd International Conference on Indonesian Social & Political Enquiries (ICISPE 2018). Atlantis Press; Semarang, Indonesia. https://www.atlantis-press.com/proceedings/icispe-18/125922564

Perwitasari I (2019a) Role of National Council for Aeronautics and Space of Republic Indonesia (DEPANRI) from institutional economic perspectives. Paper presented at 2nd International Conference on Inclusive Business in the Changing World (ICIB 2019). SciTePress; Jakarta, Indonesia. https://doi.org/10.5220/0008435507020708

Perwitasari I (2019b) Partnership valuation of membership of Indonesia in Asia Pacific Space Cooperation Organization (APSCO) with STPLEE. Paper presented at 2nd International Conference on Inclusive Business in the Changing World (ICIB 2019). SciTePress; Jakarta, Indonesia. https://doi.org/10.5220/0008429802400245

Prasad SN, Pal S (2003) Telemetry, tracking and command systems of spacecraft. IETE Tech Rev 20:6:561-576. https://doi.org/10.1080/02564602.2003.11417116

PraveenReddy G, Ahmad I, Damodar KP, Anjaneyulu KVVSSSR (2018) Study of data relay satellite system and its relevance to Indian context. Int J Pure Appl Math 118(16):1227-1244.

Rainaldo M, Wibawa BM, Rahmawati Y (2017) Analisis business model canvas pada operator jasa online ride-sharing (Studi kasus Uber di Indonesia). J Sains Seni 6(2):235-239. http://dx.doi.org/10.12962/j23373520.v6i2.25277

Solihah E, Hubeis AVS, Maulana A (2014) Analisis model bisnis pada KNM fish farm dengan pendekatan business model canvas. J Sosek KP 9(2):185-194. http://dx.doi.org/10.15578/jsekp.v9i2.1220

Tanoemihardja S, Rahman A (2002) The use of biak-tracking, telemetry and command (TT&C) station fot monitoring satellite. Chapter 10. Paper presented at The Joint LAPAN-ATSB Workshop on Small Satellite Developmetn. LAPAN; Jakarta, Indonesia.

Williamson OE (1979) Transaction-cost economics: the governance of contractual relation. J Law Econ 22(2):233-261.

Xu A, Zhang G (2018) Preliminary discussion on the TT&C and management of coomercial space in China. Paper presented at Proceedings of the 28th Conference of Spacecraft TT&C in China Technology Openess, Integration and Intelligent Interconection. Tsinghua University Press and Springer; Beijing, China. http://dx.doi.org/10.1007/978-981-10-4837-1

Zuhal (2010) Knowledge platform: kekuatan daya saing dan innovation (strength of competitiveness and innovation).Jakarta: PT Gramedia Pustaka Utama.