Quest Journals
Journal of Architecture and Civil Engineering
Volume 9 ~ Issue 1 (2024) pp: 15-29
ISSN(Online) : 2321-8193
www.questjournals.org

Research Paper

Analysis of COVID-19 Pandemic Impact to Implementation of Road Toll Construction Project in Probolinggo – Banyuwangi (Package 1 Sta.05+300 – Sta.09+000)

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ABSTRACT:
COVID-19 pandemic without exception has put almost all projects in halt including the construction projects. Indonesian government implemented a Large-Scale Social Restrictions (Pembatasan Sosial Berskala Besar abbreviated as PSBB) to every activity line. In effect, many construction works were forced to experience temporary delays, including the Package 1 STA.05+300 – STA.09+000 of Probolinggo-Banyuwangi Toll Road Construction Project. The purpose of this research is analyzing COVID-19 impact to Probolinggo-Banyuwangi Toll Road Construction Project which divided into three (3) work packages which have been temporarily suspended by Jasa Marga of Probolinggo–Banyuwangi as the owner of the road construction work.
Quatitative analysis was selected as the research method, conducted by distributing a questionnaire filled with 21 variables potentially become the impact of of COVID-19 on the road construction project. The questionnaire was distributed online through Google Form to parties related to project with result that will be treated with Principal Component Analysis (PCA). Then, strategic recommendations for project management were made to overcome the discovered pandemic impact factors.
From result of PCA analysis, this method has succeded to reduce many variable dimensions into only seven (7) factors reliable to represent 84.96 % of all data which contain of factors: (a) cutting working hours, (b) rescheduling, (c) changing contract, (d) labor efficiency and cost overrun, (e) difficulties in distribution and transportation along with the project continuity, (f) cashflow related to the weakening of money exchange rate, and (g) decreased productivity. In general, the recommended strategy to mitigate the impact is creating a work plan and setting a work priority scale.
21 research variables as the final result of this research were condensed into seven (7) factors as the impact of COVID-19 on Toll Road Construction project that able to cause delays in the continuity of Probolinggo-Banyuwangi Toll Road Construction project. Moreover, the previous strategy mentioned can be used as a reference in managing construction projects during a pandemic event, either with the same outbreak or another one that causes an implementation of Large-Scale Social Restriction to work activities.
KEYWORDS*: COVID-19 pandemic, Toll Road Construction Project, Analysis of Primary Component, Overcome Strategy*

R*eceived 17 Jan., 2024;* ***R****evised 28 Jan., 2024;* ***A****ccepted 31 Jan., 2024 © The author(s) 2024.*
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I. INTRODUCTION

COVID-19 pandemic emerged in the beginning of 2020. It is a respiratory system disease caused by SARS-CoV-2 viruses (Hansen, 2020). The emergence of this pandemic has spreading to all corners of the world and causing most countries must implement quarantine status to slow down the pandemic's spread (Critelli, 2020). Indonesia also implementing several policies under the umbrella of Presidential Decree (*Keputusan Presiden)* Number 11 of 2020 regarding "Establishment of Public Health Emergency on COVID-19 Pandemic" which takes effect on implementation of Large-Scale Social Restrictions (PSBB), closes all public elements such as schools, industry and public facilities also changing the way of work and study process into work/study from home method. This policy has been in place for one year with changes in terms and mechanisms adjustment to the pandemic status.

The COVID-19 pandemic hampered in almost all projects without exception to construction projects. As a result of PSBB implementation, construction work was forced to experience temporary delays. PSBB requires all individuals in every region must provide a permit to enter area with high potential of COVID-19 spreading. This policy impacted on goods and services delivery (equipments, materials and workers) that must enter the construction project sites. Apart from that, construction services also experienced obstacle due to issue of Minister of Public Works and Public Housing (PUPR) instruction Number 02/IN/M/2000 stating contract termination for providing construction services, although construction work is a vital activity for the country's economy.

An example of COVID-19 impact on construction project reported from a study in the United States (Alsharef et al., 2021). Biggest factor causing delays in a project is delays in material and equipment procurement along with restrictions on social interaction that cause the worker's communication to be disrupted and resulting in long work duration. Other example is reported from a research on pandemic impact to project delays in Kuwait (Alenezi, 2020). Among 17 factors in the research, it was concluded that factor with greatest impact was budget overrun due to rising material prices. This was followed by delays in instructions from a decline of consultant and workers' productivity resulting in a late scheduling.

Based on this consideration, this research analyzes the impact of COVID-19 pandemic on Probolinggo-Banyuwangi Toll Road Construction Project consisted of 3 work packages which had been temporarily suspended by the owner of the project (Jasa Marga Probolinggo-Banyuwangi) in line with issues of a postponement contract on March 18 2020 and a postponement contract due to force majeure dated March 23, 2020 with the responsible party for this project (the Probolinggo - Banyuwangi Toll Road Construction Contract Services: Contract Package 1 Sta. 05+300 – Sta.09+000) is PT.Waskita-Wijaya Karya KSO, although this project is one of the vital development targets by the Indonesian government for increasing the mobility of goods and services.

To this extent, discussion related to analysis on COVID-19 impact on the implementation of Probolinggo-Banyuwangi Toll Road Construction project package 1 Sta 05+300 – Sta. 09+000 has not been carried out by many researchers, therefore, the study problems raised in this article are: (1) which components bring significant influence due to the COVID-19 pandemic on the implementation of Probolinggo-Banyuwangi Toll Road Construction Project package 1 Sta. 05+300 – Sta. 09+000?, (2) what strategies do service providers need to implement in order to maintain project margin (business results) which already reach an agreement by companies that involved in the Project Work Plan?.

II. LITERATURE REVIEW

2.1. The Workperformance of a Project

Measures in project workperformance can be observed from aspects of cost, time and work quality called as the productivity dimensions. Effective time management will bring impact on the improvement of workperformance from a project (Gayatri & Saurabh, 2013; Ngacho & Das, 2014). Meanwhile, Salazar et al. (2013) stated the cost factor is the prominent attribute in a project management modelling which being developed. Ali et al. (2013) also stated the work quality is one of the most important attributes to project's workperformance measurement. Popaitoon & Singethai (2014) explained that project's workperformance and the knowledge absorption capacity of the project team are greatly influenced by the practices of human resource management.

Al-Tmeemy & Hatem (2015) brought evidence of there was an increase in project financial workperformance for efforts to improve the work quality through an investigation from the contractor's perspective about consequences of poor quality in project works which had an impact in terms of non-compliance with prerequisite condition, cost overruns and work delays. The result of the study concluded that the quality indicator is a key factor in achieving good workperformance of a project.

In line with the theory, Zhang et al. (2014), stated that workperformance of construction project is greatly influenced by the expertise and competency factors belong to the emotional intelligence of the project manager related to workperformance criterias such as cost, quality, time, meeting service provider requirements, meeting work safety aspects, absence of conflict, risk management, claims management and project stakeholder satisfaction.

2.2. The Integrated Management

According to Demirkesen & Ozorhon (2017), integration refers to a coordination between processes as one of the most important elements of project management and covers all aspects of the project. Integrated Management ensures a successful coordination among project activities. Asif et al. (2010), stated that integration is a process used to develop governmental structures and make the stakeholder management works in more systematic way. Whereas Iqbal (2014) stated the integrated management concept was developed because of several limitations occurred during the project life cycle in previous observations, such as time delays in construction, equipment and machine failures, cost overruns, not meeting customer requirements and so on which had a negative impact on project success. Research of Gorzelany & Fudaliński (2013) attempting to analyze the idea of integrated management with the concept of integrating rational and emotional systems which needed a role of implementing the concept of organizational members as a form of organizational culture to achieve high effectiveness.

2.3. Challenges of Project Management

A success in implementing project management to achieve a success over a project is still a challenge because there are still many construction projects considered experiencing failures as reported in several previous studies (Shahhosseini et al., 2018; Shahriari et al., 2015). Nawi et al. (2016), stated delays in project completion times are the biggest problem in the construction industry because they have significant impact on the financial condition of a project also has social impact of the project doers. Delay in project completion time has been confirmed in several previous studies (Kwatsima, 2015; Maués et al., 2017) as a factor that also supported by Al-Tmeemy dan Hatem (2015) that revealed the frequent failure and collapse of construction building on a project has become a big problem and has received attention in construction development projects because the impact magnitude of this incident is worrisome.

Several previous studies also confirmed about the low quality or not meeting the quality standard of the project work result which has a negative impact on the project workperformance (El-sokhn and Othman, 2014; Mallawaarachchi & Senaratne, 2015). As Simushi (2017) also explains, any project completion that exceeds the financial budget and scheduled time is one of biggest problems faced by many infrastructure projects today, especially for large infrastructure projects because they experience a spiking high cost overrun (until 200-400 %) greater than the planned estimation or in the contract value.

The basic elements that play a role as a benchmark factor of the successful construction projects are cost, quality and time elements, where at each stage of the project will face obstacles that able to transform these basic elements into inhibiting factors to the project sustainability. In overcome obstacles existed in the project, an effective management and strategies is needed so the main project targets can be achieved, both in term of financial profit and in the successful project completion. The project management systematically becomes an important section to control the project schedule time to be in accordance to the contract or make the work faster than the planned target as an effort to minimize effective expenditure costs and avoid sanctions (in a form of fines) due to delays in project completion. The project management has become an important strategy in various fields and organizations as explained in several studies (Haron et al., 2018; Sözüer & Spang, 2014).

According to Messah et al. (2013) as cited from Kraiem and Dickman in Wahyudi (2006), construction project delay can be categorized into three groups: (a) excusable delays caused by problem in design, changes in the work implementation, or bad weather (such as normal and natural disasters), (b) non-excusable delays where there are errors in work methods, equipment or labor or expert shortages, and (c) ineffective scheduling: a compensable delays where an error happens on the part of the project owner so these lacks can be compensated by time and cost extention according to the agreed analysis.

2.4. Principal Component Analysis

A Principal Component Analysis (PCA) is an analysis aims to reduce number of original variables that are correlated to each other (Mishra et al., 2017). Such example is in the x and y data set where PCA projected both data into one new dimension or one new axis in a form of a relationship between two data sets as illustrated in Figure 2.1. So, projection of data set collected into one dimension becomes important information as termed by the relationship of x and y in one data set. Then, Eigenvalue will determine position of the dimension that best represents the relationship between x and y data set.

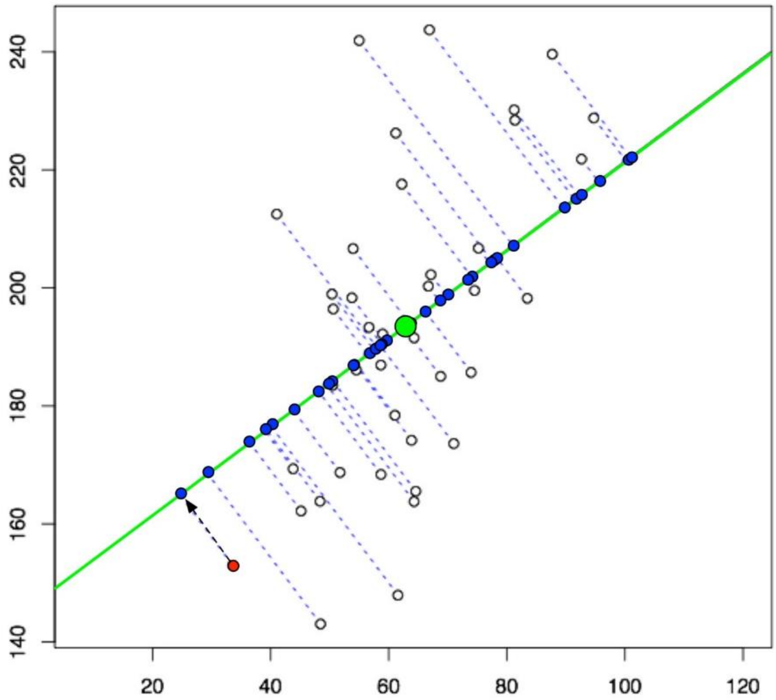

Figure Error! No text of specified style in document.**.1.** A Projection of Two Data Sets Relationship into One New Dimension by PCA Method

Principal Component Analysis (PCA) has purposes of:

1. Reduce or make less number of variables by taking the most important information from the data table.
2. Simplify the data set descriptions.
3. Summarize data by reducing number of axes/dimensions without losing too much information.

Meanwhile, the stages in carrying out PCA are explained as follows:

1. Data Standardization
   Prepare the data set for each variable and output average value for each variable. Then, each data is substracted by the average (xi-x').
2. Covariance Matrix Calculation.
   Covariance is a size of deviation between two dimensions (xi, xn). Meanwhile, variable is a size of deviation in one dimension only. The covariance formula is:

$$Cov(X,Y) = \frac{\sum_{i=1}^{n}(X_i - X')(Y_i - Y')}{(n-1)}$$

   Covariance matrix is a symmetrical matrix with number of rows and columns equal to the number of data sets. This matrix shows the deviation that occurs between two or more data sets. The form of covariance matrix is presented as follows:

$$cov = \begin{bmatrix} cov(x_1, x_1) & \dots & cov(x_1, x_n) \\ \dots & & \dots \\ cov(x_n, x_1) & \dots & cov(x_n, x_n) \end{bmatrix}$$

3. Eigenvalue and Eigenvector Calculation.
   An eigenvector is an independent vector that does not change direction when a transformation matrix is applied whereas an eigenvalue is a scalar that shows the size of the eigenvector. In PCA, the eigenvalue calculation from the covariance matrix shows the variance components that able to be put in ranks according to its importance level based on the magnitude of their values. The greater the eigenvalue, the more important the main component is. Eigenvalue can be used to extract important variables of large data sets.

III. RESEARCH METHODS

3.1 Sample and Population of the Research

Population is a generalization of area consisted of objects/subjects with certain quantities and characteristics that determined and to be studied by researchers where later will be drawn into conclutions (Sugiyono, 2020). Furthermore, in quantitative research, as said by Sugiyono, sample is part of the number and characteristics of the population. Then, what has been learned from the sample will make the research conclution able to be applied into the related population. For this reason, samples taken from population must be truly representative. The sampling technique applied in this research was a saturated sample (all workers in the Probolinggo-Banyuwangi Toll Road Construction Project). Selection of the respondents was conducted based on population related to the Toll Road project which is called a saturated sample. The characteristics of sample respondents were parties directly involved in the Probolinggo-Banyuwangi STA 05+300 – STA 09+000 Toll Road construction project.

3.2. Technique of Data Collection

This research uses a questionnaire technique by distributing questionnaire to respondents also provides a clear explanation of how to fill out questionnaire to ensure the obtainable questionnaire data is in accordance to the respondents' view. The questionnaire was distributed to 40 respondents online via Google Form.

3.3. Method of Data Analysis

Data analysis method applied in this research was a Principal Component Analysis (PCA) aims to reduce the number of original variables that have correlation to each other (Mishra et al., 2017). In PCA, total variance within data that gains attention is the diagonal of the correlation matrix. Meanwhile, full variance will be used as the basis for forming factors (the new variable as the replacement of the old variable). The new variables will be represented the old variables that have correlation. PCA is carried out on variables that meet the validity and reliability tests. The analysis uses a Jupyter Notebook program on a Phyton code base. Determination of important variables is conducted by analyzing results of an eigenvalue of more than 1.

3.4. Analysis of Pandemic Effect and Strategy Implementation for Toll Road Construction Project

After the main analysis components had been determined, the analysis of main effect from the pandemic can be created. Results of this analysis will be used as a basis for formulating strategies to be implemented in toll road construction project during the pandemic and post-pandemic time. The strategy was obtained from studying several sources such as instructions of PUPR minister Number 02/IN/M/2020, Financial Stability Board (FSB), Organization for Economic Co-operation and Development (OECD) also from several articles such as Nasseredine (2021), Pinheiro (2020), and Meyer (2021) who recommended project strategies in response to the COVID-19 pandemic.

IV. RESULT OF RESEARCH AND DISCUSSION

4.1 The Result of Principal Component Analysis

In order to reveal the influential components on Probolinggo-Banyuwangi Toll Road Construction Project as the impact factors of COVID-19 pandemic, the Principal Component Analysis (PCA) method was used because it weighing the total variation of the observed data. There are 16 variables included into this analysis: (a) Constraint in project supplies and material distribution (X_1), (b) Labor reduction(X_3), (c) Change in Working Hours (X_4), (d) working hours cutting (X_6), (e) elimination of overtime for workers(X_7), (f) difficulties in transportation for workers to the project site(X_8), (g) Decreased workers' productivity (X_9), (h) Rescheduling work items due to PSBB implementation (X_{11}), (i) Delay in withdrawal of terms or installments (X_{12}), (j) Uncertainty about project continuity (X_{13}), (k) Idle/Stalled rental equipment (X_{14}), (l) Increase price of material and equipment rental (X_{15}), (m) Delay in workers' payment or wages (X_{17}), (n) Weakening rupiah exchange rate to USD (X_{18}, (o) Project costs skyrocketing (X_{19}), and (p) there is a change in contract (X_{20}).

There were 16 variables selected out from 21 variables after put into treatment of validity testing. Since each variable has a variance value of 1, then total variance value was 16 x 1 = 16. Then, a dimension reduction was held to summarize the information contained inside the original variable by applying method of Principal Component Analysis (PCA) using the *Sklearn decomposition pca module*. At this stage, PCA will find the biggest eigenvalue from each main component (PC). Next stage is to determine the rotation of the component matrix, then, the normalized data will be multiplied by the covariance matrix to produce a component matrix. The component matrix contains coefficient that will be used to express the standard variables called as principal components. Meanwhile the loading component coefficient will explain the correlation between original variables and the components. A large correlation value indicates a close relationship between the original variable factors so that the variable can be used to interpret the components.

From the PCA calculation result, variation per principal component (PC) is calculated using the PCA explained variance ratio, where its total variance ratio is 1. Then, eigenvalue of each PC which has been stored in the pca explained variance attribute will be calculated. All eigenvalue and variance results are summarized in Table 4.3. Figures of 4.2 and 4.3 showed the distribution of variance from each PC and its cumulative (scree plot) along with the standard deviation (box plot) in graphical form.

Table Error! No text of specified style in document.**.1** Eigenvalues and Variance of Each Principal Component (PC)

PC	Eigenvalue	Variance(%)	Cumulative Variance(%)
1	4.03	21.00	21.00
2	3.36	17.5	38.50
3	2.69	14.02	52.52
4	2.13	11.1	63.62
5	1.78	9.26	72.88
6	1.25	6.51	79.39
7	1.07	5.57	84.96
8	0.92	4.79	89.75
9	0.77	3.99	93.74
10	0.48	2.49	96.23
11	0.35	1.81	98.04
12	0.17	0.89	98.93
13	0.11	0.59	99.52
14	0.07	0.36	99.88
15	0.02	0.12	100.00
16	0.00	0	100.00

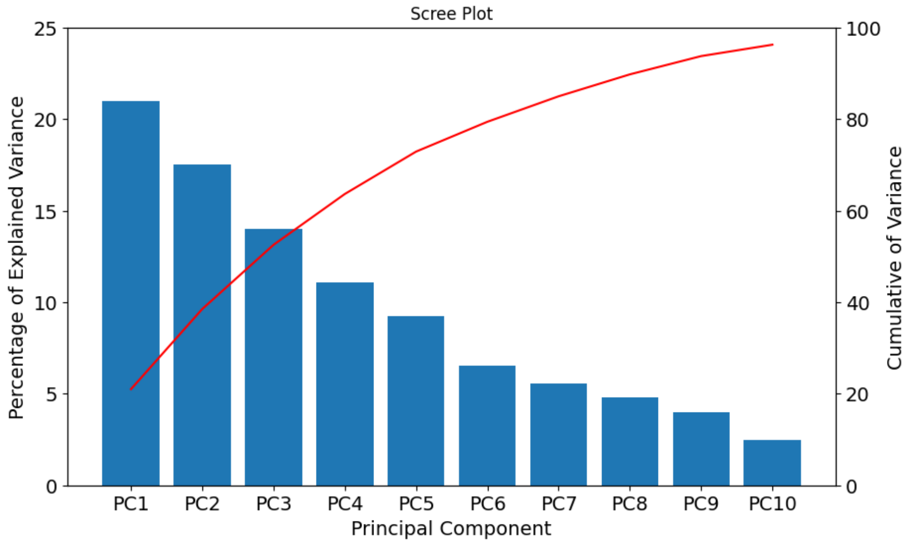

Figure Error! No text of specified style in document.**.2.** *Scree plot* variance from each Principal Component (PC)

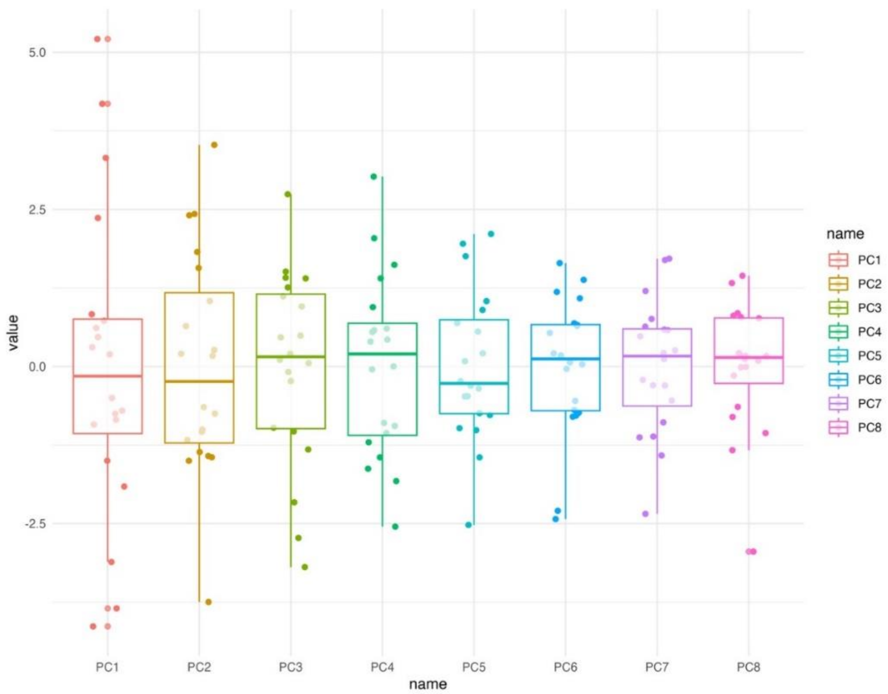

Figure Error! No text of specified style in document.**.3.** The *box plot* variable in every Principal Component (PC)

Amount of filtered components determined by the eigenvalue of the component in which components with eigenvalue greater than 1.0 were retained inside the model. Eigenvalue will explain the size of variation contributed by the components to the 16 observed variables. Based on table 4.3, the eigenvalues greater than 1.0 were Principal Components (PC) 1 to 7 and put in light blue coloumn. The cumulative variance value for the nine components is 90.5 % which means the 16 variables can be explained by the seven main components with confidence level of 90.5 %.

This analysis employed a varimax rotation procedure. It is a rotation procedure that minimizes number of high loading variables on their principal components so the data interpretation can be done easier. The result of variable loading values on the principal components is presented in Table 4.4 below.

Table Error! No text of specified style in document.**.2** Rotation of Matrix Component to Each Variable

Code	**Indicators**	**Principal Components**						
		1	**2**	**3**	**4**	**5**	**6**	**7**
X3	Labor Reduction	-0.104	0.028	-0.253	-0.184	0.148	-0.150	0.067
X4	Working Hours Change	0.014	-0.064	0.053	0.418	0.060	-0.036	-0.164
X6	Working Hours Reduction (Cutting)	0.106	0.204	-0.047	0.198	-0.126	0.036	0.095
X7	No Working Overtime for Workers	0.274	0.067	0.003	0.036	-0.039	0.138	0.048
X8	Difficulty of transportation for workers to go the site project	0.164	0.154	-0.083	0.013	-0.192	-0.103	-0.020
X9	Decline of Wokers' Productivity	-0.039	0.258	0.031	-0.064	0.400	0.070	-0.213
X11	Reschedule of Work Items due to PSBB/ Large Social Scale Restriction	0.088	-0.144	-0.084	-0.078	0.187	0.057	0.304
X12	Delays in Payment or Installment Withdrawal	-0.118	0.273	-0.247	0.015	0.005	0.122	0.158
X13	Uncertainty in Project Continuity	-0.108	-0.070	0.095	-0.036	-0.047	0.296	-0.073
X14	Idle or stalled rental equipments	0.098	-0.161	0.148	0.053	0.200	-0.249	-0.070
X17	Delays in Payment for Workers' Wages	0.204	-0.150	0.048	-0.152	-0.050	-0.047	0.048
X18	Weakening of money exchange rate from IDR to USD	-0.087	0.037	-0.225	0.152	-0.235	-0.158	-0.237
X19	Heavy Cost Overrun	0.051	-0.152	0.131	-0.223	-0.090	0.128	-0.216
X20	Changes in Work Contract	-0.190	-0.146	-0.059	0.127	-0.056	0.152	-0.006

Based on table 4.4, the variable inside a component can be found by looking at its loading value. The variables that will be inserted into PC have the highest loading value on the PC's main component. For instance, the X3 variable of "Labor reduction" is included into PC4 because it has loading value of 0,42. So, in this way, table 4.5 has classified variables according to their loading values.

Table Error! No text of specified style in document.**.3** Categorization of Variables to Each Principal Component (PC)

PC	Name	Eigen	Variance (%)	Kum Var (%)	Construct Variable of The Component	Loading Value
1	Working Hours Management	4.03	21	21	Working Hours' Cutting	0.274
					No Working Overtime for Workers	0.164
					Idle/Stalled Rental Equipments	0.204
2	Reschedule of Work Items and Working Hours	3.36	17.5	38.5	Changes in Working Hours	0.204
					Rescheduling of Work Items due to PSBB implementation	0.273
3	Change in Contract	2.69	14,02	52.52	Changes in Contract	0.490
4	Labor Efficiency and Cost Overrun	2.13	11.1	63.62	Labor Reduction	0.418
					Increase price of material and rental equipments	0.152
					Project Cost Overrun	0.140
5	Difficulty in Distribution and Transportation also in Project Continuity	1.78	9.26	72.88	Constraints in distribution of raw material and project material	0.148
					Difficulty in transportation for workers to project site	0.400
					Uncertainty of Project Continuity	0.200
6	Cashflow and Exchange Rate Weakening	1.25	6.51	79.39	Delay in Terms or Installment Withdrawal	0.296
					Delay in Payment for Workers' Wages	0.131
					Weakening the money exchange rate from IDR to USD	0.152
7	Decline of Productivity	1.07	5.57	84.96	Decline of Workers' Productivity	0.304

The matplotlib.pyplot module can be used to create graphs, and result of the program are shown in figure 4.4. Then, in the same way, graphs similar to those shown in figure 4.5, figure 4.6 and figure 4.7 will be created for PC3 to PC7. In contrast, the PC8 in figure 4.7 was not included in the analysis because the eigenvalue below 1.0. All PCs are illustrated into two-dimensional graphics to make the reading easier when compare to PC dimensions that put into one image.

Figures of 4.5, 4.6 and 4.7 showed the distribution of data respondents and their position to each PC. All respondents were classified into a positive, neutral and negative positions. Ways to filter is by positioning respondents with a value of more than 1 to positive group. Conversely, the respondents who have value less than 1 will be included in the negative group, and the respondents who did not include into either category will be included to the neutral group. Data of respondents' classification is presented in table 4.6.

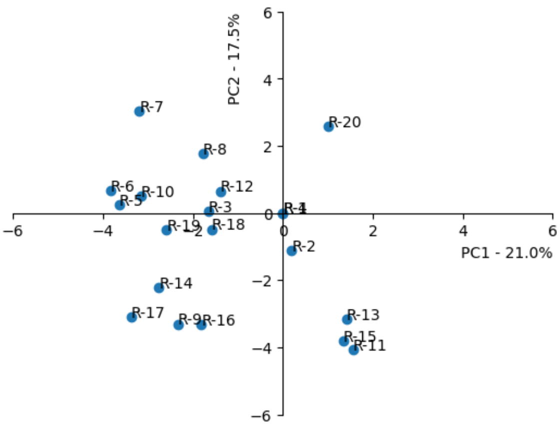

Figure Error! No text of specified style in document.**.4.** Graph of Variable Relationship in PC1 and PC2

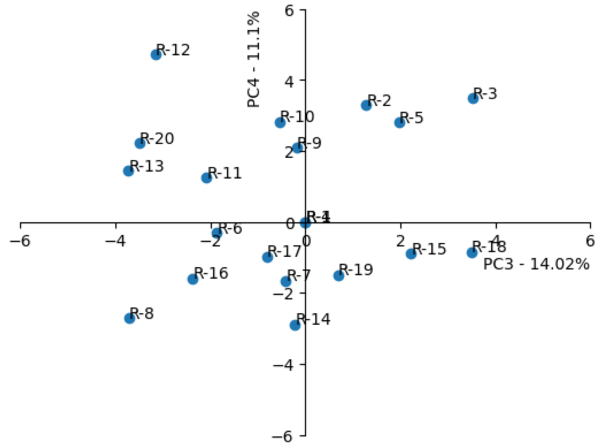

Figure Error! No text of specified style in document.**.5.** Graph of Variable Relationship in PC3 and PC4

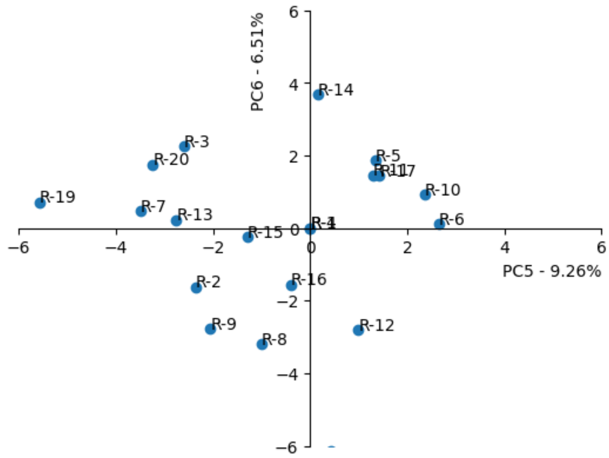

Figure Error! No text of specified style in document.**.6.** Graph of Variable Relationship in PC5 and PC6

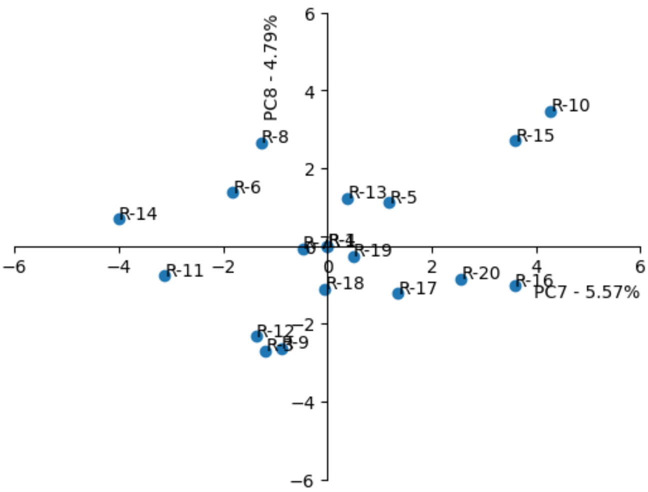

Figure Error! No text of specified style in document.**.7.** Graph of Variable Relationship in PC7 and PC8

Table Error! No text of specified style in document.**.4** The Classification of Respondents to Every PC

PC1			PC2			PC3		
Positive	**Neutral**	**Negative**	**Positive**	**Neutral**	**Negative**	**Positive**	**Neutral**	**Negative**

R-11	R-1	R-3	R-7	R-1	R-2	R-2	R-1	R-6
R-13	R-2	R-5	R-8	R-3	R-9	R-3	R-4	R-8
R-15	R-4	R-6	R-20	R-4	R-11	R-5	R-7	R-11
R-20		R-7		R-5	R-13	R-15	R-9	R-12
		R-8		R-6	R-14	R-18	R-10	R-13
		R-9		R-10	R-15		R-14	R-16
		R-10		R-12	R-16		R-17	R-20
		R-12		R-18	R-17		R-19	
		R-14		R-19				
		R-16						
		R-17						
		R-18						
		R-19						
4	**3**	**13**	**3**	**9**	**8**	**5**	**8**	**7**
PC4			**PC5**			**PC6**		
Positive	**Neutral**	**Negative**	**Positive**	**Neutral**	**Negative**	**Positive**	**Neutral**	**Negative**
R-2	R-1	R-7	R-5	R-1	R-13	R-3	R-1	R-2
R-3	R-4	R-8	R-6	R-4	R-15	R-5	R-4	R-8
R-5	R-6	R-14	R-10	R-12	R-19	R-11	R-6	R-9
R-9	R-15	R-16	R-11	R-14	R-2	R-14	R-7	R-12
R-10	R-17	R-19	R-17	R-16	R-20	R-17	R-10	R-16
R-11	R-18			R-18	R-3	R-20	R-13	R-18
R-12					R-7		R-15	
R-13					R-8		R-19	
R-20					R-9			
9	**6**	**5**	**5**	**6**	**9**	**6**	**8**	**6**
PC7								
Positive	**Neutral**	**Negative**						
R-5	R-1	R-2						
R-10	R-4	R-3						
R-15	R-7	R-6						
R-16	R-9	R-8						
R-17	R-13	R-11						
R-20	R-18	R-12						
	R-19	R-14						
6	**7**	**7**						

Table 4.6 showed the number of respondents supported PC.1 (the working hours' management component) was only four (4) respondents with job positions as general manager, head of large project section, project manager and hydrology assistant. The working hours' management component has been questioned by officials at the level of section heads and general managers as the impact of Covid-19 on toll road construction.

PC.2 (the component of work item rescheduling) was supported by three (3) respondents who had the respective position of main implementer, head of large project section, and hydrology assistant. Rescheduling this item has an impact to the implementer officials in the work field.

PC.3 (the component of changes in contract) was supported by five (5) respondents with job positions as the head of procurement section, infrastructure contract management staff, quality analysis & quality control (QAQC) staff, project manager and section head. In fact, this component was only felt by officials at the level of project managers and section head. Apart from that, staff in the contract management and QAQC sectors are workers who also experience the same thing due to COVID-19 pandemic.

PC 4 (the component of labor efficiency and cost overrun) was supported by nine (9) respondents with job positions as the head of procurement section, infrastructure contract management staff, QAQC staff, project manager, construction manager, general manager, deputy general manager, head of large projects section, and hydrology assistant. This component was complained about by officials from hydrology assistants to general manager level.

PC5 (the component of difficulty in distribution and transportation and project continuity) was supported by five (5) respondents with job position of QAQC staff, procurement staff, construction manager, general manager and project manager. This component was complained about by officials like general managers, managers and staff only.

PC 6 (the component of cash flow and the weakening of the money exchange rate) was supported by six (6) respondents with job position ranging for infrastructure contract management staff, QAQC staff, general manager and project manager. This component was complained about by officials up to the general manager level.

PC 7 (the component of declining productivity) was supported by six (6) respondents with job position ranging from QAQC staff, construction manager, project manager, head of finance and administration, and hydrology assistant.

4.2. Discussions

From the 16 studied variables, these variables can be reduced to only 7 components which are:

- PC.1: The Component of Working Hours' Management

The eigenvalue of this component is 4.03 with influential variables that able to affect the continuity of Toll Road Project due to COVID-19 are cuts in working hours, elimination of overtime for workers, and idle/stalled rental equipments. The variance value of PC 1 is 21 % meaning this component can be explained by three variables with a variation value of 21 %.

- PC.2: The Component of Item and Working Hour Rescheduling

The eigenvalue of this component is 3.36 with the influential variable that able to affect the continuity of Toll Road Project due to COVID-19 are changes in working hours and rescheduling of work items. The variance value of PC2 is 17.5 % meaning this component can be explained by two variables with a variation value of 17.5 %.

The cumulative variance value of 38.5 % showed that PC1 and PC2 can explain the impact of COVID-19 pandemic on the Probolinggo-Banyuwangi Package 1 STA Toll Road Construction Project by 38.5 %.

- PC.3: The Component of Changes in Contract

The eigenvalue of this component is 2.69 with the influential variable that able to affect the continuity of Toll Road Project due to COVID-19 is the contract changes. The variance value of PC3 is 14.02 % meaning this component can be explained by one variable with a variation value of 14.02 %. The cumulative variance value of 52.52 % showed that PC1 to PC3 can explain the impact of COVID-19 pandemic on the the Probolinggo-Banyuwangi Package 1 STA Toll Road Construction Project by 52.52 %.

- PC.4: The Component of Labor Efficiency and Cost Overrun

The eigenvalue of this component is 2.13 with influential variable that able to affect the continuity of toll road project due to COVID-19 are the labor reduction, increase price of material and equipment rental, and increase price of project costs. The variance value of PC4 is 11.1 % meaning this component can be explained by 3 variables with a variation value of 11.1 %. The cumulative variance value of 63.62 % showed that PC1 to PC4 can explain the impact of the COVID-19 pandemic to the Probolinggo-Banyuwangi Package 1 STA Toll Road Construction Project by 63.62 %.

- PC.5: The Component of Difficulty of Distribution and Transportation also Project Continuity

The eigenvalue of this component is 1,78 with influential variable that able to affect the continuity of toll road project due to COVID-19 are constraints in the distribution of project supplies and materials, difficulties in transportation for workers to the project location and uncertainty about the continuity of project. The variance value of PC5 is 9.26 % meaning that this component can be explained by 3 variables with a variation value of 9.26 %. The cumulative variance value of 72.88 % showed that PC1 to PC5 can explain the impact of COVID-19 pandemic on the Probolinggo-Banyuwangi Package 1 STA Toll Road Construction Project by 72.88 %.

- PC.6: The Component of Cash Flow and Weakening of Money Exchange Rate (From IDR to USD)

The eigenvalue of this component is 1.25 with influential variables that able to affect the continuity of toll road project due to COVID-19 are delays in withdrawing terms or installments, delays in workers' wages payment and the weakening of rupiah exchange rate. The variance value of PC6 is 6.51 % meaning this component can be explained by three variables with a variation value of 6.51 %. The cumulative variance value of 79.39 % showed that PC1 to PC6 can explain the impact of the COVID-19 pandemic on the Probolinggo-Banyuwangi Package 1 STA Toll Road Construction Project by 79.39 %.

- PC.7:The Component of Declining Productivity

The eigenvalue of this component is 1.07 with influential variable that able to affect the continuity of toll road project due to COVID-19 is a decline in workers' productivity. The variance value of PC7 is 5.57 % meaning this component can be explained by one variable with a variation value of 5.57%. The cumulative variance value of 84.96 % showed that PC1 to PC7 can explain the impact of COVID-19 pandemic on the Probolinggo-Banyuwangi Package 1 STA Toll Road Construction Project by 84.96 %.

Working hours management becomes the main component with highest variance caused by COVID-19 pandemic on the Probolinggo-Banyuwangi Package 1 Sta 05+300 – Sta. 09+000 toll road construction project.Variables of cutting working hours and no working overtime for workers emerged because the Government Regulation number 21 of 2020 that establishing PSBB or Large-Scale Social Restrictions in Indonesia. This regulation enforced limitation to any normal activities outdoors including project activities and it led to working hours' reductions to overcome the pandemic in the project area. The changes of these working hours also made the variable of rental equipment became idle/stalled. These reasoning are relevant because the use of rental equipment become less effective due to the reduced working hours (Durden, 2021).

The component of rescheduling items and working hours become the second factor due to COVID-19 pandemic on toll road construction projects. This component has a close relationship to the working hours management component because reduction in working hours lead to a rescheduling of working items and working hours, thus, the project work schedule becomes longer than the initial plan (Nweke & Nouban, 2022). It was caused by PSBB regulation which impose restriction on number of workers and limitation of working time duration in order to mitigate the impact of the pandemic. Additionally, there also existed a quarantine protocol which requires workers to isolate themselves for a minimum of 14 days if they were infected with COVID-19. These causes a prolong working pace for completing a project (Zamani et al., 2021).

The component of contract change actually related to the component of rescheduling items and working hours that emerged because the extention of project time duration due to COVID-19 pandemic. Contract changes also occurred since there was an absence of a clause for dealing with the COVID-19 pandemic. (Rehman et al., 2022). Although Covid-19 pandemic still included in force majeure clause, contractors are usually have no right to get compensation for costs unless there is an agreement between the two parties (Husien et al., 2021).

The component of labor efficiency and cost overruns are the next impact emerged due to COVID-19 pandemic. This component consists of 3 variables (Labor reduction, price increase in material and supplies, and increased project costs). The shift to working from home in several industrial sectors had made a positive contribution to productivity although challenges such as lack of direct interaction and work discipline at home have contribute a negative impact on efficiency. While the adaptation efforts to new work practices and technology investments support operational efficiencies, the labor shortages and disruption to supply chains are causing labor costs to soar. Furthermore, the increase price in material due to a halt/delay goods distribution also causes the project cost to rise (Rehman et al., 2022). There are also additional costs related to health and safety measures in the workplace that also add the operational costs. Continued economic uncertainty has a dual impact, influencing the corporate investment decisions and fueling the potential for overall cost inflation.

The component of difficulty in distribution, transportation and project continuity becomes the fifth impact emerged due to Covid-19 pandemic that explained by PCA data. This component consists of constraints in the distribution of project supplies and materials, difficulties in transportation for workers to the project location and uncertainty about project continuity. Shortages of raw materials and construction components as a result of disruption to global supply chains have become a serious obstacle, slowing projects down and increasing the logistical complexity. Moreover, mobilization restrictions, factory closures, and transportation limitations also contribute to difficulties in distributing and meeting project needs in a timely manner (Alsharef et al., 2021). In addition, health protocols that must be adhered to in the construction environment have raised additional challenges, such as adapting the work procedures, use of personal protective equipment, and limited number of workers on project sites (Wang et al., 2020). These reasonings can result in increased costs and delays in implementing toll road construction project and requiring intensive adaptation and collaboration from the parties involved to maintain the smooth running of the project also to minimize its long-term impacts.

The component of cash flow and weakening rupiah exchange rate becomes the next impact emerged due to COVID-19 pandemic that explained by PCA data. Restrictions on business activities, temporary closed to many businesses, and the global economic slowdown due to the pandemic have caused a decline in company revenues and resulting in pressure on cash flow (Rehman et al., 2022). Toll road construction project also became one of projects that experiencing difficulties in maintaining liquidity and meeting their financial obligations. In addition, the weakening of rupiah exchange rate against foreign currencies in particular within unstable market conditions gave additional pressure on companies that have liabilities denominated in foreign currencies (Financial, 2021). These conditions can cause higher debt repayment costs and pose a risk of financial exposure. Therefore, strategic adaptation and careful financial management are the important key in overcoming the dual impact of cash flow changes and exchange rate fluctuations induced by COVID-19.

The component of declining productivity where only consists from one variable, the falling productivity. The impact of COVID-19 pandemic to productivity in various sectors of Indonesia economy was a great blow. Social restrictions and lockdowns implementation to almost all sectors as an effort to slow the virus spreading have caused a decline in productivity in many construction projects (Alsharef et al., 2021). Moreover, heavy concerns about health and welfare, changes in work arrangements, and economic uncertainty have had a psychological impact which able to harm the employee productivity. It is important for companies and government to implement effective strategies and support, both in terms of safe work facilities and mental wellbeing programs, to restore and increase productivity during the post-pandemic time (Husien et al., 2021).

V. CONCLUSION

According to results of Principal Component Analysis that conducted in this research to determine the impact components due to COVID-19 pandemic on Probolinggo-Banyuwangi Toll Road Construction Project Package 1 STA 05+300 – STA. 09+000, the authors draw conclusion as explained below:

1. From 21 questions in the questionnaire which represent several parameter factors, these questions can be categorized into seven (7) main components. These principal components are:
   a) Factor of cutting working hours
   b) Factor of rescheduling
   c) Factor of contract changes
   d) Factor of labor efficiency and cost overrun
   e) Factor of difficulty in distribution and transportation also project continuity.
   f) Factor of cash flow and weakening the money exchange rate.
   g) Factor of declining productivity.

2. The seven factors mentioned as the impact of COVID-19 are factors that able to cause delays in the continuity of the Probolinggo-Banyuwangi toll road construction project. These factors can be a reference for implementing project management strategies during pandemic event, either with the same outbreak or another outbreak that causes large-scale social restrictions to be implemented. The following are the broad strategies to mitigate these factors:
   a) **Create Planning and Working Priority:** Create work plans and set/arrange the work priorities to determine which strategic steps to be taken in dealing with the impact of COVID-19 pandemic.
   b) **Operational and Equipment Management:** perform management and supervision to equipments, including designing efficient work space lay out.
   c) **Changes in Contract and Negotiations:** re-arrangement of work priorities, re-scheduling work items, and prolong the work duration. Then, carry out negotiations with related parties regarding the force majeure due to COVID-19 pandemic.
   d) **Workforce Management:** Implementing health protocols to all workers. Provide mental and physical health support through Wellness programs and ensure the professional staff available to handle mental health of the workers. Recruits multi-talented workers to overcome the labor shortages.
   e) **Material Management and Communication with Suppliers:** Allocate materials in optimum way, do *pre-order* supplies and materials to the suppliers, engage a good communication with suppliers, and request assistance from the local government to coordinate with the transportation department.

REFERENCES

[1]. Al-Tmeemy, S. M. H., & Hatem, W. A. (2015). The Consequences of Poor Quality on Project Management Success of Building Projects. Second Engineering Scientific Conference-College of Engineering, 172–182.

[2]. Alenezi, T. A. N. (2020). Covid-19 Causes Of Delays On Construction Projects In Kuwait. International Journal of Engineering Research and General Science, 8(4), 36–39. www.ijergs.org

[3]. Ali, H. A. E. M., Al-Sulaihi, I. A., & Al-Gahtani, K. S. (2013). Indicators for measuring performance of building construction companies in Kingdom of Saudi Arabia. Journal of King Saud University - Engineering Sciences, 25(2), 125–134. https://doi.org/10.1016/j.jksues.2012.03.002

[4]. Alsharef, A., Banerjee, S., Uddin, S. M. J., Albert, A., & Jaselskis, E. (2021). Early impacts of the COVID-19 pandemic on the United States construction industry. International Journal of Environmental Research and Public Health, 18(4), 1–21. https://doi.org/10.3390/ijerph18041559

[5]. Asif, M., Fisscher, O. A. M., de Bruijn, E. J., & Pagell, M. (2010). Integration of management systems: A methodology for operational excellence and strategic flexibility. Operations Management Research, 3(3–4), 146–160. https://doi.org/10.1007/s12063-010-0037-z

[6]. Critelli,Sahota, J. (2020). Impact of COVID-19 on Construction Projects. Ces, 1–6.

[7]. Demirkesen, S., & Ozorhon, B. (2017). Impact of integration management on construction project management performance.

International Journal of Project Management, 35(8), 1639–1654. https://doi.org/10.1016/j.ijproman.2017.09.008
[8]. Dharmayanti, G. C., Sudarsana, D. K., & Pradnyawati, P. M. D. (2022). Analysis of the Covid-19 Pandemic Impact on the Performance of Construction Projects in Denpasar City. International Journal of Civil, Mechanical and Energy Science, 8(4), 11–19. https://doi.org/10.22161/ijcmes.84.2
[9]. Durden, T. (2021). Managing Construction Projects during a Global Pandemic The Impact of the COVID-19 Pandemic on Construction Project Managers (Issue September).
[10]. El-sokhn, N.H. and Othman, A. A. E. (2014). PROJECT FAILURE FACTORS AND THEIR IMPACTS ON THE CONSTRUCTION INDUSTRY : A LITERATURE REVIEW. Proceedings of the 10th International Conference on Civil and Architecture Engineering, May, 27–29.
[11]. Financial Stability Board. (2021). Lessons Learnt from the COVID-19 Pandemic from a Financial Stability Perspective. In Financial Stability Board (Vol. 9, Issue July). http://www.ncbi.nlm.nih.gov/pubmed/34409008%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC8365337
[12]. Gorzelany-Dziadkowiec, M., & Fudalinski, J. (2013). Integrated Management in Small Enterprises. Review of General Management, 17(1), 19–48.
[13]. Hansen, S. (2020). Does the COVID-19 Outbreak Constitute a Force Majeure Event? A Pandemic Impact on Construction Contracts. Journal of the Civil Engineering Forum, 6(1), 201. https://doi.org/10.22146/jcef.54997
[14]. Haron, N. A., Devi, P., Hassim, S., Alias, A. H., Tahir, M. M., & Harun, A. N. (2018). Project management practice and its effects on project success in Malaysian construction industry. IOP Conference Series: Materials Science and Engineering, 291(1), 0–7. https://doi.org/10.1088/1757-899X/291/1/012008
[15]. Husien, I. A., Borisovich, Z., & Naji, A. A. (2021). COVID-19: Key global impacts on the construction industry and proposed coping strategies. E3S Web of Conferences, 263. https://doi.org/10.1051/e3sconf/202126305056
[16]. Iqbal, S., Raffat, S. K., Sarim, M., & Shaikh, A. B. (2014). Integration Management: a Report on the Construction Projects. Journal of Science International, 26(August), 1079–1081. https://www.researchgate.net/publication/264937382_INTEGRATION_MANAGEMENT_A_REPORT_ON_THE_CONSTRUCTION_PROJECTS/citation/download
[17]. Kwatsima, S. A. (2015). An Investigation Into the Causes of Delay in Large Civil Engineering Projects in Kenya. In Jomo Kenyatta University of Agriculture and Technology (p. 72). http://ir.jkuat.ac.ke/bitstream/handle/123456789/1604/Kwatsima%2C Symon Antony- MSc. Construction Engineering and mangement -2015 construct1.pdf?sequence=1&isAllowed=y
[18]. Mallawaarachchi, H., & Senaratne, S. (2015). Importance of Quality for Construction Project Success. 6th International Conference on Structural Engineering and Conctruction Management.
[19]. Maués, L. M. F., Santana, W. B., Santos, P. C. dos, Neves, R. M. das, & Duarte, A. A. A. M. (2017). Construction delays: a case study in the Brazilian Amazon. Ambiente Construído, 17(3), 167–181. https://doi.org/10.1590/s1678-86212017000300169
[20]. Meyer, A., Walter, W., & Seuring, S. (2021). The Impact of the Coronavirus Pandemic on Supply Chains and Their Sustainability: A Text Mining Approach. Frontiers in Sustainability, 2(March), 1–23. https://doi.org/10.3389/frsus.2021.631182
[21]. Messah, Y.A, Widodo, T., Adoe M.L. (2013). Kajian Penyebab Keterlambatan Pelaksanaan Proyek Konstruksi Gedung di Kota Kupang. Jurnal. Teknik Sipil, Vol. II No. 2 pp. 157-168.
[22]. Mishra, S., Sarkar, U., Taraphder, S., Datta, S., Swain, D., Saikhom, R., Panda, S., & Laishram, M. (2017). Principal Component Analysis. International Journal of Livestock Research, 12(6), 1. https://doi.org/10.5455/ijlr.20170415115235
[23]. Nassereddine, H., Seo, K. W., Rybkowski, Z. K., Schranz, C., & Urban, H. (2021). Propositions for a Resilient, Post-COVID-19 Future for the AEC Industry. Frontiers in Built Environment, 7(July), 1–16. https://doi.org/10.3389/fbuil.2021.687021
[24]. Nawi, M. N. M., Deraman, R., Hasmori, M. F., Azimi, M. A., & Lee, A. (2016). Factors influencing project delay: A case study of the Vale Malaysia Minerals Project (VMMP). International Journal of Supply Chain Management, 5(4), 178–184.
[25]. Ngacho, C., & Das, D. (2014). A performance evaluation framework of development projects: An empirical study of Constituency Development Fund (CDF) construction projects in Kenya. International Journal of Project Management, 32(3), 492–507. https://doi.org/10.1016/j.ijproman.2013.07.005
[26]. Nweke, K. I., & Nouban, F. (2022). Effect of Covid-19 Pandemic on Construction Industry Management. International Journal Peer Reviewed Journal Refereed Journal Indexed Journal Impact Factor SJIF, 8(04), 2020–2021. https://doi.org/10.17605/OSF.IO/ZRGBY
[27]. PP Republik Indonesia Nomor 21 Tahun 2020 Tentang Pembatasan Sosial Berskala Besar dalam Rangka Percepatan Penanganan Corona Virus Disease 2019 (COVID-19), (2020).
[28]. Pinheiro, M. D., & Luís, N. C. (2020). COVID-19 Could Leverage a Sustainable Built Environment. Sustainability, 12(14), 5863. https://doi.org/10.3390/su12145863
[29]. Popaitoon, S., & Siengthai, S. (2014). The moderating effect of human resource management practices on the relationship between knowledge absorptive capacity and project performance in project-oriented companies. International Journal of Project Management, 32(6), 908–920. https://doi.org/10.1016/j.ijproman.2013.12.002
[30]. Keputusan Presiden (Keppres) Nomor 11 Tahun 2020 tentang Penetapan Kedaruratan Kesehatan Masyarakat Covid-19., Pub. L. No. 031003, Sekretariat Negara 1 (2020).
[31]. Rehman, M. S. U., Shafiq, M. T., & Afzal, M. (2022). Impact of COVID-19 on project performance in the UAE construction industry. Journal of Engineering, Design and Technology, 20(1), 245–266. https://doi.org/10.1108/JEDT-12-2020-0481
[32]. Salazar-Aramayo, J. L., Rodrigues-da-Silveira, R., Rodrigues-de-Almeida, M., & De Castro-Dantas, T. N. (2013). A conceptual model for project management of exploration and production in the oil and gas industry: The case of a Brazilian company. International Journal of Project Management, 31(4), 589–601. https://doi.org/10.1016/j.ijproman.2012.09.016
[33]. Shahhosseini, V., Afshar, M. R., & Amiri, O. (2018). The root causes of construction project failure. Scientia Iranica, 25(1), 93–108. https://doi.org/10.24200/sci.2017.4178
[34]. Shahriari, M., Sauce, G., Buhe, C., & Boileau, H. (2015). Construction project failure due to uncertainties—a case study.

Occupational Safety and Hygiene III - Selected Extended and Revised Contributions from the International Symposium on Safety and Hygiene, January 2016, 165–170. https://doi.org/10.1201/b18042-35

[35]. Simunshi, S. J. (2017). An Integrated Management Strategy to Reduce Time and Cost Overruns on Large Projects. December, 1–228.

[36]. Sözüer, M., & Spang, K. (2014). The Importance of Project Management in the Planning Process of Transport Infrastructure Projects in Germany. Procedia - Social and Behavioral Sciences, 119(0), 601–610. https://doi.org/10.1016/j.sbspro.2014.03.067

[37]. Sugiyono. (2020). Metodologi Penelitian Kuantitatif, Kualitatif dan R&D. Bandung : Alfabeta

[38]. Wahyudi, R dan Indra Yono, C; 2006. Pengaruh Keterlambatan Proyek terhadap Pembekakan Biaya Proyek. Universitas Kristen Petra, Surabaya

[39]. Wang, Z., Liu, Z., & Liu, J. (2020). Risk identification and responses of tunnel construction management during the COVID-19 pandemic. Advances in Civil Engineering, 2020. https://doi.org/10.1155/2020/6620539

[40]. Zamani, S. H., Rahman, R. A., Fauzi, M. A., & Yusof, L. M. (2021). Effect of COVID-19 on building construction projects: Impact and response mechanisms. IOP Conference Series: Earth and Environmental Science, 682(1). https://doi.org/10.1088/1755-1315/682/1/012049

[41]. Zhang, X., Wu, Y., Shen, L., & Skitmore, M. (2014). A prototype system dynamic model for assessing the sustainability of construction projects. International Journal of Project Management, 32(1), 66–76. https://doi.org/10.1016/j.ijproman.2013.01.009