

The Effect of Implementation of Occupational Health and Safety Management System on the Elevated Railway Line Construction Project Between Solo Balapan-Kadipiro KM 104+700 SD KM 107+000 (Phase 1) on Cost and Time

¹Anji Hastama, ²Co. Prof. Muhammad Nur Sahid

^{1,2}Civil Engineering, Faculty of Engineering, Universitas Muhammadiyah Surakarta, Indonesia

Abstract - The number of jobs caused by work is still very high. The implementation of Occupational Safety and Health (OSH) is an obligation for all parties. Occupational accidents and diseases will have a negative impact on the project. Projects can be carried out well if the course of the project can be controlled properly. Based on previous research conducted in October-December 2022 located at Simpang Joglo, Surakarta (City) with a discussion of the effect of implementing an occupational safety and health management system on worker productivity which resulted in a very good percentage of OSH Management System implementation of 88.37%, then development is carried out with the aim of knowing the effect of implementing OSH Management System on project implementation time and costs. With data analysis using the Earned Value Method and field observations, several conclusions were obtained. Based on the application of OSH Management System and the results of calculations, it can be seen that the project runs faster than the planned time with a positive Schedule Variance (SV) value, that is: IDR 428,204,245 (positive) and a Schedule Performance Index (SPI) value of 3.857, but a deeper study is needed of the possibility of unrealistic plans. The budgeted costs incurred during the work in October-December 2022 are smaller (saving) than the planned budget or it can be said that the project is profitable with a Cost Variance (CV) value of IDR 76,941,045 and a Cost Performance Index (CPI) of 1.153. It can be concluded that the application of OSH Management System will affect the achievement of project performance.

Keywords: SMK3, control, effect of implementing SMK3, earned value, SV, SPI, CV, CPI.

I. INTRODUCTION

The number of accidents caused by work is still very high. Based on data from the International Commission on Occupational Health (ICOH) that every year there are 2.9 million deaths caused by work accidents in the world, with

80% caused by work-related diseases, and 20% due to work injuries, and there are 402 million people who experience non-fatal injuries in the world [1]. Ida Fauziyah (2023) The Indonesian Minister of Manpower said that based on the Annual Report of Employment BPJS in 2022 the number of work accidents was recorded at 265,334 people [2].

The definition of a work accident according to the laws and regulations in force in Indonesia states that in substance a work accident is an accident that occurs in an employment relationship when doing work at work, traveling to work or vice versa and when traveling on business in order to do work where the accident occurs. This work causes a result in the form of injury or injury [3].

The implementation of Occupational Safety and Health (OSH) is an obligation for all parties, and all parties must contribute to making OSH a culture in the work environment. The government's efforts to regulate OSH are by issuing several laws and regulations such as: Law Number 1 of 2009 concerning Work Safety, Law Number 13 of 2003 concerning Manpower, Government Regulation Number 50 of 2012 concerning Implementation of Management Systems Occupational Safety and Health, PermenPUPR Number 10 of 2021 concerning Guidelines for Construction Safety Management Systems, and others.

The impact of occupational accidents and diseases is not only detrimental to the workforce as one of the important factors for a construction service company, but will also cause direct obstacles and result in indirect losses, such as damaged work equipment and machinery, the environment damaged work, loss of time due to delays in the production process, cost overruns caused by work not being completed on schedule, and others. The success of a company depends on the work productivity of its workers [4].

A project will not be carried out properly if the project cannot be controlled properly. A project can be said to be successful if the cost, quality and time are exactly as planned

[5]. Project control must be carried out continuously throughout the project. Periodic reviews are an effective way to compare project progress. Project control is absolutely necessary to achieve the expected work. The quality of work is a target without neglecting the economic aspect and time of execution of work.

Control according to RJ Mockler 1997 in the book Imam Soeharto (1997) is a systematic effort to determine control with planning objectives, design information systems, compare implementation with standards, analyze the possibility of deviations between implementation and standards, then take corrective actions needed so that resources used effectively and efficiently in order to achieve the target [6].

Based on the results of research conducted by Nikita Priscilia Yolanda with the title "The Effect of Implementation of Occupational Safety and Health Management System on Labor Productivity Based on Government Regulation Number 50 of 2012 Article 6 (Case Study: Project for the Construction of the Elevated Railway Between Solo Balapan - Kadipiro)" with a target of 30 workers and 11 Health Safety Environment (HSE) workers with a measurement scale using a Likert Scale Percentage Level, and data testing using Multiple Linear Regression followed by Partial Tests and Simultaneous Tests, then the effectiveness level of implementing OSH Management System is 88,37% and it can be interpreted that the level of implementation is considered very good. Referring to Government Regulation Number 50 of 2012 Article 6, the following principles must be applied in a company as the basis for implementing the Occupational Safety and Health Management System, that is:

- 1) Determination of OSH policy
- 2) OSH planning
- 3) OSH implementation plan
- 4) OSH performance monitoring and evaluation
- 5) OSH Management System Performance Review and Improvement

Based on the development of the results of previous research, the researcher obtained the title "The Effect of Implementation of Occupational Safety and Health Management System on the Elevated Railway Development Project Between Solo Balapan - Kadipiro KM.104+700 to KM.107+000 (Phase 1) on Cost and Time ". This title discusses the effect of OSH Management System implementation on worker productivity in the Elevated Railway Development Project between Solo Balapan - Kadipiro by looking at the cost and time of project implementation. Similar research has never been done before.

From the results of previous research, it will be related to time and cost with reference to the application of the Occupational Safety and Health Management System in the project location, so that it can be seen whether the implementation of OSH Management System in the project location has an effect on project implementation time and costs.

1.1 Earned Value Concept

In a book entitled "Construction Management" by Irika Widiyanti and Lenggogeni explains that the concept of the earned value method is to calculate the budgeted cost of works performed, so that the relationship between the work that has been performed can be identified. achieved physically against the amount of the budget that has been issued.

By combining costs, schedules, and work performance, this concept presents three dimensions, namely the physical completion of the project (the percent complete) which reflects the planned cost absorption (budgeted cost), the actual costs that have been incurred (actual cost), and what is obtained from the costs that have been incurred or what is called the value of the results (earned value). There are several things that need to be understood, including:

- a) Actual Cost or Actual Cost of Work Performed (ACWP) is the cost of work that has been carried out in a certain reporting period.
- b) Earned Value (EV) or Budgeted Cost of Work Performance (BCWP) is the value of work that has been completed against the budget provided to carry out the work.
- c) Budget Schedule (Planned Value = PV) or Budgeted of Work Schedule (BCWS) is a budget for a work that is compiled and linked to an implementation schedule.

Cost and schedule variances

Cost Variance (Cost Variance-CV), is the value obtained after the work is completed with the actual value of the project. It is said to be profitable if the value is positive (+). Can be calculated by the formula $CV = BCWP - ACWP$.

Variance Schedule (Schedule Variance-SV), is the comparison between the part of the work that has been carried out with the planned. It is said the work is faster than planned if the value is positive (+). Can be calculated by the formula $SV = BCWP - BCWS$.

Productivity and performance index

The Cost Performance Index (CPI) is the comparison between the value received from completing the work and the

actual costs incurred to complete the work. Calculated using the formula $CPI = BCWP/ACWP$.

Schedule Performance Index (Schedule Performance Index-SPI), is the comparison between the completions of work in the field with the work plan for a certain period of time. Calculated with the formula $SPI = BCWP/BCWS$.

Table 2: Performance Index Criteria (Performance Index)

Mark	Information
< 1	Expenditure is greater than the budget or the implementation time is longer than the planned schedule. If it has been realistically planned, it means that something is not right in the implementation of the activity.
> 1	Expenditures are smaller than budget and execution time is faster than planned
The bigger the difference from number 1	Deviations from planning are getting bigger both in terms of time and budget, resulting in very good performance achievements. It is necessary to examine more deeply whether there may be plans or budgets that are unrealistic.

Source: Triono Agung Dumadi, et al, 2014)



Figure 1: Project Location
(Source: WIKA-BKU Document, KSO)

This research is quantitative and qualitative using the case study method with the object of research based on the development of previous research conducted by Nikita Pricilia Yolanda with the title "The Effect of Implementation of Occupational Safety and Health Management System on Labor Productivity Based on Government Regulation Number 50 of 2012 Article 6 (Case Study: Project for the Construction of the Elevated Railway Between Solo Balapan - Kadihiro)" in Zone 1 in October-December 2022.

Data collection is divided into two that is primary data and secondary data. Primary data was obtained from interviews and field observations with related parties, while secondary data as supporting data was obtained from the results of previous research conducted by Nikita Pricilia Yolanda in October-December 2022, weekly report, cost budget plan, etc

Based on the results of Nikita Pricilia Yolanda's research in that month, it was then developed by examining the planned work schedule in the S Curve with the actual work in the Weekly Report and evaluated, so that deviations were obtained. From this deviation, it will be known whether the project is experiencing delays or not. An examination was carried out on monthly reports from HSE related to OSH Management System that were realized in the field, so that it was known whether at that time the implementation of OSH Management System in the field was going well or not. From the realization of the weekly work it can be seen the costs incurred on the job. A project control analysis uses the earned value method to examine the overall project time and cost for the month.

III. RESULTS AND DISCUSSION

This development project aims to overcome the problem of traffic jams that occur at the Joglo Intersection, Surakarta (City) which is the meeting point of seven road sections, besides that this development is planned to improve airport train services. From previous studies with the results of the

Projection of cost expenditure and project completion timeframes

$$ETC = (BAC-BCWP)/CPI$$

$$EAC = ACWP + \{[BAC-BCWP]/CPI\}$$

With:

- BAC (Budgeted At Completion) = Overall Project Cost Budget
- ETC (Estimate Temporary Cost)m = Estimated Cost for Remaining Work
- EAC (Estimate All Cost) = Estimated Total Project Cost
- ETS (Estimate Temporary Schedule) = Estimated Time for Remaining Jobs
- EAS (Estimate All Schedule) = Estimated Total Project Time

II. RESEARCH METHODS

This research is located at Simpang Joglo, Surakarta (Kota) in Zone 1 (south side of the intersection) with WIKA-BKU, KSO as the contractor and the project owner from the Ministry of Transportation, Directorate General of Railways, Class I Railway Engineering Center, Central Java Region.

percentage of OSH Management System implementation of 88.37% in very good condition which affected worker productivity, the development was carried out with reference to the implementation of OSH Management System which affected the implementation time and project costs.

3.1 Job description

Details of the work carried out in Zone 1 in October-December 2022 are shown in the table below.

Table 3: Zone 1 Work Breakdown in October-December 2022

Month	Week	Type of work
Oct	43	Boredpile Drilling and Casting
	44	SSP Erection Boredpile Drilling and Casting
	45	SSP Erection
	46	Excavation of structures Bracing installation Cutting / Breaking Boredpile
Nov	47	Excavation of structures Bracing installation Cutting / Breaking Boredpile
	48	Excavation of structures Bracing installation Cutting / Breaking Boredpile
	49	Excavation of structures Bracing installation Cutting / Breaking Boredpile
	50	Cutting / Breaking Boredpile Pilecap Ironing
	51	Cutting / Breaking Boredpile Pilecap Ironing
dec	52	Cutting / Breaking Boredpile Pilecap Ironing Pilecap casting Pier Ironing
	53	Pilecap Ironing Pier Ironing
	54	Pilecap Ironing Pier Ironing Pier casting
	55	Pilecap Ironing Pilecap casting Pier casting

Based on the results of the weekly report evaluation, it can be known the deviation of progress from all work and application of SMK3 from week 43 to week 55 as follows.

Table 4: Project Weekly Progress Analysis

Minggu ke	Rencana (%)	Realisasi (%)	Deviasi (%)
43	1,4829	1,3933	-0,0735
44	1,4829	1,6441	0,0877
45	1,1823	1,1192	0,0245

46	1,1823	1,1363	-0,0216
47	1,1823	1,3411	0,1372
48	1,1823	1,0652	0,0201
49	1,1823	2,0562	0,8941
50	1,4562	0,6245	0,0624
51	1,4562	0,5080	-0,8858
52	1,4562	0,6296	-1,7124
53	1,4562	3,1808	0,0121
54	1,4272	1,4152	0,0001
55	1,4272	1,5096	0,0826

Table 5: Project Weekly Progress Analysis on OSH Management System Implementation Work

Week	Plan (%)	Realization (%)	Deviation (%)
43	0.006	0.02	0.014
44	0.006	0.02	0.014
45	0.004	0.02	0.016
46	0.004	0.02	0.016
47	0.004	0.02	0.016
48	0.004	0.02	0.016
49	0.004	0.02	0.016
50	0.006	0.02	0.014
51	0.006	0.02	0.014
52	0.006	0.02	0.014
53	0.006	0.02	0.014
54	0.006	0.02	0.014
55	0.006	0.02	0.014

The project's weekly progress can be seen in the S-Curve image below.

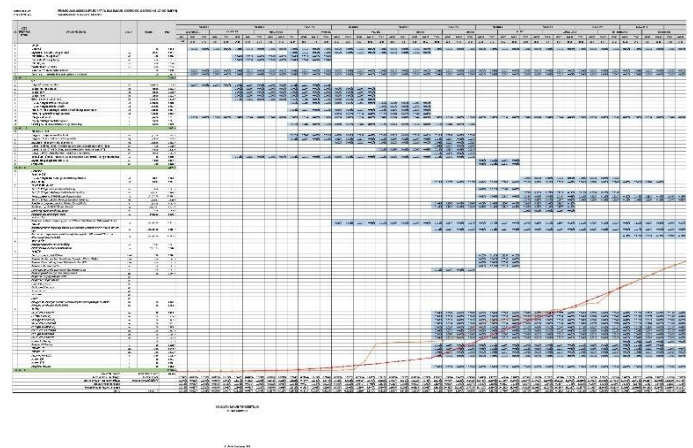


Figure 2: S-Curve
(Source: WIKI-BKU, KSO)

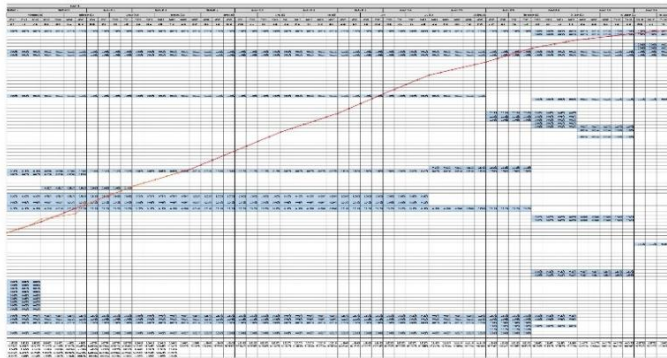


Figure 3: S-Curve
(Source: WIKA-BKU, KSO)

3.2 Analysis with Result Value Method

Some data is needed to analyze using the result value method, namely, ACWP, BCWP, and BCWS. The values obtained in this study are based on the progress of all work and the application of OSH Management System in the field. Details of these values can be seen in the table below.

Table 6: BCWS Values All Works

Month	Week	BCWS (IDR)
Oct	43	3.417.394.720,17
	44	3.417.394.720,17
	45	2.724.651.546,06
	46	2.724.651.546,06
Nov	47	2.724.651.546,06
	48	2.724.651.546,06
	49	2.724.651.546,06
	50	3.355.863.639,83
	51	3.355.863.639,83
Dec	52	3.355.863.639,83
	53	3.355.863.639,83
	54	3.289.032.129,36
	55	3.289.032.129,36

Table 7: BCWP Values All Works

Month	Week	BCWP (IDR)
Oct	43	3.210.908.398,15
	44	3.788.885.737,02
	45	2.579.235.397,40
	46	2.618.642.943,24
Nov	47	3.090.611.679,29
	48	2.454.790.515,83
	49	4.738.584.546,23
	50	1.439.182.010,08

Dec	51	1.170.703.700,75
	52	1.450.935.137,78
	53	7.330.264.431,80
	54	3.261.377.711,23
	55	3.478.925.800,50

Table 8: ACWP Values All Work

Month	Week	ACWP (IDR)
Oct	43	2.821.067.056,00
	44	3.530.903.325,07
	45	2.377.227.042,39
	46	2.259.695.755,70
Nov	47	2.657.697.019,77
	48	2.106.672.698,29
	49	4.202.887.267,83
	50	1.242.954.910,95
	51	1.061.685.375,90
Dec	52	1.361.139.881,49
	53	6.304.464.919,05
	54	2.802.749.571,05
	55	3.247.653.185,53

Table 9: BCWS, BCWP, and ACWP Values in OSH Management System Implementation Work

Mth	Week	BCWS (IDR)	BCWP (IDR)	ACWP (IDR)
Oct	43	13,220,100	46.220.702	25,853,154
	44	13,220,100	46.914.403	27,320,154
	45	8,813,400	49.848.145	23,663,154
	46	8,813,400	55.230.140	29,099,154
Nov	47	8,813,400	75.303.841	34,187,154
	48	8,813,400	94.617.543	34,187,154
	49	8,813,400	95.311.244	29,099,154
	50	13,220,100	7.973.702	35,876,154
Dec	51	13,220,100	13.355.737	49,556,154
	52	13,220,100	18.309.438	66,740,154
	53	13,220,100	23.483.140	42.170.154
	54	13,220,100	24.385.175	50,279,154
	55	13,220,100	27.078.876	53,060,154
Jumlah		149.827.800	578.032.045	501.091.000

A comparison of ACWP, BCWP, and BCWS values from week 43 to week 55 on all jobs and on OSH Management System implementation work can be seen in Figure 4 and Figure 5.

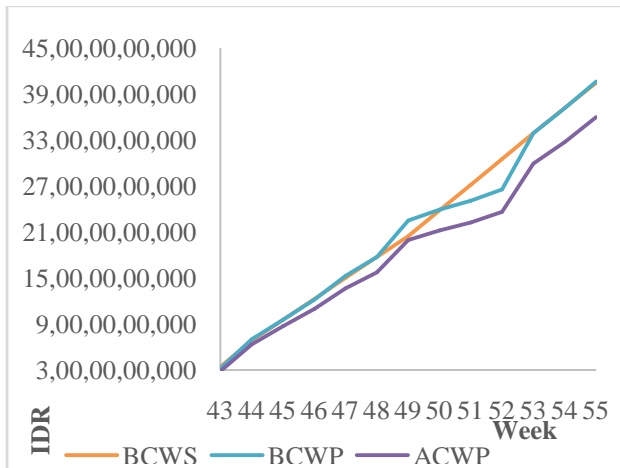


Figure 4: BCWS, BCWP, and ACWP Graph on All Works

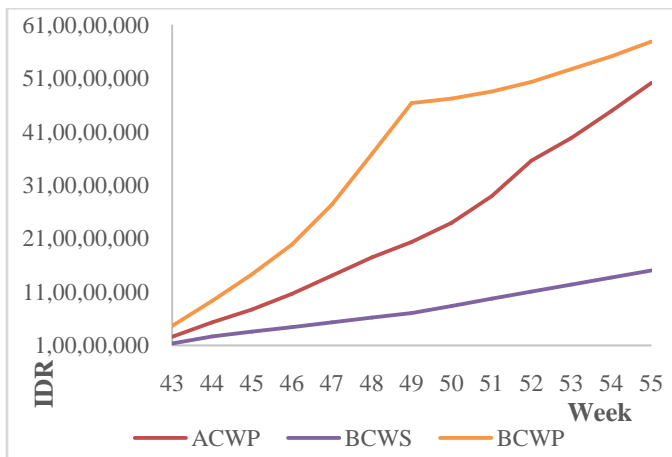


Figure 5: BCWS, BCWP, and ACWP Graph on OSH Management System Implementation Work

From Figure 4 it can be seen that the value of the BCWS curve is below the BCWP and ACWP curves, which means that the planned schedule has been fulfilled, or the project is said to be ahead of schedule. Meanwhile, the BCWP curve is above the ACWP curve, which means that the actual cost of implementing the project is below the planned cost or it can be said that the project is making a profit.

To find out the project's achievements during October-December, further analysis was carried out by calculating the SV, CV, SPI, and CPI values as shown in Table 10.

Table 10: Earned Value Analysis Terms

Term	Mark	Interpretation
CV	IDR 76,941,045	The CV value in Oct-Dec is positive, so it can be said that the project is under budget or profitable
SV	IDR 428,204,245	The SV value in Oct-Dec is positive, so it can be said that the project is ahead of schedule
CPIs	1.153	The CPI value in Oct-Dec >1, so

		it can be said that the project is under budget
SPI	3,857	The SPI value in Oct-Dec is the greater the difference from number 1, so it can be said that the project is running ahead of schedule, but a deeper study needs to be carried out whether there may be unrealistic planning
ETC	IDR 1.386.173.144	In Oct-Dec, it is estimated that the project cost for the implementation of OSH Management System still requires IDR 1,386,173,144 until the project is completed
EAC	IDR 1.879.155.144	In Oct-Dec, it is estimated that the project cost for the implementation of OSH Management System is IDR 1,879,155,144

3.3 The Effect of Implementation of OSH Management System on Time

From the results of the analysis using the Earned Value Method, the value of SV = IDR 428,204,245 (Positive) and SPI = 3,857. It can be concluded that based on the implementation of OSH Management System in October-December 2022 the project is running faster than planned, however a deeper study needs to be carried out whether there may be unrealistic planning.

3.4 The Effect of Implementation of OSH Management System on Costs

From the results of the analysis using the Earned Value Method, the value of CV = IDR 76,941,045 (Positive) and CPI = 1.153. It can be concluded that based on the implementation of OSH Management System in October-December 2022 the costs incurred by the project for implementing OSH Management System including personal protective equipment, signs, etc. are less than the planned budget (saving).

IV. CONCLUSION

Application of SMK3 in the Elevated Railway Development Project between Solo Balapan – Kadipiro KM.104+700 to KM. 107+000 went well with a percentage of 88.37% according to the results of previous studies. Good application of OSH Management System in the Elevated Railway Construction Project between Solo Balapan – Kadipiro KM.104+700 to KM.107+000 has an affects the cost and time of project implementation. Resulting in work progress faster than the time plan with a budget that is smaller than the plan. However, it is necessary to conduct a deeper

study with the possibility of an unrealistic planned budget and schedule.

REFERENCES

- [1] Purnama, I., D., 2023, Menaker Ungkap Jumlah Kecelakaan Kerja Naik Hingga 265.334 Orang di 2022, Menaker Ungkap Jumlah Kecelakaan Kerja Naik hingga 265.334 Orang di 2022 : Okezone Economy, diakses tgl 14 Februari 2023.
- [2] ILO, 2022, Social dialogue is key to mitigate work accident and increase productivity, World Day for Safety and Health at Work: Social dialogue is key to mitigate work accidents and increase productivity (ilo.org), diakses tgl 17 Maret 2023.
- [3] Firmansyah, D., A., Nugroho, A., 2023, "Analisis Yuridis Klasifikasi Kecelakaan Kerja Saat Work Form Home yang Dapat Ditanggung Program Jaminan Kecelakaan Kerja", Fakultas Ilmu Sosial dan Hukum, Universitas Negeri Surabaya, Surabaya.
- [4]] Ayu, F., K., D., Fiditia, R., M., Nourma, 2019 "Pengaruh Program K3 Terhadap Produktivitas Kerja pada Operator Alat Berat di PT BJTI Kota Surabaya", Fakultas Ekonomi dan Bisnis, Fakultas Kesehatan, UNUSA, Surabaya.
- [5] Sahid, Muh., Nur, dkk, 2019, "Kajian Faktor-Faktor Penyebab Cost Overrun pada Proyek Konstruksi Jlaan Dengan APBD Kabupaten Sukoharjo Tahun 2017 dan 2018", Fakultas Teknik, Universitas Muhammadiyah Surakarta, Surakarta.
- [6] Sahid, Muh. Nur, 2017, "Teknik Pelaksanaan Konstruksi Bangunan", Muhammadiyah University Pers, Surakarta, hlm. 99-103.
- [7] Widiasanti, I., Lenggogeni, 2013. "Manajemen Konstruksi", PT Remaja Rosdakarya, Bandung, hlm. 155-164.
- [8] Yolanda, N., P., 2022, "Pengaruh Implementasi Penerapan Sistem Manajemen Kesehatan dan Keselamatan Kerja pada Produktivitas Pekerja Berdasarkan Peraturan Pemenintah Nomor 50 Tahun 2012 Pasal 6 (Studi Kasus: Proyek Pembangunan Kereta Api Elevated Antara Solo Balapan-Kadipiro)", Fakultas Teknik, Universitas Muhammadiyah Surakarta, Surakarta.
- [9] Dumadi, T., A., dkk, 2014, "Evaluasi Pelaksanaan Proyek Menggunakan Metode Earned Value Analysis", Fakultas Teknik, Sekolah Pascasarjana, Universitas Muhammadiyah Surakarta, Surakarta.
- [10] Satyanegara, Fitri Brillian, 2022, "Analisis Manajemen Risiko Keselamatan dan Kesehatan Kerja (K3) pada Proyek Pembangunan Gedung Rawat Inap 4 Lantai Rumah Sakit Brayat Minulyo Surakarta Ditinjau dari Waktu dan Biaya", Fakultas Teknik, Universitas Muhammadiyah Surakarta, Surakarta.
- [11] Mahaptani, Ida Ayu P., S., 2019, "Metode Perencanaan dan Pengendalian Proyek Konstruksi", UNHI Press, Denpasar-Bali, hlm. 195-202.

AUTHORS BIOGRAPHY



Hastama Anji,
Bachelor Degree of Civil Engineering Student, Muhammadiyah University of Surakarta, Indonesia.



Co. Prof. Muhammad Nur Sahid,
Position in the field of research as Head Instructor of Construction Management and Controlling Project, Indonesia.

Citation of this Article:

Anji Hastama, Co. Prof. Muhammad Nur Sahid, "The Effect of Implementation of Occupational Health and Safety Management System on the Elevated Railway Line Construction Project Between Solo Balapan-Kadipiro KM 104+700 SD KM 107+000 (Phase 1) on Cost and Time" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 3, pp 155-161, March 2023. Article DOI <https://doi.org/10.47001/IRJIET/2023.703023>
