ASTONJADRO

pISSN 2302-4240
eISSN 2655-2086

Volume 14, Issue 4, December 2025, pp.01265-01272
DOI: http://dx.doi.org/10.32832/astonjadro.v14i4.19237 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

Influencing Factor of Bore Pile Delay's Work at Green Campus to Improve Time Performance

Paulus Ariyanto, Bernadette Detty Kussumardianadewi

Civil Engineering Department, University Mercu Buana, Jakarta, INDONESIA

E-mail: 41120120014@student.mercubuana.ac.id, bernadette_dt@mercubuana.ac.id

| Submitted: February 27, 2025 | Revised: September 30, 2025 | Accepted: December 19, 2025 |

| Published: December 31, 2025 |

ABSTRACT

Lack of supervision of the design of conditions in the field and late approval of design changes while the work is still ongoing, resulting in delays. Based on the time schedule (S-curve), the construction process of the Smart and Green Campus Dean's Building A of the Sentul Defense University has regressed from the planned schedule. This is due to the delay of the owner in the approval process and making design changes, which often occurs in design changes that have affected the work plan and require schedule adjustments. Therefore, it is necessary to reschedule so that the bore pile work can be completed in a more optimal time. This study aims to prove the dominant factor causing the delay in bore pile work using the RII (Relative Importance Index) method. Furthermore, to find out the activities in the bore pile work that are included in the critical activities along with their critical paths and to determine more optimal time performance using the Critical Path Method (CPM) method. The results of the analysis and calculation of the RII are the dominant factor causing the delay in bore pile work based on the variable is the X1 (owner) variable. Meanwhile, the dominant factor causing delays in bore pile work based on indicators is the owner's delay in the approval process and making design changes (X1.2). The results of the analysis carried out using the CPM method took 65 days, where the accelerated time was 40 days out of 105 days of implementation and accelerated 5 days out of 70 days of planning. Activities that are on the critical path are reinforcement fabrication (B) and drilling and casting work (D).

Keywords: relative importance index, critical path method, bore pile, green campus.

INTRODUCTION

Time management is an essential part of any project activity [1]. Project time management is needed to monitor and control the time spent in completing a project. The right cost control method and project time technique will be able to reveal the occurrence of abuse during the implementation of a development [2]. Project scheduling is the result of planning that provides information about the schedule of the plan and progress of the project in terms of resource performance in the form of costs, labor, equipment and materials as well as the project duration plan and the progress of the project completion time. The time progress displayed in the project schedule is one of the important elements in project time control [3].

To create a green campus, universities are required to implement environmentally friendly development and education practices [4]. A green university is an educational institution that meets its needs for natural resources – such as energy, water, and materials without sacrificing the ability of people in other countries and future generations to meet their own needs [5].

In the implementation of large-scale construction, one of the deep foundations that is often used is bore pile. In bore pile work, the problem that is often faced is the low productivity of the drilling rig or drilling productivity. Factors that affect the productivity of a drilling rig include land conditions, weather factors, maintenance and repair of equipment, refueling and lubricating oil, drilling diameter and depth, and the use of several heavy equipment at the same time. The bore pile foundation work requires equipment, one of which is the total station (TS), this tool functions to read, record horizontal and vertical angles along with their slope by utilizing the reflection of sunlight, therefore the weather factor is very important. Lack of supervision of the design of conditions in the field and late approval of design changes while the work is still ongoing, resulting in delays [6].

Based on the time schedule (S-curve) above, the construction process of the Smart and Green Campus of Sentul Defense University has regressed from the planned schedule. In the plan, this project will be implemented for 5 months from May 2024 to September 2024, but it was delayed due to foundation work. The drill pile foundation work itself was carried out for 70 days from the 5th week to the 14th week. The work on the drill pole was planned to start in the 5th week, but in its implementation, it was only carried out in the 10th week. Delay can be defined as the missed deadline for project completion from the time specified in the contract, or from the time agreed by the parties involved in the completion of a project [2]. Meanwhile, to prove the factors that cause delays in bore pile work, the factors causing the delay will be identified by RII (Relative Importance Index) analysis. To be more focused, this study only measures the RII value without measuring the risk value. After the delay factor is identified, then to improve the time performance of the bore pile work, a reschedule is carried out so that the bore pile work can be completed with a more optimal time so as not to cause too long a delay to the entire Green Campus project work.

RESEARCH METHODS

Analysis of the RII Method and the CPM Method

At this stage of research, the analysis of the RII method is to prove the dominant factor causing the delay in bore pile work. The factors that cause the delay in bore pile work are taken from the identification of problems in which there are main problems and also some problems or general phenomena. These factors will be used as variables and indicators that will be proven by the RII method and corroborated by previous literature or research journals. After the RII analysis is known and proven to be the dominant causative factor, then rescheduling will be carried out using the CPM method.

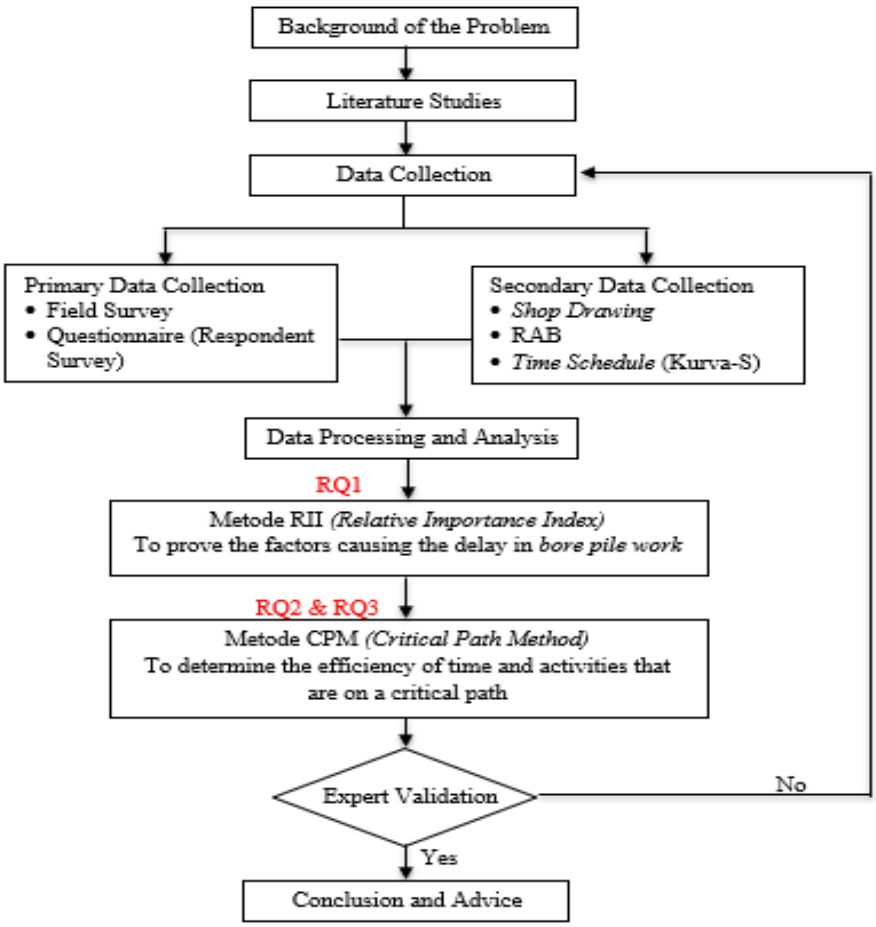

Figure 1. Research Flow Diagram

pISSN 2302-4240
eISSN 2655-2086
Volume 14, Issue 4, December 2025, pp.01265-01272
DOI: http://dx.doi.org/10.32832/astonjadro.v14i4.19237 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

Methods

This type of research is descriptive and quantitative research. The method used is a descriptive analysis method that is carried out by describing with the intention of finding elements, analyzing and even comparing [8]. Quantitative research is research conducted by collecting measurable data using mathematical or computational statistical techniques. The research method is quantitative, emphasizing numbers and the use of tables, graphs and diagrams to facilitate the presentation of research results [9].

RII is a method to analyze the most influential factors in research [10]. The choice of the RII (Relative Importance Index) method is because this method can identify most important criteria based on the answers from respondents and is the right method to prioritize indicators assessed using the Likert scale. The ranking resulting from the RII analysis method allows researchers to compare the relative importance of the criteria perceived by the respondents. The Critical Path Method (CPM) is necessary because it can determine the dependence of activities between other activities, the available time reserve and the critical path of activities that should not be late [11].

Data Analysis

In the RII analysis, the primary data obtained by the author is through a survey of respondents or the distribution of questionnaires. The research instrument, namely a questionnaire or survey of respondents. At this stage of research, the analysis of the RII method is to prove the dominant factor causing the delay in bore pile work. The factors that cause the delay in bore pile work are taken from the identification of problems in which there are main problems and also some problems or general phenomena. These factors will be used as variables and indicators that will be proven by the RII method and corroborated by previous literature or research journals. This analysis method will be done by using the data acquired from questionnaires which would produce the influential factors [12]. Identify research variables and factors that cause delays in bore pile work as indicators through the identification of research problems and literature studies against pre-existing research journals. After determining the variables and indicators or factors that cause the delay in the bore pile work, the next step is to make a questionnaire. The Validity Test is a measure that shows the level of reliability or validity of a measuring tool [10]. To test the validity, first look for the correlation value with the Pearson Product Moment formula. The reliability test is carried out after the validity test, this is to find out whether the measuring instrument or instrument can be used or not. The concept of reliability is the extent to which the results of a study can be trusted [10]. There are several formulas that can measure the level of reliability he asked: Spearman Brown, Kuder Richardson (KR-20 or KR-21). The formula used in reliability testing is Cronbach's Alpa [13]. After the indicators on each instrument are declared valid and reliable, then the RII calculation is included.

CPM or Critical Path Method is a method of analyzing project design using a fixed time estimate for each activity [14]. CPM analysis is carried out in two main stages. The first stage is to create a Work Breakdown Structure (WBS). After the Work Breakdown Structure (WBS) on the bore pile work is made and the data has been collected, the second stage is the data analysis stage and the calculation of the CPM (Critical Path Method) method.

RESULT AND DISCUSSION

After the questionnaire was tested for validity and reliability testing, then the RII calculation was carried out with the help of Microsoft Excel software. The results of the analysis of the RII calculation can be seen in table 1. The following.

Table 1. Results of RII Calculation Analysis

Code Variable	Code Indicator	1	2	3	4	5	6	ΣW	A	N	RII
X1	X1.1	0	1	2	9	2	1	60	6	15	0,667
	X1.2	0	0	1	3	6	5	75	6	15	0,833
	X1.3	0	0	1	4	5	5	74	6	15	0,822
	X1.4	0	0	1	8	4	2	67	6	15	0,744
	X1.5	0	0	4	5	5	1	63	6	15	0,700
	X1.6	0	0	0	7	5	3	71	6	15	0,789
	X1.7	0	0	2	5	4	4	70	6	15	0,778
X2	X2.1	0	0	1	6	7	1	68	6	15	0,756
	X2.2	0	0	1	6	6	2	69	6	15	0,767
X3	X3.1	0	0	3	6	3	3	66	6	15	0,733
	X3.2	0	0	0	7	6	2	70	6	15	0,778
	X3.3	0	0	1	6	7	1	68	6	15	0,756
	X3.4	0	0	1	5	8	1	69	6	15	0,767
	X3.5	0	1	2	2	8	2	68	6	15	0,756
X4	X4.1	0	0	0	4	10	1	72	6	15	0,800
	X4.2	0	0	1	5	8	1	69	6	15	0,767
	X4.3	0	0	1	10	3	1	64	6	15	0,711
	X4.4	0	0	3	5	6	1	65	6	15	0,722
	X4.5	0	0	1	10	3	1	64	6	15	0,711
	X4.6	0	0	1	10	3	1	64	6	15	0,711
X5	X5.1	0	0	1	8	5	1	66	6	15	0,733
	X5.2	0	0	1	8	4	2	67	6	15	0,744
	X5.3	0	0	1	7	6	1	67	6	15	0,744
	X5.4	0	0	0	8	6	1	68	6	15	0,756
	X5.5	0	0	2	6	6	1	66	6	15	0,733
	X5.6	0	0	1	8	5	1	66	6	15	0,733
	X5.7	0	0	1	7	6	1	67	6	15	0,744
X6	X6.1	0	0	1	6	6	2	69	6	15	0,767
	X6.2	0	0	0	9	4	2	68	6	15	0,756
	X6.3	0	0	3	11	0	1	59	6	15	0,656
	X6.4	0	0	0	10	5	0	65	6	15	0,722
	X6.5	0	0	0	2	13	0	73	6	15	0,811
	X6.6	0	0	0	7	7	1	69	6	15	0,767

Based on the RII calculation table above, it is known that the top 5 variables can be seen in table 2. below.

Table 2. Variable Rating

Variable Code	Variable Name
X1	Owner
X6	Construction Management
X4	Environment and K3
X3	Contractor
X2	Consultant

Based on the RII calculation table above, it is known that the top 5 indicators can be seen in table 3. below.

pISSN 2302-4240
eISSN 2655-2086
Volume 14, Issue 4, December 2025, pp.01265-01272
DOI: http://dx.doi.org/10.32832/astonjadro.v14i4.19237 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

Table 3. Indicator Ranking

Code Indicator	Ranking	Factors causing delays in bore pile work
X1.2	1	Delay in the approval process and make design changes
X1.3	2	Design changes occur frequently while work is ongoing
X6.5	3	The consultant was late in approving the design change
X4.1	4	Delay in work due to environmental and weather conditions
X1.6	5	There is a change in the work order by the owner

Based on the results of the RII analysis, it is proven that the owner's delay in the approval process and making design changes is the dominant factor. Because there are often design changes and the owner is late in making decisions and approving design changes, thus affecting the work plan schedule, it is necessary to reschedule using the CPM method.

In the first stage of CPM analysis, the WBS is compiled using secondary data that has been collected, namely RAB to then be used in compiling the Work Breakdown Structure (WBS). The Work Breakdown Structure (WBS) functions to map sub-jobs or activities based on similar scopes [15]. The WBS on the bore pile foundation work is shown in figure 2. as follows.

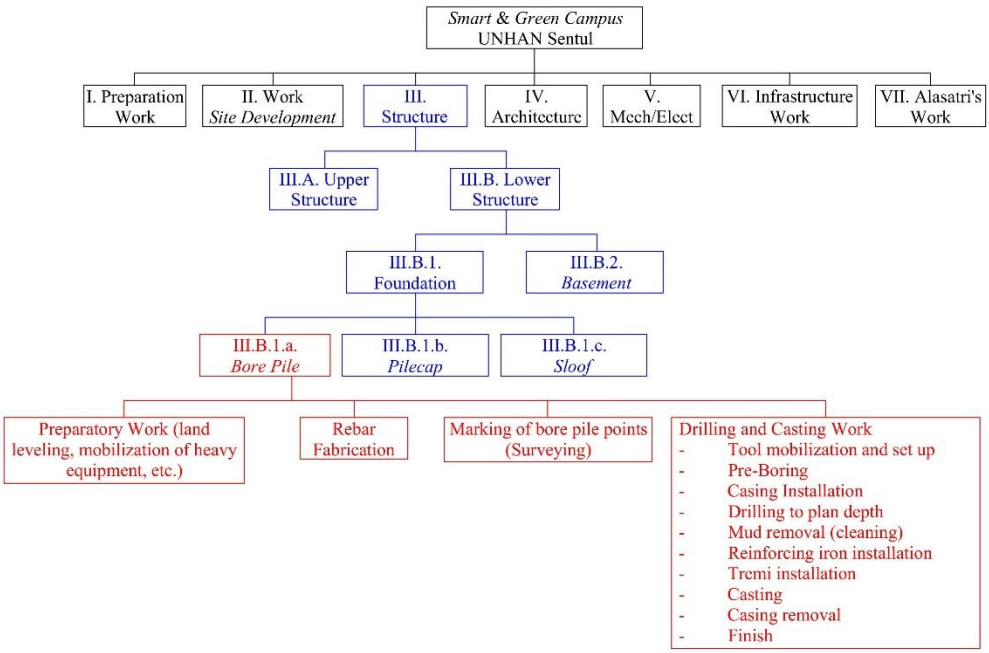

Figure 2. WBS Bore *Pile Work*

Based on the WBS and the calculation of the time duration, predecessor, and duration of each activity in the bore pile work of the Green Campus project of the Sentul Defense University can be presented in table 4. as follows:

Table 4. Predecessor of Bore Pile Work

Activity Code	Activity Name	Duration (Days)	Predecessor
A	Preparation (land leveling, heavy equipment mobilization, etc.)	2	-
B	Reinforcement steel fabrication	26	-
C	Marking of bore pile points (Surveying)	4	A

Activity Code	Activity Name	Duration (Days)	Predecessor
D	Drilling and Casting Jobs – Tool mobilization and setting up – Pre-Boring – Casing Installation – Drilling to plan depth – Mud removal (cleaning) – Installation of reinforcing iron – Tram installation – Casting – Case Lifting – Finish	52	B FS - 50%; C FS-50%

Based on table 4. Above it is explained that preparatory work such as site cleaning, land leveling and mobilization of heavy equipment with activity code A can be started without being related to the work that precedes it, as well as rebar fabrication work with activity code B can be started without being related to the work that precedes it, so it can be done earlier when iron materials and tools are available. Furthermore, the marking work of the bore pile point (C) can be started if the preparatory work (A) is completed so that in the direction of the arrow it is written with the code "FS" which means that the work can start after the previous related work is completed. In one-cycle work, namely drilling, including the installation of rebar as well as the casting of bore pile (D), it can be done when the fabrication of rebar (B) and the marking of the bore pile point (C) has been carried out 50% so that in the direction of the arrow it is written with "FS-50%" which means that the work can be started when the previous work has been carried out 50%. So, there is no need to wait for the previous work to be completed or it can be said to be done in parallel.

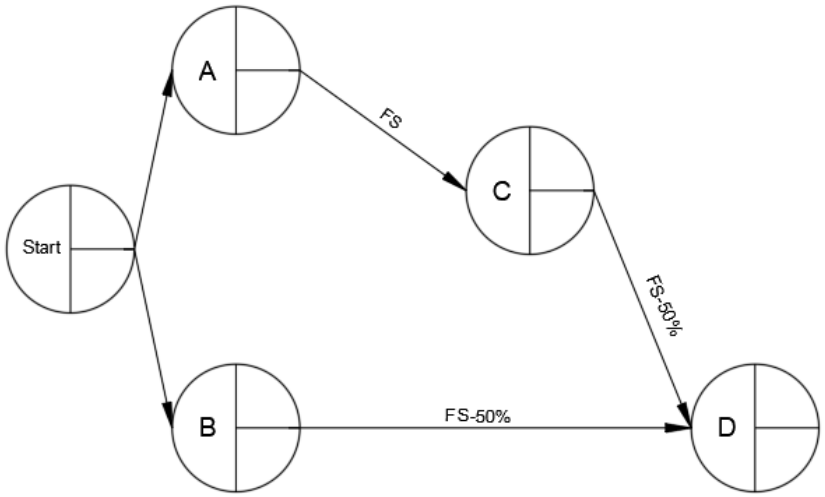

Figure 3. Bore Pile Work Network

Figure 3. Above is an arrow chart or network that represents the dependency relationship between activities (predecessors). Network planning is essentially a dependency relationship between parts of work that are depicted or visualized in a network diagram [16]. Thus, the parts of the work that must be prioritized can be stated, so that it can be used as a basis for doing the next work and it can also be seen that a work cannot be started if the previous activity has not been completed.

pISSN 2302-4240
eISSN 2655-2086
Volume 14, Issue 4, December 2025, pp.01265-01272
DOI: http://dx.doi.org/10.32832/astonjadro.v14i4.19237 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

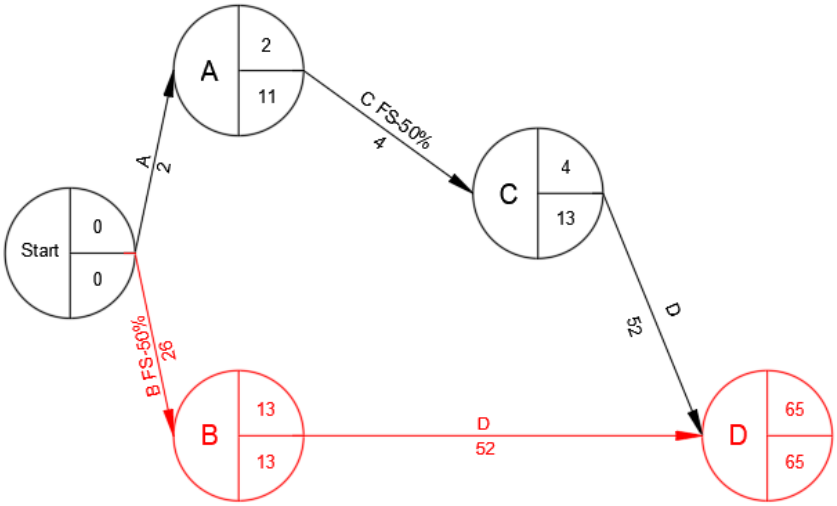

Figure 4. Critical Path Network Diagram (CPM)

Based on the work network and calculation of the critical path, it is known that the activities included in the critical path are activities B and D. The results obtained are faster than the duration of implementation due to the delay of the project for 105 days to 65 days, where this time acceleration is due to the existence of activities that can be carried out simultaneously so that time performance becomes more efficient.

CONCLUSION

The results of the analysis and calculation of the RII are the dominant factor causing the delay in bore pile work based on the variable is the X1 (owner) variable. Meanwhile, the dominant factor causing delays in bore pile work based on indicators is the owner's delay in the approval process and making design changes (X1.2). The top 5 factors that cause delays in bore pile work by variables are owner (X1), construction management (X6), environment & K3 (X4), contractor (X3), and consultant (X2). The results of the analysis carried out using the CPM method took 65 days, where the accelerated time was 40 days out of 105 days of implementation and accelerated 5 days out of 70 days of planning. Activities that are on critical paths or tracks are activity B (fabrication of reinforcing iron) and activity D (drilling and casting work).

ACKNOWLEDGEMENT

The author would like to thank the supervisor Dr. Bernadette Detty Kussumardianadewi, S.T., M.T. for helping with this research.

REFERENCES

[1] F. Simorangkir, M. A. K. Harahap, dan D. Damanik, "Analisis Penerapan Manajemen Waktu Proyek KonstruksiPerumahan Subsidi Type 36 Di Sigambogambo Lobu Siregar II Kecamatan Siborong – Borong," *J. Santeksipil*, vol. 2, no. 2, Okt 2021, doi: 10.36985/jsl. v2i2.546.

[2] R. R. Nabil, X. Furuhitho, L. Setiawan, R. H. Susanto, dan P. J. Slameto, "Perencanaan Pengendalian Biaya dan Waktu pada Proyek Pembangunan Rumah Susun Stie Tazkia Cendikia Bogor dengan Metode Earned Value," *J. Soc. Sci. Res.*, vol. 3, no. 6, hlm. 7591–7600, 2023.

[3] S. Perdana dan A. Rahman, "Penerapan Manajemen Proyek dengan Metode CPM (Critical Path Method) Pada Proyek Pembangunan SPBE," *Amaliah J. Pengabdi. Kpd. Masy.*, vol. 3, no. 1, hlm. 242–250, Feb 2019, doi: 10.32696/ajpkm. v3i1.235.

[4] T. Lartey, D. O. Yirenkyi, S. Adomako, A. Danso, J. Amankwah-Amoah, dan A. Alam, "Going green, going clean: Lean-green sustainability strategy and firm growth," *Bus. Strategy Environ.*, vol. 29, no. 1, hlm. 118–139, Jan 2020, doi: 10.1002/bse.2353.

[5] N. Ito, "Kampus universitas yang cerdas dan hijau," *J. Int. Komun. Energi Dan Lingkung. Maejo*, 2019.

[6] W. Mohdar, R. Serang, dan H. D. Titaley, "Analisa Faktor Penyebab Keterlambatan Pekerjaan Bore Pile Pada Proyek Pembangunan Sekolah Citra Kasih Ambon Dengan Metode Fault Tree Analysis (FTA)," *Parameter J. Mat. Stat. Dan Ter.*, vol. 3, no. 01, hlm. 19–32, Feb 2024, doi: 10.30598/parameterv3i01pp19-32.

[7] P. D. Saputra dan A. Hidayat, "Analisis Pengukuran Relative Importance Index (Rii) untuk Menentukan Peringkat Faktor Penyebab Keterlambatan Pekerjaan Kanopi Proyek East Connection Taxiway Bandara Soekarno-Hatta," *Constr. Mater. J.*, vol. 5, no. 3, hlm. 235–250, Nov 2023, doi: 10.32722/cmj. v5i3.6311.

[8] A. F. A. Z. Mughni, H. T. Tjendani, dan B. Witjaksana, "Analisis Kinerja Biaya Menggunakan Metode Earned Value pada Pelestarian Jalan Keluar Tol 5 Pandaan Malang," *Int. J. Adv. Technol. Eng. Inf. Syst. IJATEIS*, vol. 2, no. 4, hlm. 294–311, Jan 2024, doi: 10.55047/ijateis. v2i4.969.

[9] I. K. A. Ariana dan D. A. Lestari, "Analisis Kinerja Proyek Optimalisasi SPAM Gatak Kabupaten Sukoharjo dengan Metode Earned Value," *J. Integr. Syst.*, vol. 6, no. 1, hlm. 87–102, Jul 2023, doi: 10.28932/jis. v6i1.6521.

[10] A. E. Husin dan F. Sustiawan, "Analisa RII (Relative Important Index) Terhadap Faktor-Faktor yang Berpengaruh dalam Mengimplementasikan BIM 4D dan M-PERT pada Pekerjaan Struktur Bangunan Hunian Bertingkat Tinggi," *J. Apl. Tek. Sipil*, vol. 19, no. 4, hlm. 417, Des 2021, doi: 10.12962/j2579-891X.v19i4.9336.

[11] A. Purwantoro, K. J. Suhin, dan W. Nuswantoro, "Pengendalian Proyek Konstruksi Gedung Menggunakan Critical Path Method (CPM) dan Earned Value Method (EVM)," *J. Tek. J. Teor. Dan Terap. Bid. Keteknikan*, vol. 5, no. 2, 2022.

[12] A. Eddy Husin, N. Sari, B. Detty Kussumardianadewi, T. Ilyas, dan T. Saleh, "Analysis of the Implementation of Bim Based Quantity Take Off on HighLevel Building Structure Working with Relative Important Index," *Int. J. Adv. Sci. Technol.*, vol. 29, no. 4, hlm. 3346–3353, 2020.

[13] Y. Utami, "Uji Validitas dan Uji Reliabilitas Instrument Penilaian Kinerja Dosen," *J. Sains Dan Teknol.*, vol. 4, no. 2, hlm. 21–24, Feb 2023, doi: 10.55338/saintek. v4i2.730.

[14] L. Alfaris, M.T. *dkk.*, "RISET OPERASI," dalam *Riset Operasi*, Cetakan Pertama., vol. 1, Bandung: INDIE PRESS, 2022, hlm. Bab 10.1-10.5 hal. 95-99. [Daring]. Tersedia pada: www.indiepress.co.id

[15] A. F. Enisah dan F. Hardiyanti, "Analisis Jalur Kritis Pada Pekerjaan Konstruksi Pondasi Menggunakan Metode Critical Path Method (CPM)," *J. Tek. Sipil PPNS*, 2023.

[16] J. Thoengsal dan M. Tumpu, *Metode Optimalisasi Penjadwalan Pelaksanaan Proyek Konstruksi Menggunakan Metode Critical Path Method (CPM)*, Cetakan Pertama., vol. 1. Makassar: CV. Tohar Media, 2022. [Daring]. Tersedia pada: https://toharmedia.co.id