

Analyzing of Project Delivery Risks in Highway Construction During the Covid-19 Pandemic

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ABSTRACT

The Covid-19 pandemic has hit all sectors of the business world, and the construction sector is no exception, resulting in delays, loss of efficiency, and cost impacts due to Covid-19 and the response to related government regulations, there is little or no precedent to help contractor companies understand what the potential impacts are. Covid-19 in the future and construction program when the lockdown begins. However it is very likely that work will need to be stopped due to health and safety concerns. Even if the project does not stop altogether, it is likely to be more expensive and take more time. This study attempts to conduct a risk assessment of project delivery with the most popular system, to see risk factors and then analyze risk factor ratings at all stages of project implementation until construction handover. The Covid-19 pandemic can be said to be a new phenomenon that has not much literature, so the identification of risk factors using a literature review was validated by expert discussion method, assessment by probability and impact, while the analytical method used the Analytical Hierarchy Process (AHP) approach. The results of dominant and major priority of risks including construction work health and safety, delay in delivery schedule, delays in procuring materials, labor, and equipment and delay in certification of bills.

Keywords: Pandemic Covid-19, Risk, Project, Highway Construction

INTRODUCTION

Covid-19 virus infection was first reported in December 2019 in Wuhan - the seventh largest city in China [1]. Regardless of

where this virus originated, how it mutated from animals to humans and how massive it spread, the current Covid-19 pandemic is clearly an international public health problem. Due to its rapid transmission, countries around the world should pay increased attention to disease surveillance systems and improve country preparedness and response operations including establishing rapid response teams and increasing the capacity of national laboratory systems [2].

According to the World Health Organization (WHO), a pandemic is declared when a new disease spreads around the world beyond its limits. Another definition of a pandemic is an outbreak of an infectious disease that has spread over a large area, for example several continents or worldwide, affecting many people [3]. The rapid globalization of the Covid-19 pandemic is something the world has perhaps never experienced before. The pandemic has sparked scientists and researchers to explore the genetic properties of the new coronavirus, trends and patterns of its infection, and new tests for diagnosis [4].

The globalization of the Covid-19 pandemic and its economic impact will wreak havoc in all economies in the world, bringing the industry into recession and possibly an economic depression. As the number of infected cases and deaths rises sharply and recovery from the pandemic remains uncertain even in developed

countries, evidence of the shock in countries including China, Europe and the US is already emerging [4]. Possible macroeconomic shocks from the pandemic, covering economic activities or areas including demand, supply, supply chain, trade, investment, price levels, exchange rates, and financial stability and risk, economic growth, and international cooperation [4].

The Covid-19 pandemic has hit all sectors of the business world, including the construction sector. As the Covid-19 pandemic situation developed, further problems emerged. At this stage, Covid-19 has not in general made the project impossible to complete. But that slowed down the administration, causing delays and interruptions. Many projects have even stopped temporarily with the intention of resuming work at a later date in the hope that the pandemic will end soon. Due to the resulting delays, loss of efficiency and cost impact due to Covid-19 and related government regulatory responses, there is little or no precedent to help contractor companies understand what the potential future impact of Covid-19 will be on capital projects and construction programs when restrictions lockdown begins. Contractors, subcontractors, suppliers and labor sources are affected due to delays for project work. However it is very possible that work will need to be stopped due to health and safety concerns. Even if project planning, design, and management do not stop completely, it will likely run the risk of being more expensive and requiring more time.

According to [5] in Project Delivery Systems for Construction defines the Delivery Method as a comprehensive process of establishing contractual responsibilities for designing and building a project. Which a project is organized from the basic concept provided by the project owner (owner) until it is realized into the expected physical building. This system serves as a framework for the people and organizations involved in the

project. in Indonesia Design-bid-build (DBB) is the most popular and most widely applied type of project implementation because of the clarity of the roles played by each party involved, the division of tasks is simple, namely the service user assigns the service provider to carry out only one job.

Most studies confirm that highway construction projects have higher risks than other construction projects because highway projects are spread over a wider geographic area and face a threat from underground conditions. Infrastructure and underground projects are inherently complex, with many variables including uncertain and variable ground conditions [6]. Variable ground conditions refer to the spread of highway construction projects through several terrain types including sandy and rocky areas. The presence of unidentified underground utilities poses an added risk during construction. According to [6] several highway projects have exceeded their budget and time due to what have been called unforeseen events. According to [7].

The most difficult process in risk management is the assessment process because it involves the evaluation of the probability of occurrence of risks and their impacts on a project's objectives [7]. [8] attributed the challenge in assessing the probability and impact of risks to the inherent uncertainty in a construction project. Estimates of the level of risks are based on the likelihood of an event occurring and the significance of the consequences [9]. [10] claimed that project managers are ill prepared when it comes to risk identification. The success or failure of a project is dependent on focusing on the major risks associated with a project and making wise decisions in mitigating the risks [11]. [12] defined risk assessment as the process of evaluating potential risks, ranking them, and allowing the team to select the important ones.

In Indonesia, specifically for dealing with Covid-19, the government has set three

regulations as a form of response to the pandemic, namely the Presidential Decree on the Determination of the Covid-19 Public Health Emergency, the Government Regulation on Large-Scale Social Restrictions in the Context of Accelerating the Handling of Covid-19 and the Government Regulation in lieu of law on State Financial Policy and Financial System Stability for Handling the Covid-19 Pandemic and/or In Facing Threats That Endanger the National Economy and/or Financial System Stability. As a result, the economy was paralyzed, people's purchasing power weakened, unemployment and layoffs increased. Instead of easing regional quarantine, the government has implemented a new order of life for the community, which is called the New Normal. People are returning to their activities but still implementing strict health protocols.

In response to the above policy, 2 (two) Serang Mayor Regulations were issued regarding Changes in Budget Elaboration and Enforcement of the New Normal Order in Serang City, where procurement and infrastructure development from city budget sources will continue to be carried out but with the Covid-19 health protocol. The strict guidelines refer to the Instruction of the Minister of Public Works concerning the Protocol to Prevent the Spread of Covid-19 in the field of construction services.

The city of Serang in the last 10 years has experienced significant economic and population growth. The figures show that the population of Serang City in 2019 was 688,633 thousand people with a city area of 266.71 km² or an average of 2,582 people/km² [13]. One of the reasons for the rapid population growth is Serang as the provincial capital which has its own charm from urbanists as well as residents from other provinces and cities. Population growth is of course directly proportional to the increase in the movement of goods and people. This led to a significant growth in the flow of vehicles. As a transportation

infrastructure, roads are an important element in supporting economic growth, especially during this pandemic. A highway network is also needed to bridge gaps and encourage equitable distribution of development outcomes between regions, as well as to accelerate regional development. The total length of the highway network is 206.03 km with details of 136.49 km of good highway conditions, 63.19 km of moderate highway conditions, 6.35 km of bad highway conditions [13]. The high movement of goods/people on the one hand has not been matched by the increased capacity of roads which are the main means of transportation. One of the steps taken to improve the transportation system is to restore and increase highway capacity and quality as well as carry out routine maintenance so that highway performance can be maximized. Maintaining the quality and performance of highways is one of the priorities in development considering the limitations of the city's highway network which must be maintained despite budget constraints in the midst of a pandemic.

The Covid-19 pandemic is actually a disaster, not a risk. From a risk management perspective, disasters cannot be prevented, while risks can be prevented, even if they are affected by a risk, even if a disaster occurs, construction projects should be able to respond wisely to the impact of Covid-19. This study attempts to conduct a project delivery risk assessment to look at risk factors and then analyze risk factor ratings at all stages of project implementation up to construction handover.

This study attempts to conduct a project delivery risk assessment using the system mentioned above to look at risk factors and then analyze the risk factor rating at all stages of project implementation up to construction handover. The Covid-19 pandemic can be said to be a new phenomenon that does not have much literature, so the identification of risk factors using review literature is validated

using by experts discussion method, assessment by probability and impact, while the analytical method uses the AHP approach, in this study to looking for the most dominant main risks and determining their priority order, then looking for alternative solutions and appropriate policy strategies, so as to provide input on appropriate and optimal policy recommendations

METHOD

This research was conducted throughout 2020 during the pandemic, based on data from the Ministry of Public Works of Serang City, the construction of a number of these roads were spread over 6 Districts by completing 12 roads the total length of the highway construction sections was 4,729.30 m.

Starting with a literature review, processed through expert validation using the expert

discussion method, after becoming a reference the next stage is to fill out the following questionnaire with expert interviews whose respondents have been predetermined.

The dominant assessment is carried out by calculating probability and impact, while the priority of control or handling using the AHP approach will be obtained as a result of processed data in this study. In the process of this research, standards were achieved based on the analysis of secondary data and primary data, where secondary data is data obtained from previous research literature as well as regulations and news that are often heard in the field, while primary data is data from the results of expert discussions, questionnaires and interview. The stages of analysis in research are as figure 1 follows:



Figure 1. Flow Chart of Research Data Analysis Stages

For correspondents, data collection was carried out by identifying the population of stakeholders involved in the construction sector, namely academics, highway experts, contractors and consultants who have experience and knowledge in the field of highway construction.

RESULTS

Risk Identification

The first step was to identify risks in highway construction projects through literature review, Because the number of publications related to risks in highway projects is limited the search was extended by Focus Group Discussion (FGD). The purpose of the FGD is to eliminate independent variables and take important

variables and then group the variables into the same criteria. The intent and purpose are to group them into the most important variables considering the Covid-19 pandemic is a new phenomenon and there is not much literature. Starting from the

literature study or previous research, the identification of risk factors as table 1 was validated by 7 (seven) experts using the FGD method to eliminate independent variables and take the most important variables.

Table 1. Risk Identification

No	Variables	Source
1	Delays in procuring materials, labor, and equipment	[14]
2	Resources cannot be used effectively	[14]
3	Health and safety of construction workers	FGD [2021]
4	Construction sequencing/phasing	[15] [16]
5	Unexpected utility encounter	[17] [15]
6	Delays in delivery schedule	[17] [15] [16]
7	Revised drawings during construction	[14]
8	Work cannot be completed according to schedule	[14]
9	Changes Scope definition of the scope of work	[16]
10	Technology cannot used effectively	[14]
11	Work-zone traffic control	[15] [16]
12	Obtaining approval from other agencies	[15]
13	Third-party delays during construction	[15] [18]
14	Delays in completing utility agreements	[15]
15	Project complexity	[15]
16	Delay in certification of bills	[14]
17	Delays in right-of-way (ROW) process	[15] [16]

Risk Assessment

Which is the result of expert validation, was distributed to 36 (thirty six) respondents from construction service professionals involved in highway construction projects regarding the possibility and impact of these risks. The risk assessment is based on data from previous expert discussions regarding the risks that occur in the implementation of highway construction projects in the midst of the Covid-19 pandemic, so the data that has been obtained is processed through the data processing stages. Calculation of the level of risk using the matrix of the relationship between frequency and impact with the AS/NZS 4360 standard.

Risk assessment is an important task that must be carried out to avoid harmful effects that may arise when commencing the construction of future highway projects. This study was conducted to gain better knowledge about risk assessment and how important it is for a project to run smoothly. Risk assessment will help in a better understanding of the consequences that can

occur during the highway construction period. It helps avoid certain disasters by making decisions and planning preventive actions. With risk assessment, there will be certain performance improvements in the project.

Risk assessment is based on questionnaire data regarding the risks that occur in highway construction project delivery in the midst of the Covid-19 pandemic, after the questionnaire data collection is complete, then the data that has been obtained, both assessment questionnaire data and interview data, are processed through the stages data processing. Risk is formulated as a function of likelihood and negative impact. Or risk index = Probability (Likelihood) X Impact (Impact). Potential risks are risks that need attention because they have a high probability of occurring and have major negative consequences.

After the risk category has been converted into the form of the number, then calculation can be performed as shown in table 2 below.

Table 2. Risk Index

No	Risk	P	I	P x I	Level
1	Delays in procuring materials, labor, and equipment	3	3	9	High
2	Resources cannot be used effectively	2	3	6	Moderate
3	Health and safety of construction workers	2	4	8	High
4	Construction sequencing/phasing	2	3	6	Moderate
5	Unexpected utility encounter	1	2	2	Low
6	Delays in delivery schedule	3	3	9	High
7	Revised drawings during construction	2	2	4	Low
8	Work cannot be completed according to schedule	2	3	6	Moderate
9	Changes Scope definition	2	2	4	Low
10	Technology cannot used effectively	2	2	4	Low
11	Work-zone traffic control	2	2	4	Low
12	Obtaining approval from other institutions	2	2	4	Low
13	Third-party delays during construction	2	3	6	Moderate
14	Delays in completing utility agreements	2	2	4	Low
15	Project complexity	2	3	6	Moderate
16	Delay in certification of bills	3	3	9	High
17	Delays in right-of-way (ROW) process	1	2	2	Low

The results show that there are 4 (four) risk factors with a high level of risk, namely delays in procuring materials, labor and equipment, health and safety of construction workers, delays in delivery schedules, and delays in billing certification. As for the Moderate risk level, there are 5 (five) risk factors, namely: resources cannot be used effectively, construction sequence/phasing, work cannot be completed according to schedule, third party delays during construction and project complexity. Furthermore, there are 8 (eight) risk factors that are included in the Low risk level category, namely; unexpected utility encounters, revised drawings at construction time, changes in scope of work definition, technology cannot be used effectively, work zone traffic control, obtaining approval from other agencies, delays in completing utility agreement, and delays in right-of-way (ROW) process.

The main issues are human risks including impaired staff accessibility to the construction site and shortage of workers, technicians and operators, for situations when workers cannot return due to strict lockdown policies, new workers are hired and trained or available staff do multiple jobs with strict measures appropriate to meet the urgent demand for human resources [19]. Materials and tools are in short supply as the supply chain is also facing stagnation and inadequate materials due to lockdown policies [19]. Transportation blockages between regions

make it more difficult to transport materials, labor and equipment for construction projects.

In this study, it is explained that there are 4 (four) major risks in project delivery of highway construction in the midst of a pandemic. Knowing these main risks will help in developing prevention mechanisms, so that there will be negligible problems, less lost time and better budget planning during the implementation of construction projects. Risk assessment is an important task that must be carried out to avoid harmful effects that may arise when commencing the construction of future highway projects. This study was conducted to gain better knowledge about risk assessment and how important it is for a project to run smoothly. Risk assessment will help in a better understanding of the consequences that can occur during the highway construction period. It helps avoid certain disasters by making decisions and planning preventive actions. With risk assessment, there will be certain performance improvements in the project.

Risk Priority

The AHP approach is used to perform pairwise comparisons between risk variables for each type of risk. Through a pairwise comparison assessment, the risk weights that have the most influence on the project delivery system for highway construction projects in the midst of a pandemic are obtained. Analysis begins with distributing

questionnaires to 15 expert respondents who are experienced in road construction project activities, and the data is analyzed using expert choice software.

AHP is a decision support model developed by [20] is a decision support model that will describe complex multifactor or multi-criteria problems into a hierarchy, defined as a representation of a complex problem in a multilevel structure where the first level is the goal, which is followed by the level of factors, criteria, sub criteria, and so on until the last level of the alternative. With a hierarchy, a complex problem can be broken down into groups, which are then arranged into a hierarchical form so that the problem

will appear more structured and systematic. By analyzing the AHP method from [20] it is used to obtain the dominant risk factor from the highest to the lowest risk factor value.

Based on the relationship between the data taken from the questionnaire and the validation, the consistency ratio value for each risk variable is obtained, the weight of each risk variable is acceptable because it has a consistency ratio value of ≤ 0.1 . The final result of risk weighting which has the highest priority weight for each type of risk by expert choice can be seen in table 3 below.

Table 3. Ranking of potential priorities and risk weights

Rank	Risk	Priority %
1.	Health and safety of construction workers	11,20
2.	Delays in delivery schedule	8,90
3.	Delays in the procurement of materials, labor and tools	8,10
4.	Delays in billing certification	6,68
5.	Third party delay during construction	6,67
6.	Technology cannot be used effectively	6,00
7.	Changes to the definition of the scope of work	5,80
8.	Work cannot be completed on schedule	5,40
9.	Resources cannot be used effectively	5,30
10.	Obtaining approval from other agencies	5,20
11.	Project Complexity	5,00
12.	Revised drawings at the time of construction	4,80
13.	Work zone traffic control	4,80
14.	right-of-way (ROW) processing delay	4,40
15.	Sequence/stages of construction	4,20
16.	Unexpected utility encounter	3,70
17.	Delays in finalizing utility agreements	3,40

Table 3 above shows the cumulative ranking of risk factors, there are 5 (five) top risk ranking variables, namely health and safety of construction workers, delays in delivery schedules, delays in procuring materials, workers and tools, delays in billing certification and third party delay during construction.

During the pandemic, construction health and safety was ranked the top risk factor cumulatively in the implementation of highway construction projects with a percentage of 11.20%, which is an important condition and key for the continuity of construction activities and worker protection in the context of preventing and controlling Covid-19. Construction health is one of the core aspects of Occupational Health and Safety

(OHS) and the attention is as great as construction safety.

The domino effect that occurred as a result of the pandemic that emerged later was that contractors had to restrain themselves due to the enactment of Covid-19 prevention policies by the government such as social restrictions and regional quarantines as well as due to limited company budgets resulting in delays in delivery schedules and delays in procuring materials, labor and equipment respectively. -respectively ranked second and third with percentages of 8.90% and 8.10%.

The project's financial stability was disrupted due to the longer term/billing process but the construction specifications and quality had to be maintained, creating the next risk, namely delays in billing

certification which cumulatively was in fourth position with a percentage contribution of 6.68%. This happened due to the bureaucracy and coordination that was a little more complicated during the pandemic, such as the implementation of work from home by the government and technical problems that occurred during construction. Followed by rank, namely delays by third parties with a percentage of 6.67%. Whereas third party delays are delays experienced by owners and contractors caused by subcontractors, suppliers or other utilities.

The pandemic brought in situations and difficulties of limited workers, materials and equipment during the COVID-19 pandemic, special project management and coordination skills were needed, where the project management team had to devote full efforts to facilitate worker travel, communicate with suppliers, and stimulate project progress [19].

DISCUSSION

The results of the risk analysis show that the construction projects in this study can adapt well to the sudden changes caused by the unprecedented Corona virus. All construction service actors, especially contractors, have implemented a new protocol to maintain worker safety in stopping the spread of the virus, where this

protocol was never needed before but has now become a new standard, although this change did not come without struggles, such as delays, delays, extra costs for health protocol. and additional energy in the implementation of construction that developed when the pandemic started, this is because these construction activities do not stand alone, but also depend on other business sectors.

But so far, there appear to be no reports of the highway construction projects in this study being cancelled, suspended, or interrupted in their implementation. Nonetheless, problems and complexities abound during a pandemic, where the obstacles that often arise range from limited numbers of workers and their effectiveness, third party delays, budget changes, transportation and supply chain disruptions to restrictive government policies, such as travel bans, Work From Home (WFH) and regional quarantines that mandated.

Based on the results of the analysis above, there are several risks that are at a high and dominant scale that must be managed so that they can reduce risk. The results of the assessment are relevant to the results of the AHP analysis that was carried out previously, this provides an overview of which risk factors are the priority and dominant. The risks that need attention are in table 4 as follow:

Table 4. Research result

Rank	Risk	AS/NZS	AHP(%)	Alternative Control
1	Health and safety of construction workers	High	11,20	OHS & Instruction of the Minister of Public Work
2	Delivery schedule delays	High	8,90	Critical chain approach
3	Delays in the procurement of materials, labor and tools	High	8,10	Critical chain approach
4	Delays in billing certification	High	6,68	Cashflow control
5	Third party delay during construction	Moderate	6,67	Coordination
6	Technology cannot be used effectively	Low	6,00	Resource optimization
7	Changes to the definition of the scope of work	Low	5,80	Critical path approach
8	Work cannot be completed on schedule	Moderate	5,40	Critical path approach
9	Resources cannot be used effectively	Moderate	5,30	Resource optimization
10	Obtaining approval from other agencies	Low	5,20	Coordination
11	Project Complexity	Moderate	5,00	Construction Management
12	Revised drawings at the time of construction	Low	4,80	Shopdrawing
13	Work zone traffic control	Low	4,80	Construction Management
14	right-of-way (ROW) processing delay	Low	4,40	Socialization
15	Sequence/stages of construction	Moderate	4,20	Construction Management
16	Unexpected utility encounter	Low	3,70	Construction Management
17	Delays in finalizing utility agreements	Low	3,40	Construction Management

During the pandemic, health and safety of construction workers was ranked 1 (one) risk factor cumulatively and included as high risk, which is an important condition and key for the continuity of construction activities and worker protection in the context of preventing and controlling Covid-19. [21] literature shows that although the biggest cause of death in a construction project is accidents (falls), it is very difficult to observe the consequences caused by health hazards because the illness can have a long period of time. Construction health is one of the core aspects of OSH and the attention must be equal to construction safety. That overall, companies in all regions are implementing the same basic policies adhering to the guidelines set by the local government, these include social distancing, increased sanitation efforts, additional sanitation stations, Covid-19 signs, and employee screening. Furthermore, in practice, stakeholders and the project team continue to socialize the importance of the health program and have implemented it for workers by checking the temperature every time they enter the location, limiting the number of workers, maintaining distance and using masks and gloves if necessary. Apart from workers, residents are also advised not to enter the project area and maintain a safe distance to break the chain of transmission of Covid-19. For workers or project teams who come from outside the area, especially those from outside the area, especially the red zone, they are required to do a rapid or swab test first.

Delays in delivery schedules are closely related to delays in the procurement of materials, labor and equipment. One of the reasons for the delay in delivery is the existence of a regional lock that states that each region issues regulations to all people who will leave or enter the area must provide an entry permit to the area that has the potential to spread the Covid-19 virus, making service providers/suppliers/vendors constrained in sending goods/ services in the form of equipment, materials or workers to

the construction project site. [19] found construction materials and machinery to be in short supply as the supply chain also faced inadequate staff and materials due to lockdown policies, blocking of transportation in cities and villages making delivery of materials more difficult for development projects. During the 2020 construction period when the pandemic began to spread, the construction-related industry had to adapt, where many requirements had to be met in logistics and were very closely related to the delivery schedule for materials, workers and tools. Where this adjustment requires additional time and procedures, from the results of the respondents it was obtained information that these delays usually occur during a pandemic.

CONCLUSION

The findings of this study enrich road construction risk categories and risk response strategies from a global pandemic perspective. This implies that the future construction scheme including budget, supply chain and project management should consider the possible effects of the epidemic and worker safety. In general, these risk factors come from problems that arise as a result of government policies on preventing the spread of the Corona virus outbreak, although the variables in this group are not necessarily included in the most dominant risk. Of all these variables, it shows that the problem of implementing a project management system is still a priority in line with the increasing work risks due to the Covid-19 pandemic, which has recently increased the tension of transmission again. The special circumstances caused by the Covid-19 pandemic demand flexible project management and coordination skills to develop appropriate and effective response strategies.

Risk assessment and risk management play an important role in the success of a highway project. This study is one of the efforts in the literature to investigate the project delivery risks of highway

construction using empirical data based on projects that have been completed. From the results of the risk analysis that has been carried out on the specific highway construction project delivery at the construction implementation stage amid the Covid-19 pandemic.

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