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ROAD CONSTRUCTION DELAY RISK IDENTIFICATION BASED ON THE RELATIVE IMPORTANCE INDEX METHOD

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ABSTRACT

The Widening Project to Add Lanes to the Siak IV Pekanbaru Access Road is one of the road construction projects that experienced a delay of 27.791% of the planned schedule. The delay requires risk identification and assessment as an initial form of risk management. This study aims to identify the causal factors of the risk of delays during the construction period by using one of the risk identification methods, namely the Relative Importance Index (RII) method with a Likert Scale, the influence from no effect or 1 to very influential or 5. Out of 63 risk variables delays obtained 11 valid risks by the validity test with the Item-Level Content Validity Index (I-CVI). Therefore, using the RII method, a list of risks from the highest impact to project delay was obtained which was equipment with a value of 1.00 and the last was rain with a value of 0.25. To prove the risk factors, The Critical Path Method (CPM) was then applied, revealing 26 activities categorized as critical paths in 9 main works of the project. In conclusion, the risks were proved which caused the project delay and impacted the critical path in progress of the project.

Keywords : risk; risk management; risk identification; relative importance index; critical path

1. INTRODUCTION

Based on Infrastructure Statistical Information from the Ministry of Public Works and Public Housing of the Republic of Indonesia (2022), the condition of Indonesia's national roads in 2021 is in durable condition with a percentage of 91.81% with a length of 46,965 km. This condition has increased compared to 2020 which reached 91.27%. Meanwhile, regional roads in 2021 will reach 463,607.5 km consisting of 47,874 km of provincial roads and 415,733 km of regency/city roads. In general, the condition of regional road durability in Indonesia is at the percentage of 74.45% stable for provincial roads and 63.64% stable for district/city roads with an increasing number of areas connected by roads in stable condition (meeting the categories of good and moderate conditions), then it has an impact on Indonesia's economic growth. According to data from the Central Agency on Statistics (2023), in 2022 it will grow by 5.31%, which is greater than in 2021 which experienced an increase of 3.70%. The highest growth in Gross Domestic Product (GDP) in terms of the business sector was in transportation and

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warehousing at 19.87% while from the expenditure side, there was in exports at 16.28%. Based on these data, it can be seen that the more roads are in steady condition, the more Indonesia's economic growth will increase.

Risk in the concept of negative risk is an unpleasant or harmful result of an action. This cannot be eliminated or destroyed but can be minimized and the impact and level of occurrence can be reduced. Risks in road construction can be in the form of financial risks, delay risks, and Occupational Health and Safety (OHS) risks. Based on some of these risks, the risk of delay can be a very detrimental matter for both stakeholders and the community because, in addition to causing financial risks, it can also cause OHS risks. If the project is carried out in the long term, it can be detrimental to the finances of the contractor who implements it and so does the project owner, also if the project is at the strategic center of community activities, it can increase the risk of accidents or work-related illnesses. This can be controlled with proper risk management starting with risk identification, risk analysis, and risk mitigation.

Identification of risks of delays in road construction based on the Relative Importance Index (RII) method has been widely applied in identifying risks. For instance, the research conducted by Garg & Rawat, (2021), Tobing et al. (2019), Vishwakarma et al. (2016), Vasishta et al.(2018), and Damanik et al. (2020) has significantly contributed to the field of project management, particularly in the identification of risks within construction projects. While Garg & Rawat's study likely focuses on risks in road projects, Tobing et al. may delve into building construction projects. Vishwakarma et al.'s research is expected to offer insights into road project risks, while Vasishta et al. might provide strategies for risk analysis in such projects. Damanik et al.'s work likely contributes to risk identification across construction projects. Collectively, these studies advance understanding of risk management, providing valuable methodologies and insights applicable to mitigating delays and enhancing project success in the construction industry. This method has been widely applied in various case studies so it would be interesting if this RII was applied to a project that took place in Riau, Indonesia to find out what the risk factors for delays are, from the least influential to the most influential to be used as a reference in handling them.

The Widening Project to Add Lanes to the Siak IV Access Road (Pekanbaru) is located on Paus Street, Kec. Rumbai Pesisir, Pekanbaru, Riau which is a province road. This road construction project is started on May 13th, 2022, and is planned to be completed on November 23rd, 2022 with a contract value of Rp. 18,600,000,001.00 (including 10% Value Added Tax or VAT). Realization in the field until the final date of the work plan only had progress of 72.219%. There was a deviation of 27.791%. According to Sandhyavitri (2022), delay which is greater than 20% classified into a high-risk category, so it is necessary to identify and treat risks.

The relatively simple identification of risks with the RII approach is expected to produce a relatively comprehensive study result for the field of risk management in road construction with delay cases such as the Siak IV (Pekanbaru) Access Road Widening Adding Lane Extension Project. Thus, this research was conducted as an effort to contribute to the field of risk management, especially road construction with the main hope being one of the references in the application of the RII Method to road construction.

2. RESEARCH METHOD

This type of research is qualitative research, where this research aims to collect detailed actual information that describes existing symptoms, identifies problems, or examines prevailing conditions and practices, but the obtained data will be analyzed in a quantitative method. In this study, the identification of the risk of delays in the Siak IV (Pekanbaru) Access Road Lane Extension Widening Project was carried out using qualitative data collection methods in the form of interview results and distribution of questionnaires with supporting data in the form of technical data obtained such as plan schedules and realization schedules. In this study, several methods were used such as the Content Validity Index (CVI) method for risk validation, the Risk Importance Index (RII) method for risk analysis, and the Critical Path Method (CPM) to find the project's critical path.

2.1. CONTENT VALIDITY INDEX (CVI)

A validity test is a test to obtain the validity or validity of the data to check the accuracy of the data collected by the researcher to the actual object. One of the validity test methods is the Content Validity Index (CVI) method. The CVI method requires the role of several experts who have the task of determining which items in a population are relevant to the existing items and calculating the percentage of relevant items from each expert (expert) to take the average percentage of these experts. For example, three experts will give approval scores. Expert 1 on a set of items gives a match value of 90%, expert 2 gives a match value of 100% and expert 3 gives a match value of 90%. The average value is 93%, this value is called the average compliance percentage or called the Average Congruency Percentage (ACP). ACP must be greater than 90% which is a condition of acceptance of an item (Popham, 1978; Waltz et al., 2010). Requirements for acceptable CVI values can be seen in Table 1.

Table 1. Valid CVI Score

Number of Expert	Valid Score	Reference
2	≥ 0,800	L. L. Davis (1992)
3-5	1,000	Polit et al. (2007); Polit & Beck (2006)
≥ 6	≥ 0,830	Polit et al. (2007); Polit & Beck (2006)
6-8	≥ 0,830	Lynn (1986)
≥ 9	≥ 0,780	Lynn (1986)

Lynn (1986) divides CVI into two types. The first type is related to the content validity of each item or is called the Item-Level Content Validity Index (I-CVI) and the second type is related to the global scale content validity or is called the Scale-Level Content Validity Index (S-CVI). The I-CVI was used to measure expert agreement at the item level, while the S-CVI was used to measure expert agreement at the overall questionnaire level. The I-CVI value can be calculated by the following equation.

$$\text{I} - \text{CVI} = \frac{\text{Total Experts Agree}}{\text{Number of Experts}} \tag{1}$$

Lynn (1986) suggests that there are at least three experts and no more than 10 experts are needed. The recommended measurement scale is an ordinal scale with 4 points. This is done to avoid the midpoint or neutral. Some commonly used labels are: 1 = not related, 2 = slightly related, 3 = quite related, 4 = very related. However, I-CVI item scores with a scale of 4 can be simplified into relevant (with a value of 1) and irrelevant (with a value of 0).

2.2. Relative Importance Index (RII)

According to Standards Australia (1999), risk identification is the process of determining what could happen, why, and how. Risk identification is an analytical process to systematically and continuously find out what risks (potential losses) are occurring. Risk identification is the initial stage of risk management to be able to describe and detail the types of risks that may arise from activities that are being carried out or activities that will be carried out.

According to the Project Management Institute (2017), the technique of collecting data for risk identification is used in this research called a checklist and interview. A checklist is a list of items, actions, or points to consider. The risk checklist was developed based on historical information and knowledge that has been gathered from similar projects and other sources of information while the interview was conducted with experienced individuals, stakeholders, and academic experts. Interviews should be conducted in an environment of trust and confidentiality to encourage honest and impartial contributions.

Based on several references from previous construction projects, 14 types of risk categories were obtained with a total of 63 risk factors, with examples in Table 2.

Table 2. Risk Identification

Risk Category	Variable	Risk	Reference
Construction	A1	Equipment	Ankit Vishwakarma et al. (2016), Garg & Rawat, (2021), Damanik et al. (2020), Vishwakarma et al. (2016), Tobing et al. (2019), Mahamid et al. (2013).
	A2	Product quality	Vishwakarma et al. (2016), Mahamid et al. (2013).
Design	B1	Uncertainty in indirect cost	Vishwakarma et al. (2016), Mahamid & Laissy (2019).
	B2	Design errors and omissions	Mahamid & Laissy (2019), Genc (2021), Garg & Rawat, (2021), Vasishta et al.(2018), Faisal & Tenrisukki Tenriajeng (2021).
Topography	C1	Uncertainty in landscape activities	Vishwakarma et al. (2016).
	C2	Project location	Vishwakarma et al. (2016), Mahamid & Laissy (2019), Vasishta et al.(2018), Tobing et al. (2019).
Politics	D1	Issues related to government permit acquisition	Vishwakarma et al. (2016), Mahamid & Laissy (2019), Genc (2021), Vasishta et al.(2018), Tobing et al. (2019).
	D2	Other political or external issues	Vishwakarma et al. (2016), Garg & Rawat, (2021).
Land acquisition	E1	Uncertain land acquisition schedule	Vishwakarma et al. (2016).
	E2	Decision changes	Vishwakarma et al. (2016).
Environment	F1	Natural obstacles: hills, rivers, trees	Vishwakarma et al. (2016), Genc (2021), Mahamid et al. (2013).
	F2	Environmental Impact Assessment (AMDAL) required	Vishwakarma et al. (2016), Vasishta et al.(2018).

Risk Category	Variable	Risk	Reference
Organization	G1	Level of knowledge of the main group	Vishwakarma et al. (2016), Al-Mohammad & Bin Jamaludin (2020).
	G2	Lack of methods and expertise	Vasishta et al.(2018), Tobing et al. (2019) , Faisal & Tenrisukki Tenriajeng (2021).
Unintended	H1	Unanticipated damage during construction	Vishwakarma et al. (2016).
	H2	Utilities not relocated promptly	Vishwakarma et al. (2016).
Utilitas	I1	Bahan bakar	Vishwakarma et al. (2016), Faisal & Tenrisukki Tenriajeng (2021).
	I2	Listrik	Vishwakarma et al. (2016).
Material	J1	Material costs	Vishwakarma et al. (2016), Garg & Rawat, (2021), Vasishta et al.(2018).
	J2	Poor material management	Mahamid & Laissy (2019), Genc (2021), Garg & Rawat, (2021), Damanik et al. (2020), Tobing et al. (2019).
Law and Order	K1	Local disturbances	Vishwakarma et al. (2016), Vasishta et al.(2018), Tobing et al. (2019), Faisal & Tenrisukki Tenriajeng (2021), Mahamid et al. (2013).
	K2	Traffic	Vasishta et al.(2018).
Climate and Weather	L1	Unexpected weather conditions	Vishwakarma et al. (2016), Mahamid & Laissy (2019), Genc (2021), Garg & Rawat, (2021), Vasishta et al.(2018), Tobing et al. (2019).
	L2	Rain	Vishwakarma et al. (2016), Mahamid & Laissy (2019), Genc (2021), Garg & Rawat, (2021).
Contract	M1	Contract Change Order (CCO)	Tobing et al. (2019) , Faisal & Tenrisukki Tenriajeng (2021).
	M2	Errors or discrepancies in the contract	Tobing et al. (2019).
Others	N1	Funds/Money	Vishwakarma et al. (2016), Mahamid & Laissy (2019), Genc (2021), Garg & Rawat, (2021), Vasishta et al.(2018), Tobing et al. (2019), Faisal & Tenrisukki Tenriajeng (2021).
	N2	Emotional issues	Vishwakarma et al. (2016), Mahamid & Laissy (2019), Genc (2021).

The Relative Importance Index (RII) method is a factor analysis method that has the most influence on an object of research. RII is far more efficient compared to other methods such as the Frequency Index, Severity Index, and Importance Index because it only needs one scoring value from the experts which is the score of risk impact. In addition, this analytical method is processed by statistical calculations with input from the results of the questionnaire, which will be converted into influencing factors. RII identifies the most influential factors by using a ranking system based on the weight of the scores given by the respondents after filling out the questionnaire. In previous research, the use of the RII method was used to determine the factors that influenced the research, through calculations according to Equation 2 and Equation 3.

$$RII = \frac{\sum W}{A \, x \, N} \tag{2}$$

With the W is the weight given by the respondent for each cause ranges from 1 (not significant) to 5 (very significant), A is the Highest weight, and N is the total respondents.

The above equation can be broken down as follows:

$$RI = \frac{n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5}{5(n_1 + n_2 + n_3 + n_4 + n_5)} \tag{3}$$

The RII is the Relative Importance Index and n_1, n_2, n_3, n_4, n_5 are the value given by the respondents from the questionnaire with the number "1" represents no effect, "2" represents slightly influential, "3" represents quite influential, "4" represents influential, and "5" represents very influential.

This method only requires one assessment, namely the level of influence of risk from experts, and has its multiplier constant so that it makes it easier to collect and process data. According to Rooshdi et al. (2018), this method can identify almost all existing risk factors and the appropriate method for prioritizing Likert Scale-type assessments. RII has the largest value of 1 (one) and the smallest value of nearly 0 (zero).

Therefore, the risk factors will be integrated into a questionnaire that encompasses both Content Validity Index (CVI) and Relative Importance Index (RII) scoring mechanisms, as illustrated in Figure 1.

Kuesioner Validasi Risiko dan RII pada Proyek Pelebaran Menambah Lajur Jalan Akses Siak IV (Pekanbaru)

Kategori Risiko	Variabel	Risiko	Validasi		Penilaian RII				
			Ya	Tidak	1	2	3	4	5
Konstruksi	A1	Peralatan							
	A2	Kualitas produk yang dihasilkan selama masa konstruksi berlangsung							
	A3	Kondisi pasar konstruksi yang tidak pasti							
	A4	Masalah produktivitas kontraktor							
	A5	Waktu pekerjaan yang tidak efektif							
	A6	Perbedaan antara kondisi perencanaan dengan kondisi lapangan yang berbeda dan tidak sesuai							
	A7	Ketidakpastian dalam penyelarasan horizontal							
	A8	Ketidakpastian dalam persyaratan akses							
	A9	Pekerjaan tambahan							
	A10	Pengulangan pekerjaan							
	A11	Penggantian spesifikasi							
	A12	Kurangnya jumlah tenaga kerja							
	A13	Tenaga kerja kurang kompeten							
	A14	Kurangnya pengalaman							
Desain	B1	Biaya tidak langsung yang tidak pasti							
	B2	Kesalahan dan kelalaian desain							
	B3	Pertimbangan parameter dasar yang tidak tepat							
	B4	Konstruksi di wilayah perbukitan							
Topografi	C1	Ketidakpastian dalam aktivitas lansekap							
	C2	Lokasi proyek							
Politik	D1	Masalah-masalah yang terkait dengan perolehan izin Pemerintah.							

Figure 1. CVI and RII Questionnaire

In this study, samples from the population came from the owners, contractors, and supervisory consultants with the following criteria:

1. Referring to the Stakeholder Theory by Freeman (1984), the respondent is someone who is on the board of directors of the organizational structure of each party, namely the owner, supervisory consultant, and contractor.

2. According to Damanik et al. (2020), an expert must have experience in his field with a minimum of 10 years of experience.

3. An expert must have a background related to his field such as relevant studies or have a suitable degree. In this case, the expert must have a background in engineering, especially civil engineering.

Based on the aforementioned criteria, the selection of experts from the three stakeholders is perspectives delineated in Table 3.

Table 3. Experts to Give Evaluation

Evaluator	Number	Explanation
Owner	2	Met the requirements.
Supervision Consultant	4	Met the requirements.
Contractor	2	Met the requirements.

Based on the table above, it can be seen that the total of experts to give scoring for CVI and RII is 8 people.

2.3. Critical Path Method (CPM)

According to Kirkpatrick & Levin (1982), the path with the longest activities from start to finish is called the critical path. The critical path can be obtained from a method called the Critical Path Method or CPM for short. In 1958, the US-based chemical company Du Pon Company solved difficulties in manufacturing processes using the CPM Method. The CPM method itself is a refinement of the PERT method which was discovered in 1957 by the Navy Special Project Office.

According to Kirkpatrick & Levin (1982), the Critical Path Method (CPM) is the most comprehensive project planning and monitoring method of all other systems that use network performance principles. CPM focuses on the right balance between cost and time to complete large projects. In CPM, the time needed to complete the various stages of the project is known with certainty. In addition, the relationship between the amount of resources used and the time required to complete the project is also considered to be known. Thus, CPM can also be defined as a network analysis that seeks to optimize the total cost of a project by reducing or speeding up the overall time to complete the project in question.

Microsoft Project is a project administration software used to plan, manage, monitor, and report data from a project. The ease of use and flexibility of worksheets as well as the scope of project elements make this software very supportive of project administration processes. Microsoft Project provides elements of good project management by combining ease of use, power, and flexibility to manage projects more efficiently and effectively.

3. RESULTS AND DISCUSSION

Data analysis begins with risk validation then risk identification and RII analysis. In addition, critical work included in the critical path will be obtained from the Microsoft Project application.

3.1.1. Project Risk Factor Validation

Based on the results of the literature study, 63 risk factors were obtained that could cause delays in a project. Validation is carried out by experts who meet the criteria as previously described.

These experts will be given a questionnaire which is then distributed to the stakeholders of the Siak IV (Pekanbaru) Access Road Lane Widening Widening Project which is carried out directly in the field when the project is almost at the end of construction or can be called Provisional Hand Over (PHO). The questionnaire was filled with assistance and directions from researchers with the intention that the respondents were not wrong in giving judgments and considerations.

After the data has been collected, it is sufficient to proceed with data processing, namely testing the research instrument in the form of a validity test. The validity test using the I-CVI method has an example of calculation for variable A1 as follows:

Calculation of variable A1

There are 8 experts with each expert giving a value of 1 or yes and a value of 0 or no on the questionnaire. It turns out that all experts agree (yes) and none of the experts disagree (no). Using Equation 1, the following calculations are obtained:

$$I - CVI = \frac{Total\ Experts\ Agree}{Number\ of\ Experts}$$

$$I\text{-}CVI = \frac{8}{8} = 1{,}000$$

Referring to Table 1, the valid I-CVI value with 8 experts is 0.830 so variable A1 is a valid risk factor. Further results of the analysis can be seen in Table 4.

Table 4. Valid Risk Factors

Variable	Risk	CVI
A1	Equipement	1.000
A5	Ineffective work time	1.000
A6	Differences between planning conditions and field conditions	1.000
B2	Design errors and omissions	1.000
D4	Uncertain land acquisition costs	1.000
E1	Uncertain land acquisition schedule	1.000
G4	Lack of coordination between parties involved	1.000
K1	Local interference	1.000
K2	Traffic	1.000
L2	Rain	1.000
M1	Contract Change Order (CCO)	1.000

The table above shows the risk factors which were met the requirements with the valid I-CVI value of ≥ 0.830 with a total of 11 risk factors whereas these risk factors were approved by experts, and their existence was determined in the project.

3.1.2. Project Risk Factor Analysis

After obtaining 11 valid risk factors, an RII assessment is carried out with the example of calculating the A5 variable as follows:

There are 8 experts with the assessment given, namely:

a. One expert gives a score of 5;

b. One expert gives a score of 4;

c. Four experts gave a score of 3;

d. Two experts give a score of 2.

Then the calculations using the RII method are carried out according to Equation 3.

$$RII = \frac{n_1+2n_2+3n_3+4n_4+5n_5}{5(n_1+n_2+n_3+n_4+n_5)}$$

$$RII = \frac{0+2(2)+3(4)+4(1)+5(1)}{5(0+2+4+1+1)} = 0.625$$

Based on the calculation results above, the RII value for these risk factors is 0.625. The RII has a range of values from 1.000 to nearly 0.000. The highest value (valued at 1.000) means the variable has the most significant effect on the project delay. Meanwhile, the lower value (<1.000) means the variable has a smaller or no impact on the project. The RII Method assessment for all valid or valid risk factors in the Siak IV (Pekanbaru) Access Road Widening Project can be seen in Table 5.

Table 5. RII Score

Variable	Risk	Score	Rank
A1	Equipment	1.000	1
A6	Differences between planning conditions and field conditions	0.975	2
B2	Design errors and omissions	0.975	3
E1	Uncertain land acquisition schedule	0.950	4
D4	Uncertain land acquisition costs	0.900	5
G4	Lack of coordination between parties involved	0.850	6
M1	Contract Change Order (CCO)	0.825	7
A5	Ineffective work time	0.625	8
K1	Local interference	0.350	9
K2	Traffic	0.300	10
L2	Rain	0.250	11

3.1.3. Project Critical Path

A road widening project involves several distinct stages. In Stage I preparatory work, heavy equipment mobilization and the mobilization of workers, and operators are carried out. Following this, Stage II preparatory work focuses on land acquisition and preparation. This includes acquiring land on the left side and right side for various purposes such as electric poles, fences, and tree cutting. Excavation work then commences, followed by backfill work to fill and compact the excavated sections. Foundation work involves the installation of Base B and Base A layers. Prime coat and tack coat applications are applied on the road surface, with specific segments identified for treatment. Asphalt pavement work involves laying Asphalt Concrete Binder Course (AC-BC) and Asphalt Concrete Wearing Course (AC-WC). Finally, finishing touches such as road median construction, road markings, signs, and demobilization activities are completed to finalize the road widening project.

The critical path of the Siak IV (Pekanbaru) Access Road Lane Widening Widening Project (Pekanbaru) was obtained using the help of the Microsoft Project application with reference data, namely the plan schedule (planned S curve) and realization schedule (realized S curve) obtained from the contractor. The critical path contains critical works that have a significant influence on the start of the next work or the entire duration of the project. Jobs that are classified as critical work are:

1. Stage I preparatory work:
    a. Heavy equipement mobilization;
    b. Mobilization of workers and operators.
2. Stage II preparatory work:
    a. Land acquisition between STA 1+805 to STA 2+000 (LS or Left Side);
    b. Land acquisition between STA 1+605 to STA 1+796 (LS);
    c. Land acquisition of electric poles (PLN) STA 2+761 to STA 3+300 (RS or Right Side);
    d. Land acquisition of fences and cutting of trees STA 1+605 to STA 2+375 (RS);
    e. Land acquisition between STA 2+251 to STA 2+500 (RS).
3. Excavation work:
    a. Excavation STA 2+001 to STA 2+250 (RS);
    b. Excavation STA 2+251 to STA 2+500 (RS).
4. Backfill work:
    a. Backfilling of STA 2+001 to STA 2+250 (RS);
    b. Backfilling of STA 2+251 to STA 2+500 (RS).
5. Foundation work:
    a. Base B STA 2+001 to STA 2+250 (RS);
    b. Base B STA 2+251 to STA 2+500 (RS);
    c. Base A STA 2+001 to STA 2+250 (RS);
    d. Base A STA 2+251 to STA 2+500 (RS).
6. Prime coat:
    a. Prime coat STA 2+001 to STA 2+250 (RS);
    b. Prime coat STA 2+251 to STA 2+500 (RS).
7. Tack Coat:

   a. Existing road tack coat STA 3+001 to STA 3+334;
   b. Tack coat STA 2+251 to STA 2+500 (RS).
8. Asphalt pavement work:
   a. AC-BC STA 2+001 to STA 2+250 (RS);
   b. AC-BC STA 2+251 to STA 2+500 (RS);
   c. Existing road AC-WC STA 3+001 to STA 3+334;
   d. AC-WC STA 2+251 to STA 2+500 (RS).
9. Finishing:
   a. Road median;
   b. Road markings;
   c. Road signs;
   d. Demobilization.

3.2. DISCUSSION

Discussion regarding the relationship between the level of risk factor assessment based on the RII Method and the critical work obtained through the CPM Method in Microsoft Project will be discussed below:

3.2.1. Equipment (with an RII value of 1.00)

Equipment shortages led to considerable delays in the Adding Lane IV Access Road Project in Pekanbaru. The deficiency stemmed from the insufficiency of the fleet, which consisted of only 1 vibratory roller unit, 1 motor grader unit, 1 water tank truck unit, 2 excavator units, and 2 dump trucks. However, the scale of the project demanded a more extensive fleet to effectively handle the workload and meet project deadlines. Throughout the construction period, various obstacles arose, including overheating, machine damage, spare parts shortages, and equipment maintenance issues.

3.2.2. Differences between planning conditions and field conditions (with an RII value of 0.975)

The difference between planning conditions and field conditions that are different and not suitable is one of the causes of project delays with the second rank. The plan conditions stated in the design are not the same as the field conditions when the construction took place. For instance, when an excavation is carried out it turns out that the soil layer below is soft soil so it is necessary to do land improvement and also regarding field conditions such as there are electric poles, fiber optic cables, trees, traffic lights, and fences.

3.2.3. Design errors and omissions (with an RII value of 0.975)

Ranked third, alongside the second position with an equal RII value, lies the issue of design errors and omissions. As outlined in the Detailed Engineering Design (DED), the width of the previously constructed or existing road was presumed to be consistent. However, discrepancies in road width were identified from the initial to the final STA points, necessitating additional surveying time and consequently impacting project timelines. Furthermore, the existing road only possesses Asphalt Concrete-Binder Courses (AC-BC) with a thickness differing from the planned AC-BC, requiring additional time to accurately determine the correct thickness for the overlay layer.

3.2.4. Uncertain land acquisition schedule (with an RII value of 0.950)

The uncertain land grant schedule occupies the fourth position with an RII value of 0.950. The new road that was built occupies community land or the area of several institutions such as education and police dormitories. An uncertain schedule due to slow negotiations by the contractor causes this to cause project delays.

3.2.5. UNCERTAIN LAND ACQUISITION COSTS (WITH AN RII VALUE OF 0.900)

Land acquisition costs are in fifth place with an RII value of 0.900. This is one of the causes of project delays because if the land has not been acquired then it is not legal to construct buildings on it. The cause of this is in the form of the parties involved asking for a high price so that negotiations need to be carried out which is quite time-consuming.

A comprehensive overview of the intricate interplay between critical works and associated risk factors can be seen in Table 6.

Table 6. Relationship between Risk Factors and Critical Work

No.	Risk Factor	Critical Work	Explanation	
			Risk Factor	Critical Work
1.	A1	1,2,3,4,5,6,7,8,9	Equipment	Stage I preparatory work; Stage II preparatory work; Excavation work; Backfill work; Foundation work; Prime Coat; Tack Coat; Asphalt pavement work; Finishing.
2.	A6	2,3,4,8	Differences between planning conditions and field conditions	Stage II preparatory work; Excavation work; Backfill work; Asphalt pavement work.
3.	B2	2,3,4,8	Design errors and omissions	Stage II preparatory work; Excavation work; Backfill work; Asphalt pavement work.
4.	E1	2,3,4	Uncertain land acquisition schedule	Stage II preparatory work; Excavation work; Backfill work;
5.	D4	2,3,4	Uncertain land acquisition costs	Stage II preparatory work; Excavation work; Backfill work;

Based on the table above, it can be concluded that risk factor A1, namely equipment, is the most significant cause of the number one risk of project delays affecting 9 critical works.

4. CONCLUSION

The conclusions that can be drawn from research with a review of the Widening Project to Add Lanes to the Siak IV Access Road (Pekanbaru) at the construction stage are the risk factors obtained from the literature study are 63 risk factors with 11 valid factors according to the decision of the experts with the top RII rating and its value obtained is equipment (with an RII value of 1.00); then, differences between planning conditions and field conditions (with an RII value of 0.975); thirdly, design errors and omissions (with an RII value of 0.975); next is uncertain land acquisition schedule (with an RII value of 0.950); lastly, uncertain land acquisition costs (with an RII value of 0.900). The risk factors affected the works that are critical obtained by using Microsoft Project from the start to the end with critical path starting from stage I preparatory work; stage II preparatory work; excavation work; backfill work; foundation work; prime coat; tack coat; asphalt pavement work; and finishing work.

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