



Technology Landscape for Surveying and Mapping in Construction Industry

F. Hidayat^{1*}, A. Arifin², M. A. A. Farrosi², B. W. Soemardi², R. G. K. Pradoto², E. R. Puri²

¹Department of Civil Engineering, Faculty of Engineering,
Parahyangan Catholic University, Bandung 40164, INDONESIA

²Faculty of Civil and Environmental Engineering,
Bandung Institute of Technology, Bandung 40116, INDONESIA

*Corresponding Author

DOI: <https://doi.org/10.30880/ijie.2022.14.09.010>

Received 25 April 2022; Accepted 20 August 2022; Available online 30 November 2022

Abstract: Over time, the construction industry has faced many challenges: by 2030, it's estimated that the number of construction projects will increase by 85%, but on the other hand, projects must be highly productive but efficient. These challenges often arise from how the construction industry able to capitalize technology and its willingness as well as ability to respond new technology. To provide a comprehensive view on how the technology is evolving the construction, a construction technology landscape is needed. The technological landscape is conducive to solving current problems and anticipating future needs. The study includes the collection and analysis of data through literature studies, as well as through surveys to construction practitioners in the industry. This study shows that although it has been applied since the 15th century, the utilization and development of survey and mapping technology in Indonesia is still quite far behind the construction industry in other countries. The result of the survey shows that although development of this technology is quite far behind the development of the world, the industry adaptation to survey and mapping technology in Indonesia has experienced quite significant developments. Currently, advanced technology (hardware and software) is increasingly used in various construction projects in Indonesia.

Keywords: Technology landscape, surveying, mapping, construction industry

1. Introduction

The sector of the construction industry in Indonesia has increased from year to year, which became one of the pillars support the growth of the national economy [1]. It is becoming a considerable challenge that will be faced by the perpetrators of construction services in Indonesia in particularly the contractor. Globally, the construction industry is also facing increasing challenges from time to time. In the year 2030, the estimated number of construction projects will increase by 85%, but on the other hand, projects are required to have high productivity, but efficient. One solution to overcome these problems is through the application of technology. The technology is the overall means to provide things necessary for the sustainability of construction projects both from the tooling, equipment, materials, methods of construction and also a variety of software. McKinsey & Company (2017), estimated by applying the technology will improve productivity by 14-15% and savings of 4-5% [2]. This can be seen in Fig. 1. Therefore, it is imperative that the Indonesian construction industry invest more in the adoption, development and application of technology to better support the development of the country [3].

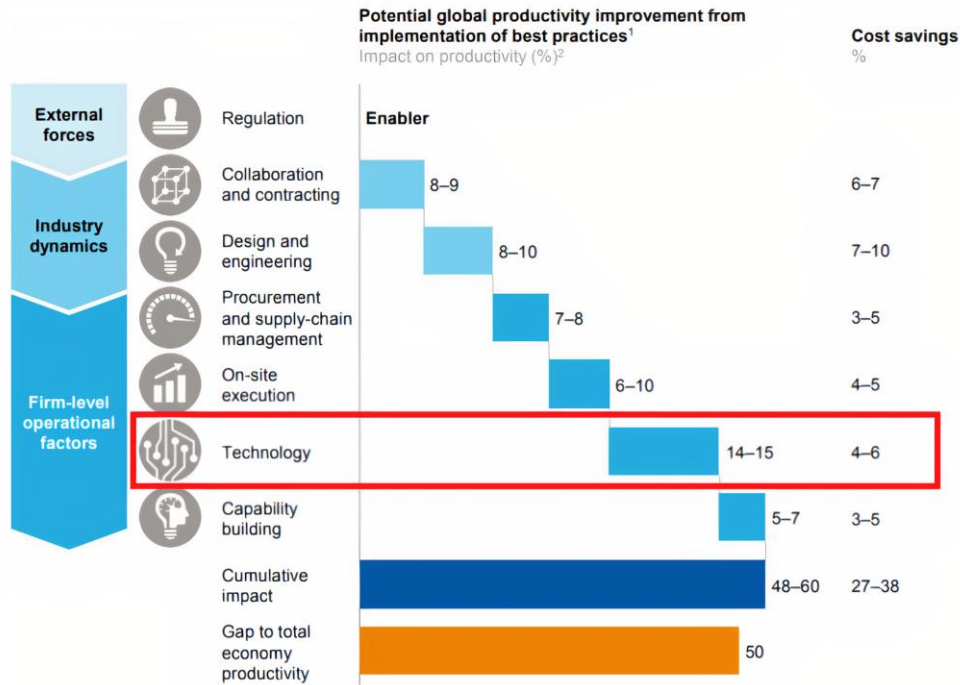


Fig. 1 - The impact of technology adoption on productivity [2]

Over the centuries, with the continuous development of architectural knowledge, technology and experience in the process of large-scale construction projects, several project-related degree programs have emerged: architects, construction technicians and engineers, project sponsors and financiers Creative tensions among technology development, material and equipment suppliers, work organizers, and participants in multiple technology development projects stimulate or hinder creativity and innovation in architecture and construction sector [4].

At this time, the challenges facing the construction sector are escalating due to the Covid-19 pandemic, which has slowed the business of construction companies, especially contractors, due primarily to the weakening demand. For the construction of projects/infrastructure in the country, behavioral changes in the work environment with the fulfilment of the obligations of the medical process, the throughput of the supply chain is limited and limited by restrictions, productivity decreases, causing delays in the project completion dates, as well as reallocation of the project budget. Therefore, the application of technology with a base of digitization will be increasingly required, especially to reduce physical activity, but still provide a level of high productivity and efficiency.

2. Technology Landscape for Surveying and Mapping

Construction technology as a set of tools, machinery, modifications, software, and other things that are innovative, which is used during the construction phase of a project that supports the development of construction methods in the field, including construction equipment semi-automatic or automatic [5]. The use of technology has been implemented in construction projects to overcome the problems on construction projects, for example the use of Building Information Modelling (BIM) to support the integration process of the project, the use of technology Virtual Reality (VR) for the simulation of the project, the use of high-tech equipment to support the construction process, for example the use of 3D scanning, drones, and other things.

The use of such technology can be described as the landscape of technology. The landscape of technology is beneficial to answer the problems that continue to evolve and predict future needs. An example of the field of science and technology that is developing is the mapping (surveying). Mapping is the study of the visibility of the face of the earth that uses a tool and produce accurate information. In other words, mapping and geography it's the same because the same discuss the things that are in or above the earth during it affects the surface of the earth [6]. Advances in technology mapping (visualization), is currently experiencing a very rapid development. A lot of companies that offer photo map for the desired region with scene specific and the level of resolution spatial diverse. This is evident with the launch of the satellite Lansat by NASA on 23 July 1972, which was given the name of the ERST-1 (Earth Resource Technology Satellite) [7].

In a construction project, surveying and mapping plays important role. The function of mapping is very important because it provides information regarding key references for positions, elevation, dimensions, and configurations for all construction objects and operations. Survey and mapping in the construction project basically consists of three major parts, namely: (a) The measurement framework of the vertical base: measurement-measurement is erect, in order to get

the relationship upright between the measured points, (b) The measurement framework of the horizontal basic: measurement of horizontal to get the relationship of the measured points on the surface of the earth, and (c) Measurement of detail points. In planning the civilian buildings (for example the planning of highway, railway, irrigation, dams, and others) relies heavily on maps and mapping [8].

The process of collecting data mapping in the construction consists of the method of field surveying and methods of remote sensing. The method of field surveying is used to get data and a live picture of the area of construction such as the use of the Theodolite, Total Station, GPS, etc., while the method of remote sensing is the process of collecting data obtained without having to go straight to the area of construction such as the use of the method of Aerial Photography, Airborne Imagery, and Satellite Imagery [9]. In the conditions of the pandemic Covid-19, the reduction of the activity of the physical in order to suppress the number of the spread of the virus needs to be done, though it will be a challenge in mapping activities in the construction project itself. Thus, any solution that can be done is with the collection of mapping data through the method of field surveying needs to be limited and the method of remote sensing can be utilized a lot more for the purpose of mapping in construction projects is still achieved. But it also needs to be studied more deeply by looking at how the application of mapping technologies that are needed at this time on the construction project to get an overview of the challenges in the future.

Landscape of technology in this study is defined as follows: (i) An overview of the development of mapping technologies in Indonesia, and the comparison of its position on the world, (ii) An overview of the development of mapping technologies that are currently used the construction project in Indonesia, (ii)(a) An overview of the role of mapping technologies in the stages of the construction project in Indonesia, and (ii)(b) An overview of the development efforts, in learning, and the application of mapping technologies in construction projects in Indonesia. Conceptually, a technological landscape framework will provide an overview of relevant information about how a particular technology is being utilized and developed, as well as its potentiation in the future. For the construction industry, such information can further be used to identify potential opportunities to overcome the obstacles and challenges facing construction projects, which in turn will lead to higher productivity and competitiveness. This can be seen in Fig. 2.

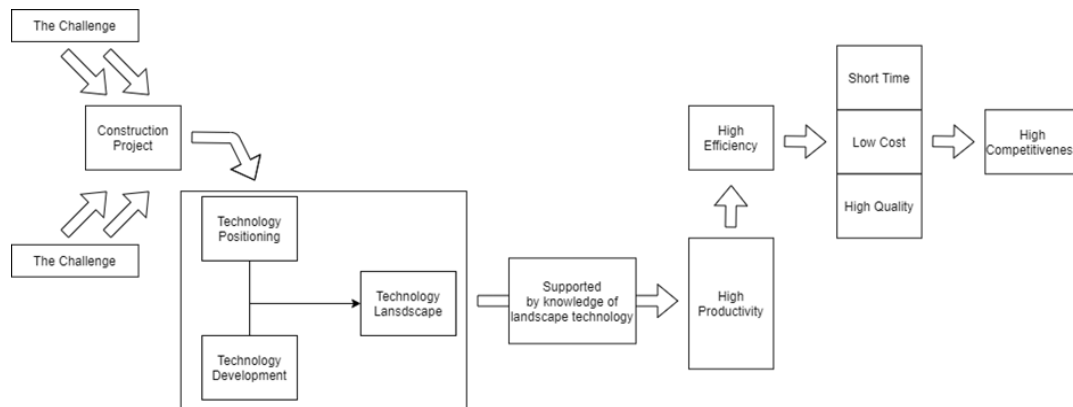


Fig. 2 - Conceptual framework for construction technology landscape

3. Methodology

In this study, the method used to obtain an overview of the development of mapping technology in the Indonesian construction industry uses field research approach. The instrument used is through a questionnaire form addressed to parties involved in mapping activities on construction projects. Therefore, the development of construction technology landscape follows the subsequent stages (in Fig. 3):

- Map the classification of construction technology as patent right and brainstorming.
- Construct an initial mapping for classification of construction technology based on Word Intellectual Property Organization (WIPO) until the mapping technology is selected for further study.
- Arrange a pilot study of the landscape of mapping technology through literature review to determine the positioning of technology in Indonesia and over the world as well as the development of mapping technology in Indonesia.
- Review the literature study for selected classification of construction technology to obtain an overview of the positioning of construction technology in Indonesia and over the world.
- Compose the questionnaire form to obtain an overview of the positioning of construction technology in Indonesia, as an overview of the role of mapping technology in the stages of construction project in Indonesia and also an overview an attempt to develop, learn, and application of mapping technology to construction projects in Indonesia.
- Distribute the questionnaire form.
- Analyse the results to obtain an overview of the landscape of construction technology in Indonesia.

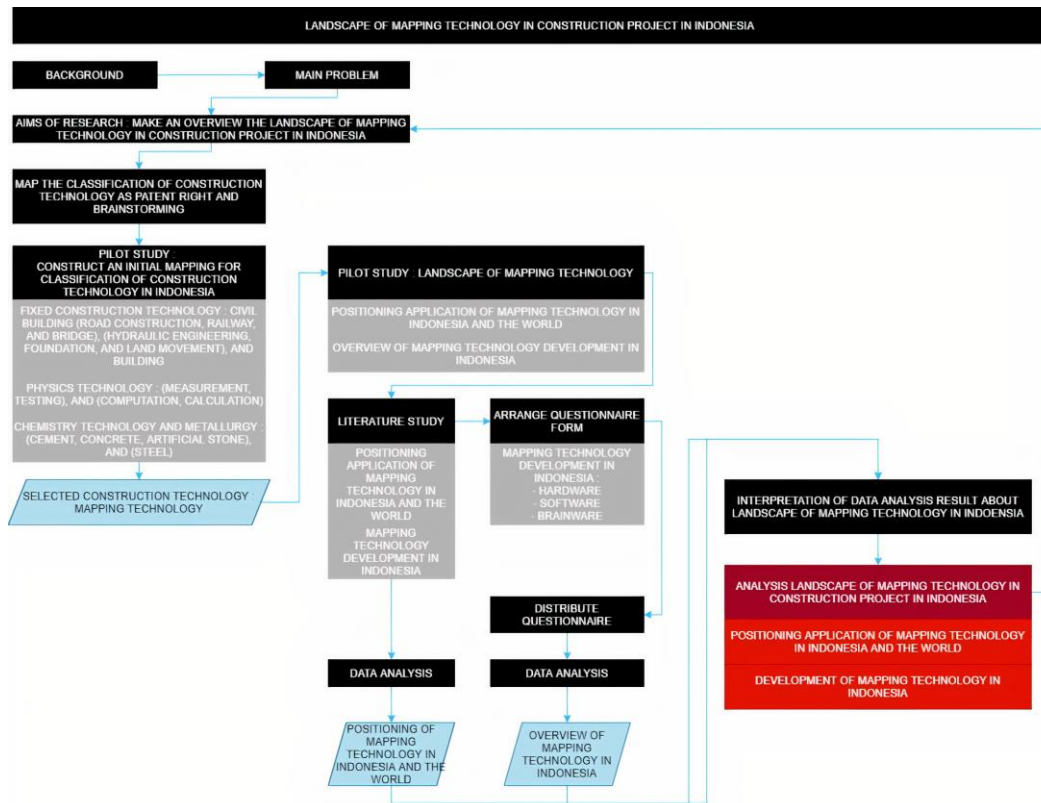


Fig. 3 - Steps for developing construction technology landscape

4. Results and Discussion

4.1 Positioning of Mapping Technology in Indonesia and the World

At first, Indonesia was quite behind in the development of mapping technology, but in the end Indonesia was able to adapt and develop rapidly. Indonesia began to adapt to the development of mapping technology in 1292 AD. Rapid development began in the 1950s. In the 1950s, Indonesia's adaptation to mapping technology began with photogrammetry. Then in the 2000s, one example of the application of mapping technology in the developing world was the application of UAV and LiDAR. Indonesia was able to adapt to the development of world mapping technology shortly after the technology was introduced. This can be seen in Fig. 4.

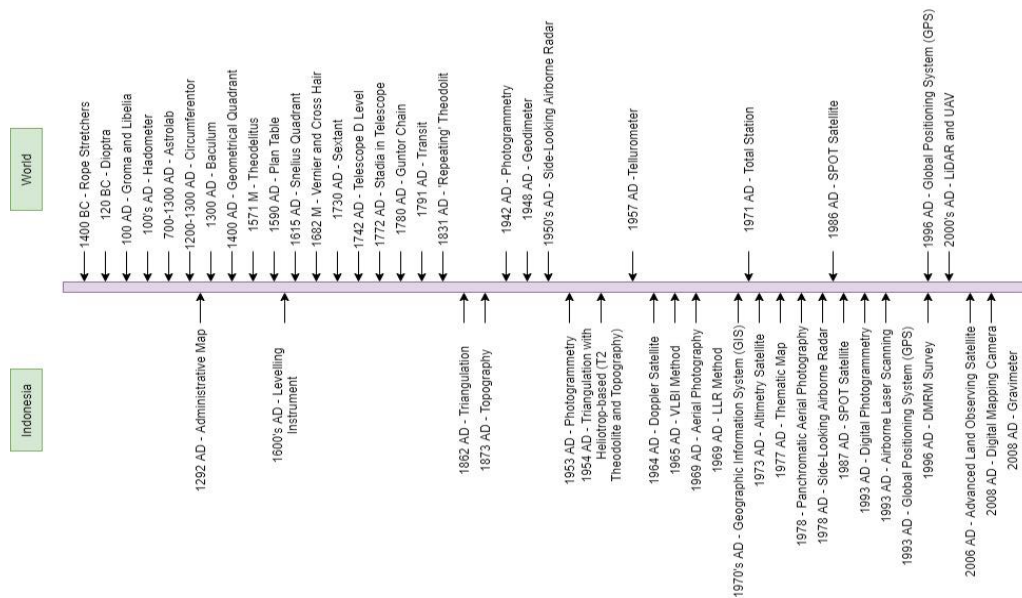


Fig. 4 - Positioning of surveying and mapping technology in Indonesia and the world

4.2 The Development of Surveying and Mapping Technologies in Construction Projects in Indonesia

Based on the results of this research where the mapping technology is divided into 3 parts, named equipment, software, and methods. In terms of equipment, the 3 highest order commonly used for mapping are Total Station, GPS, Levelling Instrument. The total station is an electronic survey instrument that functions to measure angles and distances automatically. In construction projects, total stations are used at the initial design stage when determining the levelling of a building. GPS or Global Positioning System is a satellite-based navigation system. Levelling instrument is a tool to measure an object or line is in a flat position. An example of using a levelling instrument in a construction project is measuring a floor whether it is level or not. The three uses of these tools play an important role in construction projects. This can be seen in Fig. 5.

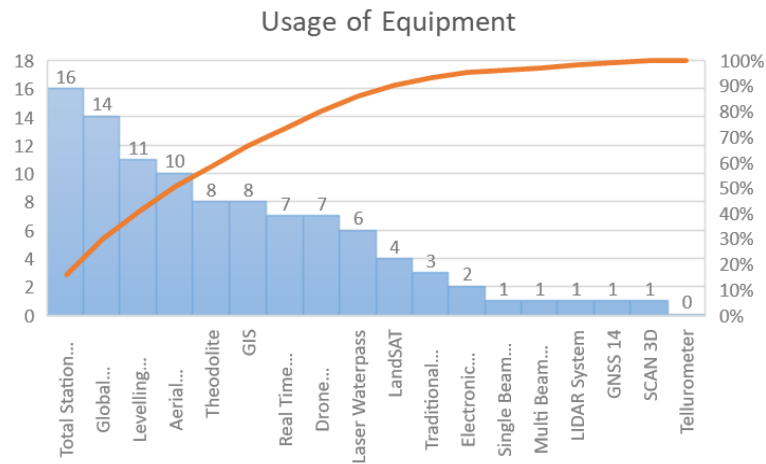


Fig. 5 - The utilization of surveying and mapping equipment

In terms of software, the 3 highest order commonly used for surveying and mapping are Autocad MAP, ArcGIS, and Global Mapper. AutoCad MAP is a software that is used to draw the design in the form of maps based on geographic information systems. In the construction of road construction, Autocad MAP software is used to describe the road plan complete with information related to geographic information systems. ArcGIS software provides information on GIS-based soil and geospatial conditions. This software is very useful in planning construction at an early stage because by determining the location of the project to be built, the engineer will know how the soil and geospatial conditions are around the project. Global Mapper is software to find out information about contour. This can be seen in Fig. 6.

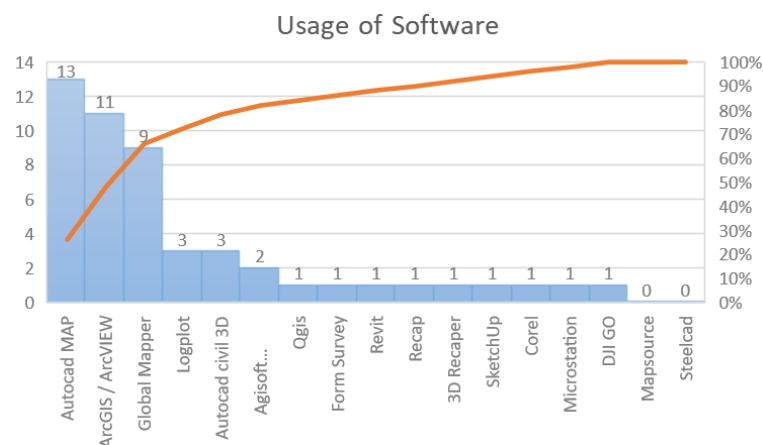


Fig. 6 - The utilization of surveying and mapping software

And in terms of method, the 3 highest order commonly used for mapping are measurement methods with Total Stations, mapping with drones, and processing in the studio. Manual mapping takes a long time and requires human labour. However, with mapping using drones, mapping in construction projects will take a shorter time and the results of mapping are more accurate than manual ones. However, the mapping method used in Indonesia still uses a lot of total stations compared to drones. This can be seen in Fig. 7.

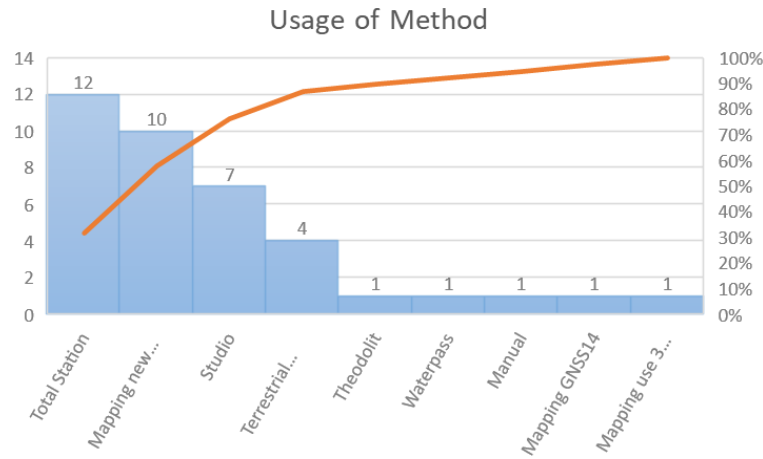


Fig. 7 -The usage of mapping method (brainware)

Based on the results of this research, it can be seen when the equipment, programs, and methods in the use of mapping technology were first used in Indonesia. Table 1 shows the 3 highest order in the use of mapping technology were first used. The top 3 of this hardware are equipment that has been used for a long time in the order of Levelling Instrument (1992), Total Station Theodolite (1998), and GPS (2014). The top 3 of this software are software that has been used for a long time in the order of Autocad MAP (1998), ArcGis and Global Mapper (2009). The top 3 of this method are Total stations, mapping with drones, and processing in the studio which have been used since 1993.

Table 1 - Recap of equipment, program, and method according to first time used in Indonesia

	Description	Year
Equipment (Hardware)	Levelling Instrument	1992
	Total Station Theodolite	1998
	GPS	2014
Program (Software)	AutoCAD Map	1998
	ArcGIS	2009
	Global Mapper	2009
Method	Total Station	1993
	Mapping with Drones	1993
	Processing in the Studio	1993

4.3 The Usage of Mapping Technologies in Construction Projects in Indonesia

In general, the use of technology in its application to construction projects is fairly even, controlling and controlling field work performance for the commissioning process. Where the planning process has the greatest weight because critical activities are an early stage that has a role before the design is implemented. This can be seen in Fig. 8.



Fig. 8 - The utilization of surveying and mapping technology in construction project

This research also analyses the attempt of maintenance-development, duplication and use of mapping technology. Where for equipment, software, to the methods used, are generally developed through a training process. Then in terms of attempts to obtain mapping technology, it is found that the procurement of equipment is generally carried out through a rental process, for software procurement it is carried out through a purchase/download process, and for methods learning attempts are generally carried out through a special training and learning process.

5. Conclusion

An overview the landscape of construction technology in Indonesia can be grouped in two parts:

- Positioning of Mapping Technology in Indonesia and Over the World
In describing the development of mapping technology, Indonesia is quite behind compared to developments in the world. Indonesia began to adapt to the development of mapping technology in 1292 AD. And began in 1950 Indonesia was able to adapt to the development of mapping technology over the world.
- Development of Mapping Technology in Construction Projects in Indonesia
- Mapping technology has developed rapidly, however the use of this technology in Indonesia in general still uses early technology (1992-1998), except for Global Mapper Software (2009) and GPS hardware (2014).
- Mapping technology is always applied to construction projects and has the most important role in the planning/design process because mapping activities are the basis of planning/design activities.
- In an attempt to develop hardware, software, and brainware, mapping technology is generally carried out through a training process. And in terms of learning efforts in general, it is carried out through special purchases and learning (training), except for hardware considering that large investments are required for the procurement process (generally renting).

Acknowledgement

The author would like to acknowledge the Faculty of Civil Engineering and Environment, Bandung Institute of Technology and the Department of Civil Engineering, Faculty of Engineering, Parahyangan Catholic University, for their support and cooperation.

References

- [1] Okviyanto S. H. (2011). The impact of construction sector development towards Indonesian economy: A social accounting matrix analysis. Master Thesis, Universitas Indonesia.
- [2] McKinsey & Company. (2017). Reinventing construction: A Route to higher productivity. McKinsey Global Institute, pp. 7.
- [3] Soemardi B. W., Kusuma B. & Abduh, M. (2020). Technology assessment in Indonesian construction industry. IOP Conference Series: Material Science and Engineering, 849, 012077.
- [4] Skibniewski M. J. & Zavadskas E. K. (2013). Technology development in construction: A continuum from distant past into the future. Journal of Civil Engineering and Management, 19, 136-147.
- [5] Jones K. (2020). Construction technology is reshaping the industry. <https://www.constructconnect.com/blog/technology-reshaping-construction-industry>.
- [6] Ambarwati W. & Johan Y. (2016). The history and science of mapping. Journal of Enggano, 1, 80-82.
- [7] Rachman A. S., Kamal E. & Teak D. W. (2004). The application of satellite imagery to the spread of mangrove ecosystem in the area of Stem Tomak Air Bangis Pasaman Barat. Journal of Mangrove and Coastal, 3, 1-7.
- [8] Yusuf H. & Halim H. (2014). Textbook survey and mapping. Deepublish.
- [9] Abidin Z. H. (2007). Surveying. Pembangunan Jaya University.