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RISK ANALYSIS OF PEMALANG DISTRICT ROAD AND BRIDGE CONSTRUCTION DELAYS

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ABSTRACT

Delays in road and bridge construction projects pose significant challenges within the construction industry. These delays can be attributed to various risk factors that have the potential to disrupt project timelines. This study focuses on identifying the risk factors that contribute to delays in road and bridge construction projects in the Pemalang district. A comprehensive review of relevant literature was conducted to identify these risk factors, which were then incorporated into questionnaires distributed among contractors, owners, and consultants. The questionnaire data was analyzed using the mean score ranking method, along with validity and reliability tests, and descriptive statistical analysis facilitated by the SPSS program. The research findings unveiled a total of 54 risk factors categorized into 11 distinct categories. Among these, the top 10 causes of delays in road and bridge construction projects in the Pemalang district were identified based on mean values ranging from 4.18 to 4.57. These factors encompassed issues such as shortages of construction materials (4.57), delays in goods delivery (4.48), equipment delivery delays (4.40), difficulties in contractor funding (4.37), inadequate workforce or inability to meet project demands (4.37), rainfall intensity (4.35), poor material quality (4.30), ordering time inaccuracies (4.27), insufficient skilled labor (4.23), and equipment damage (4.18). Furthermore, interviews were conducted with experts to discuss the 10 risk factors with the highest impact. Strategies to mitigate these risks were derived from these discussions. The outcomes of this research are anticipated to provide valuable insights for stakeholders involved in the planning and execution of road and bridge construction projects. By understanding the underlying risk factors and implementing the recommended strategies, it is expected that project delays can be significantly reduced in future endeavors.

Keywords: Bridge Construction; Project Delay; Risk Management; Road Construction

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1. INTRODUCTION

Road and bridge construction projects play a crucial role in the development of regional infrastructure. These projects not only enhance community mobility and accessibility but also contribute to the local economy. In the context of the Pemalang district, the Public Works and Spatial Planning Office serves as the technical agency responsible for organizing infrastructure facilities, particularly roads, and bridges. The local government has jurisdiction over district roads and village axis roads. Over the years, the budget allocated for road projects has consistently increased. However, the implementation of these projects often faces delays, which have detrimental effects on both the budget utilization and the community's access to crucial transportation infrastructure.

The construction industry has drawn attention to the issue of project delays due to their frequent occurrence. Construction delays can lead to significant time and cost overruns, project abandonment, and even legal disputes (Rashid, 2020). These delays not only impact the economic feasibility of capital projects but also increase the likelihood of disputes and claims (Mahamid, 2011). Construction companies must recognize and understand the causes of delays to mitigate their impact, as delays can result in late project completion, reduced productivity, increased costs, and contract terminations. Addressing these issues is vital for maintaining a company's competitiveness (Arantes & Ferreira, 2020). Identifying project risks and incorporating risk response measures into project management plans, such as the Work Breakdown Structure (WBS) or the risk management plan, is of utmost importance (Hudoyo et al., 2019).

Evaluating the performance of each activity throughout the lifecycle of a public construction project is critical for ensuring successful infrastructure delivery (Rahman et al., 2013). Timely completion, adherence to budget, and conformity to specifications are key factors determining the success of infrastructure projects (Belay et al., 2021). Achieving these objectives necessitates full collaboration and coordination among the project team throughout the project's lifespan (Alias et al., 2014).

Construction projects in various regions often face challenges related to poor cost and time performance (Sinesilassie et al., 2018). Extensive research has identified numerous causes and risk factors contributing to time delays in road construction projects. For example, in Palestine, Mahamid (2013), identified risks such as contractors' financial stability, payment delays, political instability, poor communication among project parties, inadequate equipment, and intense competition for bid opportunities. In Ethiopia, road infrastructure projects have experienced significant delays due to factors like scope changes, economic fluctuations, and increases in material costs (Belay et al., 2021).

Factors affecting project delays include difficulties in sourcing or accessing materials or equipment, issues with human resource availability or performance, changes or ambiguities in the scope of work or project documentation, ineffective planning or scheduling processes, poor communication or coordination among team members, and external factors beyond the construction firm's control, such as weather or permit delays (Rachmayanti & Arumsari, 2021). Research on bridge construction delays in India revealed that factors like late payments to contractors, information procurement delays, inadequate project management, compensation difficulties, design modifications, weather-related problems, and labor strikes significantly impact project completion (Tayade et al., 2008). Similarly, in Nepal's Postal Highway Project, Suwal & Shrestha (2016) found that delays were caused by low bidding rates, inadequate pre-execution planning, clearance hold-ups, and inadequate site management. In the city of Banjarmasin, delays in bridge construction projects were attributed to material delivery delays, negligence-related damage, and subpar work quality (Isramaulanan et al., 2017). According to a study conducted in Hargeisa, several key factors were identified as major contributors to construction project delays. These factors included a gradual delay in payment disbursement, inaccurate estimation of project costs, and delays in approving significant changes to the project scope. The findings from this study hold significant implications for future projects, highlighting a lack of emphasis on effective project management practices such as comprehensive cost, scope, and risk management in the construction industry (Fashina et al., 2021). According to research conducted in Algeria, the study findings highlight the top five causes of delays in construction projects. These include sluggish processing of change orders, impractical contract durations, delayed approval of variation orders for additional quantities, payment delays for completed work, and inadequate planning and scheduling by contractors (Rachid et al., 2019). A study conducted in India aimed to identify the root causes of delays in various types of projects, including transportation, power, buildings, and water/irrigation sectors. The study revealed that financial-related causes, such as delays in settling claims by owners, financial difficulties faced by contractors, delays in payment for extra work or variations, and late payments from contractors to subcontractors or suppliers, were identified as the most critical causes of delay across all project types (Prasad et al., 2019). A study conducted in Ethiopia has proposed several risk mitigation measures for project delays. These measures include rewarding contractors who perform well, enhancing the capacity of staff, implementing selective public-private partnerships, improving performance monitoring and information sharing, and utilizing innovative techniques and tools for project cost and time forecasting (Kassa, 2020).

The purpose of this research is to address the lack of studies on time overruns in road and bridge construction projects specifically in Pemalang district. Although it is generally noticed that construction projects in the area often experience delays, there is a need to comprehensively analyze the factors contributing to these delays. The main objective of this research is to identify and examine the factors that influence the delay of road and bridge construction projects in the Pemalang district. By obtaining valuable insights, the findings of this study are intended to provide essential information for stakeholders involved in the planning and execution of future road and bridge construction projects. Ultimately, the aim is to mitigate and minimize project delays, thereby enhancing the overall efficiency and effectiveness of construction endeavors in the district.

2. METHODS

This research starts by identifying the problem, then to obtain risk factors, a review of previous research literature discussing the risk factors causing construction project delays is conducted. The researcher surveyed parties involved in road and bridge work packages that experienced delays at the Public Works and Spatial Planning Department of Pemalang District from 2019 to 2021, including the owner, technical team, field supervisor, contractor, and supervisor consultant.

Table 1. The Respondents Involved in Project Delays

Parties	Total
Owner / Technical team / Field supervisor	41
Consultant Supervisor	8
Contractor	11
Total	**60**

The data obtained is then processed, analyzed and processed and tested using the SPSS program with the descriptive test to get the mean value and factor analysis. Based on the results of processing and analyzing the data obtained, interviews were then conducted by experts in the field of construction to obtain solutions to the problem of delays in road and bridge construction projects.

2.1 Ranking Based on Mean Score

The mean score ranking method is a popular statistical approach that involves calculating the average (mean) of responses obtained from a questionnaire survey. The survey utilizes a 5-point Likert scale to collect the responses. In equation (1), the mean score (M) is determined by taking the average of all the responses for a particular item.

Here, f represents the frequency of responses, and S denotes the score assigned to each attribute by a respondent on a scale of 1 to 5.

$$M = \frac{\sum f \; x \; S}{N} (0 < M \;\leq 5), \quad (1)$$

Furthermore, the weighting is assigned by respondents based on factors ranging from 1 to 5. Specifically, 1 represents the number of respondents considering the factor as very low importance, 2 denotes the number of respondents perceiving it as low importance, 3 signifies neutrality, 4 indicates high importance, and 5 represents very high importance. The M value falls within the range of 0 < Mean Score ≤ 1.

3. RESULTS AND DISCUSSION

3.1 Validity and Reliability Test

The study used SPSS to calculate the correlation value between the score of items and the overall score of the study. The results of the analysis showed that by comparing the obtained value to the r table value by using a two-sided test, with a significance level of 0.05 and a sample size of n=60. This comparison was done to understand the relationship between the item score and the total score of the study.

$$r_{xy} = \frac{N \sum_{xy - (\sum x)} (\sum y)}{\sqrt{\left(N \sum x^2 - (\sum x)^2 \left(N \sum y^2 - (\sum y^2)\right)\right)}} \quad (2)$$

r_{xy} represents the correlation coefficient between two variables X and Y. The sum of products of X and Y is denoted by $\sum xy$, while the sum of squared values of X is represented by $\sum x^2$ and the sum of the squared values of Y is represented by $\sum y^2$. The square of the sum of X values is represented by $(\sum x)^2$, and the square of the sum of Y values is represented by $(\sum y)^2$.

The sample for the questionnaire consisted of 60 individuals who have experience in managing bridge projects and the significance level was set at 5%. This resulted in a degree of freedom (df) of 58 (df = n-2 = 60-2 = 58). Using the r table, the r table value at a significance level of 5% was found to be 0.254. The r table value was then compared to the calculated r value. If the calculated r-value is greater than the r table value, it can be concluded that the statement is "Valid", on the other hand, if the calculated r value is less than the r table value, it can be stated that the statement is "Invalid".

Table 2. Result of the Validity Test

Category	Code	Variable	Value r (r count)	Value (r table)	Conclusion
Labors	X1.1	Labor skills	0,659	0.254	Valid
	X1.2	Labor discipline	0,532	0.254	Valid
	X1.3	Work motivation of labor	0,335	0.254	Valid
	X1.4	A shortage of labor force or mismatch in the number of workers with the work required	0,405	0.254	Valid
	X1.5	Nationalism of labor	0,174	0.254	Invalid
	X1.6	Replacement of new labor	0,078	0.254	Invalid
	X1.7	Communication between labor and the head builder	0,493	0.254	Valid
Material	X2.1	Delay in delivery of goods	0,515	0.254	Valid
	X2.2	Shortage of construction materials	0,535	0.254	Valid
	X2.3	Poor quality of materials	0,599	0.254	Valid
	X2.4	Damage to materials in storage	0,598	0.254	Valid
	X2.5	Material changes in form, function, and specifications	0,637	0.254	Valid
	X2.6	Scarcity due to specialty	0,626	0.254	Valid
	X2.7	Inaccuracy of ordering time	0,645	0.254	Valid
Equipment	X3.1	Delay in delivery/provision of equipment	0,641	0.254	Valid
	X3.2	Equipment damage	0,737	0.254	Valid
	X3.3	Availability of adequate equipment/as needed	0,6	0.254	Valid
	X3.4	Equipment productivity	0,58	0.254	Valid

Category	**Code**	**Variable**	**Value r (r count)**	**Value (r table)**	**Conclusion**
	X3.5	Lack of foreman or operator skills in operating equipment	0,78	0.254	Valid
Site Characteristic	X4.1	Conditions on the surface and beneath the surface	0,635	0.254	Valid
	X4.2	Sight or response of the surrounding environment	0,628	0.254	Valid
	X4.3	The physical attributes of the surrounding structures of the project site	0,372	0.254	Valid
	X4.4	Material storage areas	0,768	0.254	Valid
	X4.5	Access to the project site	0,488	0.254	Valid
	X4.6	Workspace requirements	0,643	0.254	Valid
	X4.7	Project Location	0,323	0.254	Valid
Financial	X5.1	Lack of incentive money for contractors if the completion time is faster than the schedule	0,229	0.254	Invalid
	X5.2	Material price	0,658	0.254	Valid
	X5.3	Funding difficulties at the contractor	0,673	0.254	Valid
	X5.4	Payment difficulties by the owner	0,718	0.254	Valid
Environment	X6.1	Rainfall intensity	0,355	0.254	Valid
	X6.2	Social and cultural factors	0,539	0.254	Valid
	X6.3	Unexpected events such as fires, floods, severe weather, storms/hurricanes, earthquakes, and landslides	0,278	0.254	Valid
Changes	X7.1	Design changes by the owner	0,645	0.254	Valid
	X7.2	Design errors made by the planner	0,804	0.254	Valid
	X7.3	Errors in soil investigation	0,886	0.254	Valid
Scope and Contract/Work Documents	X8.1	Inadequate or flawed pre-execution planning, including incorrect or incomplete drawings and specifications	0,741	0.254	Valid
	X8.2	Change in scope of work during implementation	0,783	0.254	Valid
	X8.3	Delays in owner's decision making	0,773	0.254	Valid
	X8.4	Frequent additional work requests	0,756	0.254	Valid
	X8.5	Requests for changes to completed work	0,692	0.254	Valid
	X8.6	Misunderstanding between work drawings (consultant) and contractor	0,806	0.254	Valid
Planning and Scheduling	X9.1	Incomplete identification of the type of work	0,801	0.254	Valid
	X9.2	Poorly organized/integrated work sequence plan	0,715	0.254	Valid
	X9.3	Inaccurate determination of work time duration	0,759	0.254	Valid
	X9.4	Frequent changes in the owner's work plan	0,806	0.254	Valid
	X9.5	Incorrect or inappropriate construction/work execution methods	0,721	0.254	Valid
Work Inspection,	X10.1	Differences in subcontractor schedules for project completion	0,735	0.254	Valid

Category	Code	Variable	Value r (r count)	Value (r table)	Conclusion
Control, and Evaluation System	X10.2	Unscheduled submission of material samples by contractors	0,665	0.254	Valid
	X10.3	The lengthy approval process of material samples by the owner	0,754	0.254	Valid
	X10.4	Delay in material inspection and testing process	0,623	0.254	Valid
	X10.5	Contractors' inability to fulfill their duties and complete the work on time	0,691	0.254	Valid
	X10.6	A lot of work results that must be repaired/repeated because of defects/incorrectness	0,735	0.254	Valid
	X10.7	The evaluation processes for assessing the work's progress are time-consuming and exceed the planned timeline	0,703	0.254	Valid
Managerial	X11.1	Field manager experience	0,411	0.254	Valid
	X11.2	Communication between owners and contractor representatives	0,487	0.254	Valid
	X11.3	Communication between planners and contractors	0,497	0.254	Valid

Based on the correlation analysis results, the correlation value for invalid variables X1.5, X1.6, and X5.1 was obtained. When the calculated r-value is compared to the r-table value of 0.254, it was determined that certain items were not strongly correlated to the total score. These items were deemed invalid and thus were removed from the study. On the other hand, items with calculated r values greater than 0.254 were found to be significantly correlated to the total score and were thus retained for further analysis.

When evaluating the reliability of the instrument used in the research, only scores from valid items were used. Items that were deemed invalid, were excluded from the reliability testing. A common standard for determining the reliability of the instrument is using the Cronbach Alpha value, where an instrument is considered reliable if the value is above 0.60. If the Cronbach Alpha value for the variables being researched falls within this threshold, it can be concluded that the instrument is a reliable measure of these variables.

$$r_{11} = \left[\frac{k}{k-1}\right]\left[1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right] \tag{3}$$

Where:
r_{11} = reliability of the instrument,
k = number of questions or number of items,
$\sum \sigma_b^2$ = sum of item variances,
σ_t^2 = variance of the total score

Table 3. Result of the Reliability Test

Reliability Statistics	
Cronbach's Alpha	N of Items
0,968	54

Based on the reliability test results, these variables can be considered reliable. From the testing results for all items in the questionnaire in the managerial factor, it can be seen that the Cronbach Alpha (α) value is 0.968 (higher than 0,60). Therefore, it can be concluded that all variables are reliable.

3.2 Project Risk Ranking Analysis

The results of the valid questionnaire data obtained are then used in the risk factor ranking process. This process is carried out to determine which risk factors have the most influence on the construction project delays of roads and bridges in the Pemalang district. The analysis method used is the mean method. The characteristics of data include the Mean value, this analysis is to obtain the Mean value (the average value of the data). Mean is the average of the data set that we have.

Table 4. Ranking Analysis of Delay Factors that Influence Construction Delays for Roads and Bridges

Category	Code	Variable	Mean	Rank
Labors	X1.1	Labor skills	4,23	9
	X1.2	Labor discipline	4,03	16
	X1.3	Work motivation of labor	3,82	23
	X1.4	A shortage of labor force or mismatch in the number of workers with the work required	4,37	5
	X1.5	Nationalism of labor	Eliminated	
	X1.6	Replacement of new labor	Eliminated	
	X1.7	Communication between labor and the head builder	4,02	17
Material	X2.1	Delay in delivery of goods	4,48	2
	X2.2	Shortage of construction materials	4,57	1
	X2.3	Poor quality of materials	4,30	7
	X2.4	Damage to materials in storage	3,92	21
	X2.5	Material changes in form, function, and specifications	4,07	15
	X2.6	Scarcity due to specialty	4,02	19
	X2.7	Inaccuracy of ordering time	4,27	8
Equipment	X3.1	Delay in delivery/provision of equipment	4,40	3
	X3.2	Equipment damage	4,18	10
	X3.3	Availability of adequate equipment/as needed	4,13	13
	X3.4	Equipment productivity	4,17	12
	X3.5	Lack of foreman or operator skills in operating equipment	3,88	22
Site Characteristic	X4.1	Conditions on the surface and beneath the surface	3,70	29
	X4.2	Sight or response of the surrounding environment	2,92	53
	X4.3	The physical attributes of the surrounding structures with the project site	3,20	50
	X4.4	Material storage areas	3,13	52
	X4.5	Access to the project site	3,77	27
	X4.6	Workspace requirements	3,15	51
	X4.7	Project Location	3,63	32
Financial	X5.1	Lack of incentive money for contractors if the completion time is faster than the schedule	Eliminated	
	X5.2	Material price	3,58	34
	X5.3	Funding difficulties at the contractor	4,37	4
	X5.4	Payment difficulties by the owner	3,67	30
Environment	X6.1	Rainfall intensity	4,35	6

Category	Code	Variable	Mean	Rank
	X6.2	Social and cultural factors	2,80	54
	X6.3	Unexpected events such as fires, floods, severe weather, storms/hurricanes, earthquakes, and landslides	4,17	11
Changes	X7.1	Design changes by the owner	3,43	42
	X7.2	Design errors made by the planner	3,57	35
	X7.3	Errors in soil investigation	3,78	26
Scope and Contract/Work Documents	X8.1	Inadequate or flawed pre-execution planning, including incorrect or incomplete drawings and specifications	3,50	40
	X8.2	Change in scope of work during implementation	3,57	36
	X8.3	Delays in owner's decision making	3,63	32
	X8.4	Frequent additional work requests	3,28	49
	X8.5	Requests for changes to completed work	3,43	42
	X8.6	Misunderstanding between work drawings (consultant) and contractor	3,52	38
Planning and Scheduling	X9.1	Incomplete identification of the type of work	3,32	46
	X9.2	Poorly organized/integrated work sequence plan	3,53	37
	X9.3	Inaccurate determination of work time duration	3,48	41
	X9.4	Frequent changes in the owner's work plan	3,37	44
	X9.5	Incorrect or inappropriate construction/work execution methods	3,72	28
Work Inspection, Control, and Evaluation System	X10.1	Differences in subcontractor schedules for project completion	3,32	47
	X10.2	Unscheduled submission of material samples by contractors	3,33	45
	X10.3	The lengthy approval process of material samples by the owner	3,30	48
	X10.4	Delay in material inspection and testing process	3,50	39
	X10.5	Contractors' inability to fulfill their duties and complete the work on time	4,02	17
	X10.6	A lot of work results that must be repaired/repeated because of defects/incorrectness	3,80	24
	X10.7	The evaluation processes for assessing the work's progress are time-consuming and exceed the planned timeline	3,67	31
Managerial	X11.1	Field manager experience	4,10	14
	X11.2	Communication between owners and contractor representatives	3,93	20
	X11.3	Communication between planners and contractors	3,80	24

Based on the overall mean rank shown in Table 4 of the causes of construction delays for roads and bridges in Pemalang District, the top ten causes of construction delays for roads and bridges in Pemalang District are as follows:

Table 5. The Top 10 Ranks of the Factors that Influence Construction Delays for Roads and Bridges

Code	Variable	Mean	Rank
X2.2	Shortage of construction materials	4,57	1
X2.1	Delay in delivery of goods	4,48	2
X3.1	Delay in delivery/provision of equipment	4,40	3
X5.3	Funding difficulties at the contractor	4,37	4
X1.4	A shortage of labor force or mismatch in the number of workers with the work required	4,37	5
X6.1	Rainfall intensity	4,35	6
X2.3	Poor quality of materials	4,30	7
X2.7	Inaccuracy of ordering time	4,27	8
X1.1	Labor skills	4,23	9
X3.2	Equipment damage	4,18	10

The researcher ranked the causes into the top 10 highest to focus on the risks with the most significant impact, which leads to delays in road and bridge construction projects. The highest contributing factors have a range of mean values between 4.18 to 4.57. After obtaining the top-ranking factors that influence the causes of construction delays for roads and bridges in the Pemalang district, interviews were conducted with several experts to obtain their risk responses.

Table 6. Risk Responses

Code	Variable	Risk Response
X2.2	Shortage of construction materials	The number of suppliers for a type of material is sought to be more than one.
X2.1	Delay in delivery of goods	Carry out a direct check of the location of the material to be shipped to the project to ensure that the material is in ready condition to be shipped.
X3.1	Delay in delivery/provision of equipment	Ensuring the availability of equipment before work is carried out.
X5.3	Funding difficulties at the contractor	Encouraging providers to use the facilities provided by service users in the form of advance payments and the submission of Monthly Certificates
X1.4	A shortage of labor force or mismatch in the number of workers with the work required	Adjusting the number of laborers to the weight of the work
X6.1	Rainfall intensity	Starting the tender or work at the beginning of the year to anticipate delays caused by high-intensity rainfall at the end of the year
X2.3	Poor quality of materials	Ensuring that the material being procured is by the specifications planned by the consultant by conducting material testing
X2.7	Inaccuracy of ordering time	Ordering materials taking into account the type and schedule of work to be carried out
X1.1	Labor skills	Improving the skills of workers by providing regular education and training and selecting

Code	Variable	Risk Response
		competent and professional labor according to their field
X3.2	Equipment damage	Ensuring that equipment is maintained according to procedure and ensuring the availability of spare parts on the project, especially for elements that are prone to wear

4. CONCLUSION

The reasons for delays in road and bridge construction projects in the Pemalang district are classified into 11 groups that encompass 54 different factors. The major contributing factors leading to delays in road and bridge construction projects in the Pemalang district have a range of mean values between 4.18 to 4.57, there is a shortage of construction materials (4,57), delays in delivery of goods (4,48), delay in delivery/provision of equipment (4,40), contractor funding difficulties (4,37), inadequate number of workers or inability to meet the demands of the work (4,37), rainfall intensity (4,35), poor quality of materials (4,30), inaccuracy of ordering time (4,27), lack of skilled labor (4,23), and equipment damage (4,18). Risk responses for delays in the completion of road and bridge construction projects are as follows: Shortage of construction materials and delay in delivery of goods can be addressed by increasing the number of suppliers for a particular type of material to anticipate when other suppliers may be unable to deliver and by conducting direct checks on the location of materials that will be shipped to the project to ensure that they are ready to be sent. Delays in the delivery/provision of equipment can be addressed by ensuring the availability of equipment before work begins and increasing the number of tools to meet the needs of the work. To prevent delays caused by high levels of rainfall intensity, it is necessary to start tenders or work at the beginning of the year to anticipate delays caused by high levels of rainfall intensity at the end of the year. Adjusting the number of workers to the weight of the work and improving their skills through regular education and training, as well as selecting competent and professional workers according to their field, can address the issue of an inadequate number of workers or inability to meet the demands of the work and lack of skilled labor. Contractor funding difficulties can be addressed by encouraging contractors to use the advance payment and Monthly Certificate submission facilities provided by the client. Poor quality of materials can be addressed by inspecting materials shipped to the work location and rejecting materials that do not meet specifications. To avoid incorrect timing of orders, it is necessary to pay attention to the type and schedule of work to be carried out. To prevent equipment damage, it is necessary to ensure that the equipment is maintained according to procedure and to ensure the availability of spare parts on the project, especially for parts that are prone to wear and tear.

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