Quest Journals
Journal of Architecture and Civil Engineering
Volume 9 ~ Issue 7 (2024) pp: 44-53
ISSN(Online) : 2321-8193
www.questjournals.org

Research Paper

Delay in Teko Kali Ngrowo Scale Area Project In Tulungagung Regency

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ABSTRACT : *Lateness of project or often called as delay is serious problem which able to affect the overall development of the project. Project delay is caused by so many different factors within the existing sectors. It is necessary to find out causes of delay in a project to prevent ongoing losses. This research aims to determine the causal factors of delays in development of Teko Kali Ngrowo area and finding out impact from the causal factors of delays in the development of Teko Kali Ngrowo area.*

In this research, the results of S curve evaluation have found the type of work that experienced a decline at the implementation stage. Then, by analysis to the previous researches, interviews and field reports to seek for research variables, and then make grouping using a fishbone diagram, followed by distribution of questionnaires were conducted to assess the criteria and sub-criteria for this research. Next, an analysis was carried out by Analytical Hierarchy Process method.

After an evaluation to the S-curve of the project works has been performed, it discovered that there were several works within the project which experiencing delays. By applying the AHP method, there were several causal factors of delays able to be found in the development project of Teko Kali Ngrowo Tulungagung area, with the following criteria's: (1) workers' shortage in the field with a weight value of 12.68%, (2) financial situation decreases when the project is implemented with a weight value of 9.0%, (3) social and cultural with a weight value of 8.27 %, (4) changes in work plans with a weight value of 8.12 %, and (5) increase in material prices with a weight value of 7.33%.

KEYWORDS: *Tulungagung Regency, Cause of Delay, S-Curve, Area Project, Analytical Hierarchy Process*

***R**eceived 21 July, 2024; **R**evised 02 Aug., 2024; **A**ccepted 04 Aug., 2024 © The author(s) 2024.*
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I. INTRODUCTION

The government of Indonesia encouraging KOTAKU (*Kota Tanpa Kumuh)* program or City Without Slums as a way to deal with slum problem by making improvement or upgrading access access and environmental infrastructure in urban settlements. This program was launched because large number of slums still present in the country. By the law of Minister of Public Works and Public Housing No.2/PRT/M/2016 which aims to bring improvement for the quality of slum settlements and slum housing as well as enables the *Directorat Jenderal Cipta Karya or* Directorate General of Human Settlements to collaborate with various parties to create live able settlements becomes the primary basis of this development project. There are two matters which make an area is included into slum area; the first reason is no or having poor service from its supporting infrastructures (such as roads, drainages and waste channels) that made these areas tend to experience degradation whereas the second reason is the houses appearance within these areas are visually cannot be said as in decent condition for habitable. [1]

Teko Kali Ngrowo is one of the locations of KOTAKU project with a planning area of 56.47 ha and have main problem of water puddles (flooding) within the settlements because of inappropriate macro and micro drainage management system within the area also worsened by old drainages conditions which being ignored (not enough attention) and damaging many drainages and experience sedimentation. A construction project must be put in to schedule to control each work stage to be completed on time because timely work will reduce costs and shorten the completion of the project. According to Rahmi, any postponed project will increase costs because there is a direct relationship between time, cost and quality. The sooner of a project is completed, the sooner the developer or owner will gain profits from its operations [2]. However, delays on a project completion can be caused by occurrence of several factors during the planning and project implementation stages.

Delays in the project of *Teko Kali Ngrowo* regional scale as seen from the S curve showed that completed workload was lower than the expected workload plan in certain weeks during the work implementation, starting from the 5th to 9th weeks, 12th week, 15th week, 18th week, 25th week, 26th week, and 28th week. From the position of actual S curve that situated below the planned S curve, then it is necessary to evaluate a reasoning for the project delays within those weeks, so the development of *Teko Kali Ngworo* area in Tulungagung Regency can be finished according to the scheduled time.

II. LITERATURE REVIEW

The regional planning approach emphasizes on the best or optimal location for program, project and activities of construction development [3]. In relation to this theory, it means there is an opportunity to develop *Teko Kali Ngrowo* area which also becomes one of KOTAKU development project, since this region has raw industry materials that if those materials well developed, it can drive economic growth of this area. Good or bad of a construction project depends on the cost, quality and production time. Construction is a type of work which will be held over limited period of time and will use calculated resources and costs to finish construction of a building or infrastructure [4]. Project progress must be made during the construction process, and determining the main goals and objectives, including preparing all means to achieve these targets is comprised into a stage called "A Construction Management" [5].

Overdue or delayed in completion of work due to lack of productivity will bring impact of many waste or ineffective acts within many sectors such as in direct financing that spent for government projects, as well as losses on many private projects [6]. Delays in project implementation have major impact on increasing project implementation costs, which also resulted in time overrun, disputes and termination of job contract. These effects able to cause lossess for the parties involved, therefore it requires more attention about delays in the project implementation [7]. Within a project management, there is a typical process consisted of planning, organizing, mobiling or actuating and controlling stages that carried out to determine and achieve predetermined targets through human resources and other resources [8].

AHP or Analytical Hierarchy Process method is a decision support model by Thomas L. Saaty that describes complex multifactors or multicriteria problems within a hierarchy. According to Saaty, hierarchy is a representation of problem in a multi level structure with the initial structure being the goal, followed by levels of factors, criteria, sub-criteria and so on until the last alternative level mentioned. [9]

III. RESEARCH METHOD

3.1. Type and Data of Research

The location of the research was in *Teko Kali Ngrowo* area in Tulungagung and type of research was a qualitative survey with data analysis using AHP (Analytical Hierarchy Process) method. Qualitative research is a type of research focuses on meaning, social construction and complexity of the phenomenon being studied according to Creswel [10]. Primary data was taken from questionnaires and interviews to obtain data about the field condition whereas the secondary data came from project documents and literature studies related to the topic of this study. Number of respondents for AHP research which selecting experts for its respondents for making and selecting alternative decisions does not have a specific formulation, but it is limited to a minimum of two respondents as cited from Zulhadi [11]. For total respondents in this research, the researcher used 8 respondents who were experts in their fields.

3.2. Research Variables

Research variable of project delay was taken from results of previous literature studies and weekly field report data.

Table 1. Table of project delay variable

No	Criteria	Sub Criteria	Sources
1	Human Resource	Lack of experienced workers	Rahmi & Tabrani (2019), Boy *et al* (2021), Johari & Gunawan (2021), Buya & Ashad (2022), Jaya et al (2022) [2,12,13,14,15]
		Work Accident	
		Workers' shortage due to pandemic time	
2	Method	Changes in Design by the Project Owner	Rahmi & Tabrani (2019), Ramadhan (2020), Boy *et al* (2021), Jaya et al (2022) [2,12,15,16]
		Changes of Work Plan	
		Misunderstanding between work design illustrator with the contractor	

No	Criteria	Sub Criteria	Sources
3	Environment	Factor of Socio-cultural	Rahmi & Tabrani (2019), Ramadhan (2020), Boy *et al* (2021), Buya & Ashad (2022), Jaya et al (2022) [2,12,14,16]
		Rain intensity	
		Project environment is inside red zone area	
4	Financial	Delay in payment by the owner	Rahmi & Tabrani (2019), Ramadhan (2020), Boy *et al* (2021), Jaya et al (2022) [2,12,15,16]
		Increase in material prices	
		Economic situation declines	
5	Materials	Late in fabrication of special materials needed for the project	Rahmi & Tabrani (2019), Boy *et al* (2021), Johari & Gunawan (2021), Buya & Ashad (2022), Jaya et al (2022) [2,12,13,14]
		Late in material delivery	
		Material damages within the storage or warehouse	
6	Equipment's	Late in equipment/ tool delivery	Rahmi & Tabrani (2019), Ramadhan (2020), Boy *et al* (2021), Jaya et al (2022) [2,12,15,16]
		Equipment damages during the project ongoing	
		Unskilled or lack of ability by the operator in operating work equipment's	

3.3. Research Stages

This section explains research stages carried out to determine influential factors of project delay in the development of *Teko Kali Ngrowo* regional scale project:

1. Evaluation of the S-curve for finding what type of work that experiencing delay and review the causes of delays.
2. Creates Cause and Effect Diagram. Steps in creating a cause-and-effect diagram are as follows:
   - Identifies key problems
   - The main problem is placed on the right side of the diagram.
   - Identifies minor causes and place them on the main diagram.
   - Identifies minor causes and assign them to major causes.
   - The diagram is completed, then an evaluation is carried out to determine the real cause.
3. Performs analysis using the AHP Method. Steps in weighting causes of delays using AHP are as follows:
   - Develop a hierarchy
   - Create a pairwise comparison matrix
   - Calculate the weight / priority of each variable
   - Determine eigenvalues of vectors to test their consistency
   - Checking consistency of the hierarchy
   - Repeating steps number 2,3,4,5 for each hierarchy level.

IV. DISCUSSION

4.1. Evaluation of S-Curve

From the S-curve analysis, delays were found in *second month* (from 5th week to 8th week) especially in drainage work, monument work, also in green open space work. Several problems arose include workers shortage because of drastic increase in Covid case, restrictive government regulations about limitation or number of workers in an area, problems with land acquisition since residents use the land for selling products (build stalls), the economic sector as a whole resulted in delays in disbursement cost from the project owner, increase of material prices as well as delays in materials delivery due to Covid Lockdown procedure for all regions of Indonesia. On the *third month*, many delays or problems occurred in each work item due to pandemic condition where number of workers and skilled craftsmen on the project was limited in carrying out works and finishing stage (especially in the monument work sector), and there were several design changes in the green open spaces and the monument to make the construction works can be finished ahead of the scheduled time. While in the *fourth month*, there was

a delay (15th week) due to material damage during a demonstration by local apparatus. Project delays in the *fifth month* (18th week) was occurred because rain and work plan changes. As for the *seventh month*, where the work focused on improving condition of drainages, building safety on four sides of the bridge and green open space for public, it had delays related to the temporary stalls relocations where residents sell their products during drainage improvements and construction of green open space for public were carried out. Delays in the delivery process of heavy equipment into the work field, especially for construction activities in securing the arch's bridges as well as unskilled operators in operating work equipment have made the work in the field took longer time to complete.

Table 2. Table of weekly total deviation percentage for each work item

Work Items	Plan	Completed	Deviation
Drainages	25,485	20,242	5,244
Monument	2,096	0,129	1,967
Open Green Space	3,511	1,6197	1,891
Bridge's Safety	2,136	0,7761	1,360
Electrical	0,823	0,5488	0,274

4.2. The Causal-Effect Diagram

Fishbone diagram was created by analyzing the previous researches related to any project delay factors then making direct observations in the work field to determine causal factors of delays in the *Teko Kali Ngrowo* area project which later forming it into a fishbone diagram.

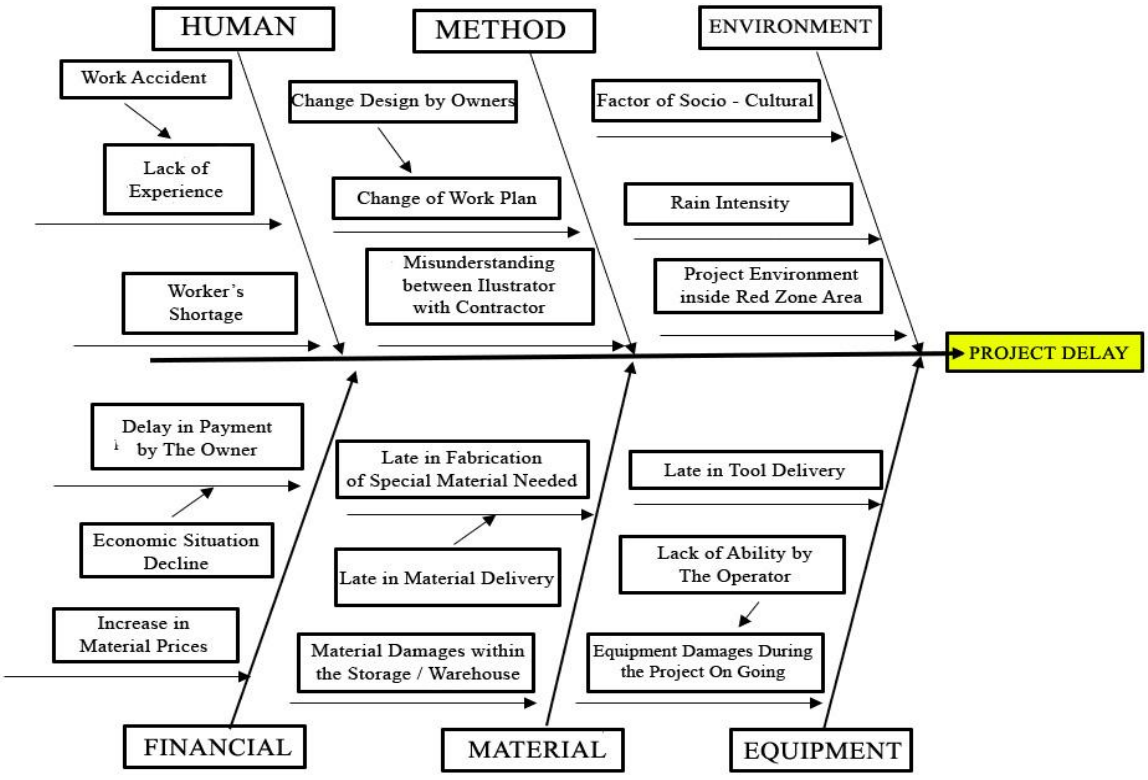

Figure 1: The fishbone diagram for factors of project delay

4.3. The Analytical Hierarchy Process (AHP)

1. Constructing hierarchy

In AHP method, criteria are arranged into a hierarchical form were consisted of three hierarchical levels starting from level 0 (Goal) to select the priority factors as the cause of project delay, level 1 to find criteria for determining delay factors and level 2 is an elaboration of the first level of criteria about factors that have greatest influence on project delay.

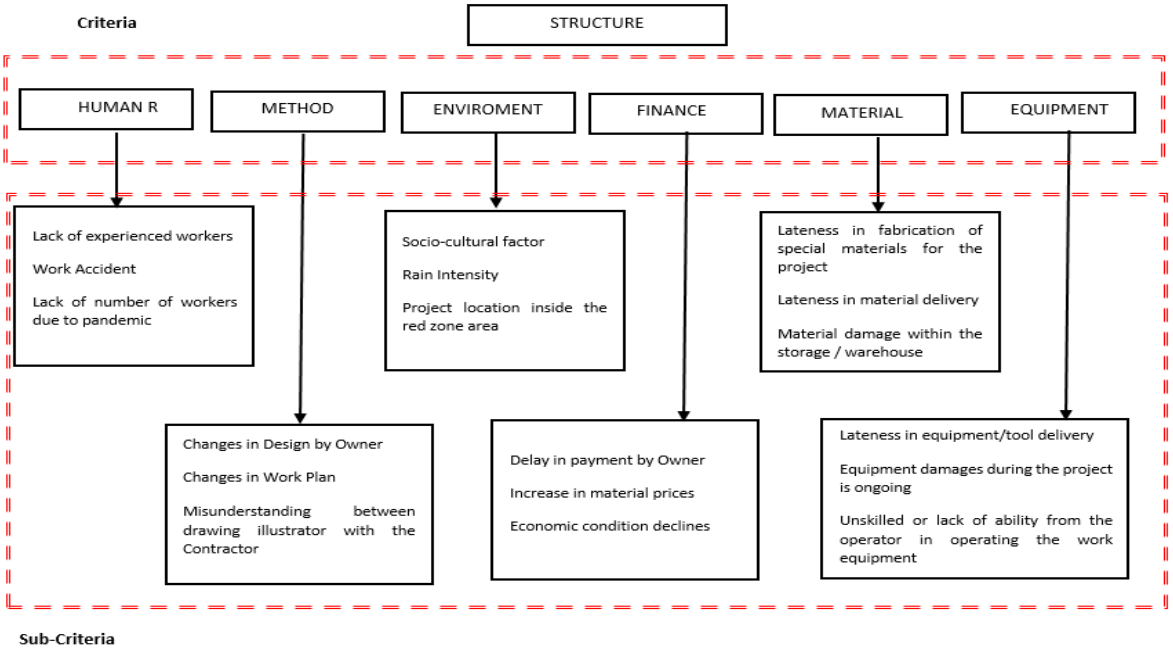

Figure 2: Hierarchy arrangement for factors of project delay

2. The main criteria of pairwise matrix

Geometric mean data was obtained from the questionnaire result, then, a pairwise comparison matrix calculation was performed to get the main criteria for this study.

Table 3. Respondents answer for main criteria of geometric mean value

Criteria	Criteria	R1	R2	R3	R4	R5	R6	R7	R8
Human Resources	Method	5,00	4,00	4,00	3,00	4,00	5,00	2,00	3,00
Human Resources	Environment	0,25	3,00	0,20	0,25	4,00	2,00	3,00	1,00
Human Resources	Financial	0,50	0,25	0,50	0,50	0,25	3,00	3,00	1,00
Human Resources	Material	5,00	0,20	3,00	2,00	3,00	3,00	1,00	5,00
Human Resources	Equipment	5,00	2,00	5,00	3,00	6,00	3,00	2,00	2,00
Method	Environment	0,20	0,25	3,00	0,33	0,25	2,00	0,25	2,00
Method	Financial	5,00	2,00	5,00	2,00	1,00	0,50	1,00	0,20
Method	Material	0,50	1,00	5,00	2,00	2,00	0,50	1,00	1,00
Method	Environment	5,00	4,00	5,00	6,00	5,00	4,00	2,00	3,00
Environment	Financial	0,20	0,13	3,00	0,25	1,00	0,33	4,00	0,50
Environment	Material	5,00	6,00	2,00	5,00	0,50	0,25	3,00	2,00
Environment	Environment	3,00	5,00	4,00	5,00	3,00	3,00	1,00	0,20
Financial	Material	0,50	0,33	1,00	0,50	3,00	1,00	8,00	0,25

Criteria	Criteria	R1	R2	R3	R4	R5	R6	R7	R8
Financial	Equipment	2,00	4,00	3,00	6,00	2,00	4,00	0,50	6,00
Material	Equipment	2,00	4,00	2,00	3,00	1,00	5,00	0,25	4,00

Calculating the geometric mean value

A21 = (Z1, Z2, Z3, …. ,Zn) ^(1/n) ..... (1)

A21 = (5 X 4 X 4 X 3 X 4 X 5 X 2 X3) ^ (1/8)
= 3,61

Table 4. Main criteria of pairwise comparison matrix

Criteria	Human R	Method	Environment	Financial	Material	Equipment
Human R	1	3,61	0,99	0,72	2,01	3,19
Method	0,277061	1	0,58	1,33	1,22	4,05
Environment	1,013257	1,731537	1	0,58	1,97	2,20
Financial	1,393545	0,749894	1,731537	1	0,92	2,77
Material	0,496683	0,817765	0,508133	1,091879	1	1,98
Equipment	0,3132	0,247078	0,455461	0,361142	0,50405	1
Total	4,493747	8,155584	5,259568	5,081658	7,624092	15,18866

After creating a pairwise comparison matrix, then normalization is carried out to obtain the relative weights and the eigenvectors value by dividing the matrix elements with the number of all existing elements.

Si is the calculation of all criteria in I column from K matrix (result from weighting the criteria, Then, S value will be:

$$n3 = \frac{s3}{\sum_{i=1}^{n} si} \quad \text{..... (2)}$$

$$S = \begin{bmatrix} 4{,}493747 \\ 8{,}155584 \\ 5{,}259568 \\ 5{,}081658 \\ 7{,}624092 \\ 15{,}18866 \end{bmatrix} \qquad N = \begin{bmatrix} n1 = \frac{s1}{\sum_{i=1}^{n} si} \\ n2 = \frac{s2}{\sum_{i=1}^{n} si} \\ n3 = \frac{s3}{\sum_{i=1}^{n} si} \end{bmatrix}$$

N_{21} = 3,61 / 4,493 = 0,442557

Table 5. Result of main criteria normalization

Criteria	Human R	Method	Environment	Financial	Material	Equipment	Total
Human R	0,2225315	0,442557	0,187642	0,141213	0,264078	0,210213	1,468234
Method	0,0616549	0,122615	0,109804	0,262419	0,160392	0,266469	0,983354
Environment	0,2254816	0,212313	0,19013	0,113648	0,258128	0,144554	1,144254
Financial	0,3101075	0,091949	0,329217	0,196786	0,120126	0,182307	1,230492

Criteria	Human R	Method	Environment	Financial	Material	Equipment	Total
Material	0,1105276	0,100271	0,096611	0,214867	0,131163	0,130619	0,784058
Equipment	0,0696969	0,030296	0,086597	0,071068	0,066113	0,065839	0,389608
Total	1	1	1	1	1	1	6

From data listed within the table above, the weight of the main criteria is able to be obtained:

Table 6. Weight of criteria in factors of project delay

Criteria	Weight	Priority
Human R	1,46823	I
Method	1,23049	II
Environment	1,14425	III
Financial	0,98335	IV
Material	0,78406	V
Equipment	0,38961	VI

To obtain a good solution for the problem, consistency is needed when filling the criteria of weights. If CR < 0.1 then the pairwise comparison values in the given criterion matrix are consistent, if CR > 0.1 then the pairwise comparison values in the given criteria matrix are inconsistent. So, when the values are not consistent, a process of values filling in in the pairwise matrix for the criteria and alternative elements must be repeated.

To calculate Consistency Index (CI), the following equation must be applied:

$$CI = (\lambda\ maks - n) / (n-1) \quad \text{..... (3)}$$

Where:

CI = Consistency Index
n = Number of elements

To calculate the Consistency Ratio (CR), the following equation must be applied:

$$CR = CI/IR \quad \text{..... (4)}$$

Where

CR = Consistency Ratio
CI = Consistency Index
IR = Index Random consistency

Table 7. Index of random consistency

Matrix Order	2	3	4	5	6	7	8	9	10
R1	0,00	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49

λ max = (0,24471 x 4,493747) + (0,16389 x 8,155584) + (0,190709 x 5,259568) + (0,205082 x 5,081658) + (0,130676 x 7,624092) + (0,064935 + 15,19)
= 6,464046071

n = 6

CI = (6,4640-6)/(6-1) = 0,092809

CR = CI/IR = 0,092809/1,24 = 0,074846

The value from respondents' assessment to criteria and alternative obtained value of 0.1, then the result is called as consistent result.

By the formula calculation above, all criteria and sub-criteria whether people, finance, method, machines and equipment, materials and environment or nature can be calculated and after each criterion and sub criterion are met, there will be a synthesis process carried out to calculate total value of the current criteria. The first act to do is searching the global value (global priority) from the local priority value (local priority). To get the global priority value, local priority must be multiplied by the priority of the level above it and the following table shows result of global prioritization of criteria and sub-criteria in details.

Table 8. Weighting overall global priority of project delay focus

Level 0 (Goal)	Level 1 (Criteria)	Relative Weight	Level 2 (Sub Criteria)	Relative Weight	Overall Weight	Priority
Main factors of delay in project *Teko Kali Ngrowo* area	Human resources	0,24471	Inexperience (Lack of work experience)	0,25731	0,06297	7
			Accident	0,22418	0,05486	9
			Worker's shortage	0,51851	0,12688	1
	Method	0,16389	Changes in Design by the Owner	0,19379	0,03176	14
			Changes in Work Plan	0,49580	0,08126	4
			Misunderstanding between drawing illustrator with the contractor	0,31041	0,05087	10
	Environment	0,19071	Socio-Culture	0,43385	0,08274	3
			Rain Intensity	0,35362	0,06744	6
			Red Zone	0,21253	0,04053	13
	Financial	0,20508	Delays in Payment by the Owner	0,20339	0,04171	12
			Increase in material prices	0,35766	0,07335	5
			Economic situation declines	0,43895	0,09002	2
	Material	0,13067	Material damages in the Storage or Warehouse	0,21101	0,02757	16
			Late in material delivery	0,35898	0,04691	11
			Late in fabrication of special materials needed in for the project	0,43001	0,05619	8

Level 0 (Goal)	Level 1 (Criteria)	Relative Weight	Level 2 (Sub Criteria)	Relative Weight	Overall Weight	Priority
	Equipment	0,06493	Late in equipment delivery	0,32205	0,02091	17
			Damages in the equipment while the project is ongoing	0,22603	0,01468	18
			Unskilled operator (lack of ability)	0,45192	0,02935	15

The result shows criteria of human resources and labor shortage factors have a weight value of 0.12688 or 12.68 % meaning that the process of implementing development for *Teko Kalingrowo* area requires lots of human resources, because productivity is used as a measure for the success of a project in making products that meet the desired quality, so the higher the comparison, the better the result.

The second result is financial criteria as represented by economic decline becomes delay factor to *Teko Kali Ngrowo* area scale project weighted of 0.09002 or 9.0 %, showed economic decline can affect many parties, both sides from the owner and the response from the local community. It shows the *Teko Kali Ngrowo* regional scale project requires stable funding during the development process because funding is applied within several stages.

The third result is socio-cultural criteria as represented by environmental/nature factor with value of 0.08274 or 8.27% in field interpretation of socio-cultural problem (the difficulty of relocation by street vendors and coffee shops around Sugai and market areas). If these social and cultural barriers exist, work can be done quickly with the help of department personnel.

The fourth result is method criteria as represented by changes in work plans with weight of 0.0812 or 8.12 %. CCO changes and changes approval usually took long time to adapt in the actual work field condition, therefore, changes to work plan are made along with the work implementation.

The fifth result is financial criteria as represented by an increase in material prices with value of 0.07353 or 7.3 %. Therefore, whenever the material prices rose too high, the contracts must be changed immediately so that production process can run smoothly.

When there is a delay then repairs will be prioritized on problems considered as the main factors of the delay. Worker shortage factor overcomes with solution of selecting additional workers and having workers grouped based on skills and coordinated by professional workers to make them more efficient. While economic decline factor caused by pandemic overcomes with solution in making efforts to make workers continue to receive their weekly wages on time also ensure welfare and safety of workers be guaranteed and recruits local people as project workers to help improving the economy condition in that area. In socio-cultural factor, the proposed solution is to remain in strict order while implementing K3 or OSH requirements for workers and to make relocation easier for local communities, along with approaches or mediation carried out between the project personnels and the local community. Compensation is given or temporary relocation of selling places or locations will be the appropriate solution in overcomes this delay factor. While the changes in work plan factor can be overcome by adjusting number of workers when there are changes to drawings and these changes (in the drawings) must be done quickly and precisely so no party will not experience difficulty in understanding the working drawings. Finally, for factor of increase in material prices, the price determination must be in accordance with decree issued by the Regent of this region and addendum must immediately be made according to the new price.

V. CONCLUSION

Each criterion which able to cause delay has a priority factor as the cause of delay and by calculation using AHP method, the results are found and stated in rank from the highest priority to the lowest priority factors are:

1. Human resources criteria with sub criteria of worker shortage with a weight value of 12.68 %;
2. Financial criteria with sub criteria of economy with a weight value of 9.0 %;
3. Environmental/nature criteria with sub criteria of socio-cultural with a weight value of 8.27%;
4. Method criteria with sub criteria changes in work plan with a weight value of 8.12%; and
5. Financial criteria with sub criteria an increase in material prices with a weight value of 7.3 %.

In addition, corrective action based on the result of questionnaire and weekly reports revealed that due to workers' shortage, there was a selection of prospective workers which at the first priority is those who had coordinated as professional workers. For the economic decline factor, ensuring the welfare or necessity of workers

always able to be met is necessary to maintain workers ready for the project work. While for social and cultural factor, the K3/OSH inspection also preparation for workers and casual meeting with stall owners can be held to gain their willingness to be relocated temporarily, and for changes in work plan factor has a solution by increasing number of workers when implementing design changes and determining drawings in short time (quickly and precisely). For the unit price changes due to price increase, an addendum to the work contract must be determined immediately if there is a change in unit price value due to price increase. Moreover, the use of other methods in analysis such as the use of fuzzy-AHP method can be carried out in further research to achieve more effective results.

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