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DETERMINANT FACTORS OF PERCEIVED RISK-BASED MAINTENANCE MANAGEMENT (PRBMM) FOR PUBLIC SCHOOLS

Nurul Diyana Mohd Dahari[1], Irwan Mohammad Ali*[2], Natasha Khalil[3], & Suriani Ngah Abdul Wahab[4]
***Corresponding Author**
[1]Jabatan Kerja Raya Negeri Selangor,
[2,3,4]College of Built Environment, Universiti Teknologi MARA, Perak Branch, 32610 Seri Iskandar Campus, Perak, Malaysia.

2022748383@student.uitm.edu.my, irwan9471@uitm.edu.my, natas582@uitm.edu.my, & suria275@uitm.edu.my
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ABSTRACT

Maintenance is one of the key factors that keeps buildings safe and functional. However, there has been extensive research recently about the poor condition of public school facilities and the struggle to keep up with the demands of maintaining their timeworn school infrastructure. Perceived risk affects maintenance work decisions. This encompasses the perspectives of various stakeholders, such as the building's owner, facility managers, maintenance staff, and occupants, regarding the potential and impact of adverse occurrences resulting from maintenance practices. The problem addressed in this research is the absence of a comprehensive Perceive Risk-Based Maintenance Management (PRBMM) model for public schools. This research aims to identify the determinants of perceived risk in risk-based maintenance management. Numerous constructs from previous studies were used to create questionnaires. There were a total of 137 web-based self-administrative questionnaires that were distributed to technical experts who were in charge of the building maintenance of the public schools. The 137 sets were answered and completed. The data is then analysed using SPSS Statistics, Version 29. The findings suggest that the conceptual framework for this research consists of four determinant factors as independent variables, such as performance risk, financial risk, *safety risk, and operational risk. Meanwhile, the responses perceive risk in risk-based maintenance management as a dependent variable.*

Keywords: *Conceptual framework, Determinant factor, Perceived risk, Public school, Risk-based maintenance*

INTRODUCTION

Building elements degrade at different rates due to materials, construction methods, age, and environmental conditions (Adejimi, 2015). Insufficient maintenance can accelerate the deterioration of a building, potentially compromising the safety and well-being of its occupants. In government-funded public schools, effective maintenance is crucial for managing the lifespan of buildings and ensuring their continued functionality (Abdullah & Bakri, 2021; Herath & Mittal, 2022). Maintenance practices are essential for preserving the structural integrity, physical condition, and investment value of these facilities (Bentley, 2012; Gerrard & Barron, 2020). Specific areas of concern include roofing, asbestos, disability accessibility, safety, fire code compliance, and outdated mechanical and electrical systems, all of which require immediate and ongoing attention (Chanter & Swallow, 2017).

In Malaysia, there is an urgent need for government intervention to address the challenges associated with maintaining aging school infrastructure (Mansor et al., 2020; Martorell, Stange, & McFarlin, 2016; Othman Mydin, Agus Salim, Tan, Tawil, & Ulang, 2014; Yong & Zailan Sulieman, 2015). The key issue addressed by this research is the lack of a comprehensive Perceived Risk-Based Maintenance Management (PRBMM) model specifically designed for public schools. Without a well-defined PRBMM framework, managing the maintenance of aging school infrastructure becomes challenging, leading to inadequate responses to various risks. This research aims to identify and analyse the determinants of perceived risk in risk-based maintenance management for public schools. By uncovering these key factors, the study seeks to contribute to the development of a robust PRBMM model that effectively addresses and mitigates risks associated with maintaining public school facilities.

Perceived Risk in Risk-Based Maintenance Management (PRBMM)

The concept of perceived risk in risk-based maintenance management (PRBMM) has evolved significantly since (Bauer, 1960) initial definition, reflecting a deeper understanding of its behavioural implications (Aven, 2016; Ayyub & Popescu, 2003; Mitchell, 1992; Tsurkan-Saifulina, 2022; Veisten, Flügel, Rizzi, Ortúzar, & Elvik, 2013). The complex nature of perceived risks encompassing operational, safety, performance, time, psychological, financial, and social dimensions illustrate their profound impact on building efficiency and performance (Kinateder, Kuligowski, Reneke, & Peacock, 2015). These diverse risks underscore the complexity of decision-making, resource allocation, and task prioritization in PRBMM.

The existing literature highlights that safety, performance, financial, and operational risks are particularly pertinent in the context of public school maintenance (Al-Ansary, El-Sharkawy, & Alsulaiman, 2023; Cvetković, Nikolić, & Lukić, 2024; Mestry & Bodalina, 2015; Moghayedi, Michell, Le Jeune, & Massyn, 2024; Pförtner & Hower, 2022; Sarosa, 2022; Tsang, 2002; Vasvári, 2015; Zaki, Tayel, Reda, Mahmoud, & Labib, 2018). However, while these studies provide valuable insights, there is a need for a more integrated approach that combines these risk dimensions into a cohesive PRBMM model tailored to public schools. This study's focus on assessing maintenance hazards from the perspectives of various stakeholders building owners, facility managers, maintenance staff, and occupants provides a comprehensive view of perceived risks. By incorporating these perspectives, the research aims to bridge gaps in the existing literature and develop a more robust and practical PRBMM framework. This approach will enhance understanding and management of perceived risks, ultimately leading to improved maintenance practices and outcomes for public schools.

Financial risk (FR)

Financial risk plays a critical role in building maintenance, as it directly impacts the stability and effectiveness of maintenance operations. The factors influencing financial risk, including hidden costs, operating expenses, and warranty considerations, underscore the complexity of budgeting and resource management in maintenance activities (Ahmed, 2020; Akomea-Frimpong, Jin, & Osei-Kyei, 2022; Bafandegan Emroozi, Kazemi, Doostparast, & Pooya, 2024; Hani Mahmoud & Othman, 2021; Hassanain, Al-Zahrani, Abdallah, & Sayed, 2019; Kushwaha & Shankar, 2013; Sweeney, Soutar, & Johnson, 1999).

While existing research highlights the importance of financial risk factors, there is a need for a more significant understanding of how these risks interact and influence maintenance decision-making over the long term. The perception of financial risk particularly in relation to budget sufficiency, funding stability, and resource availability requires ongoing evaluation to ensure sustainability and cost-effectiveness in maintenance practices.

Future research should focus on developing strategies to better predict and mitigate financial risks, incorporating more detailed analyses of hidden costs and warranty impacts. This approach will contribute to more effective financial planning and resource allocation, ultimately enhancing the overall stability and performance of maintenance operations in public schools.

Performance Risk (PR)

Performance risk is a significant factor in maintenance management, as it encompasses the potential for service failures and associated cost implications, which can lead to budget overruns and additional expenses (Kushwaha & Shankar, 2013; Sweeney et al., 1999). The perception of performance risk is influenced by factors such as technical and building system complexity, equipment difficulty, and the need for specialized knowledge (Li & Li, 2023; Okudan, Budayan, & Dikmen, 2021). Moreover, in educational settings, elements such as comfort, lighting, and sound quality further affect risk perception (Heschong, Wright, & Okura, 2002).

While existing studies emphasize the importance of addressing performance risk to ensure effective maintenance and enhance learning environments (Al Yahya, 2014; Bressane et al., 2024; Hauashdh, Nagapan, Jailani, & Gamil, 2024; Sayfulloevna, 2023; Scheerens, 2015), there is a need for more comprehensive research on how these risks interact with maintenance strategies and their direct impact on student achievement (Kezar, Kitchen, Estes, Hallett, & Perez, 2023). Future research should aim to explore the specific mechanisms through which performance risk influences maintenance outcomes and educational quality. By developing targeted strategies to mitigate performance risk, stakeholders can improve maintenance practices and create more supportive and effective learning environments.

Safety Risk (SR)

Safety risk is a critical aspect of school maintenance, encompassing a wide range of potential dangers that can significantly impact the well-being of students and staff. The identification of safety risks, including physical hazards, structural integrity issues, health and sanitation concerns, and emergency preparedness, is essential for preventing accidents, injuries, and fatalities (Al-Worafi, 2024; Chandrappa & Das, 2024; Duhung, Ibrahim, & Puyu, 2024; Janius et al., 2024; Tong et al., 2024). Factors such as hazardous substances, faulty electrical wiring, uneven flooring, structural deficiencies, inadequate sanitation, and insufficient emergency preparedness must be meticulously addressed to ensure a safe learning environment (Mubita, 2018; Mubita, Milupi, Monde, Machila, & Sikayomya, 2024; Wisdom Erae, 2021).

Despite the comprehensive coverage of safety risks in the literature, there remains a need for more detailed and systematic approaches to risk assessment and management in school maintenance. Future research should focus on developing integrated safety management frameworks that address the multifaceted nature of safety risks and incorporate best practices for risk mitigation. Enhancing safety protocols and response strategies will contribute to a safer and healthier school environment, ultimately supporting the overall well-being and educational outcomes of students.

Operational Risk (OR)

Operational risk is a crucial factor in maintaining school facilities, encompassing a variety of hazards that can disrupt normal operations, such as equipment failures and building issues. These risks can lead to equipment damage, decreased operational efficiency, and periods of inactivity, which in turn affect overall productivity and may result in additional costs (Alavi, Abd. Wahab, Muhamad, & Arbab Shirani, 2014; Najeeb, 2024; Tezel, Koskela, & Tzortzopoulos, 2016; Zehra et al., 2024). This study's focus on how maintenance issues can impact daily school operations highlights the importance of understanding and mitigating operational risks (Cornwell, Bilson, Gepp, Stern, & Vanstone, 2023; Katzis et al., 2023; Nwile & Amie-Ogan, 2024; Savolainen, 2023).

Factors such as work duration, availability of alternative facilities, and the impact on daily life are critical in evaluating operational risks (Atkin & Brooks, 2021; Gunduz, Naji, & Maki, 2023). Additionally, perceived operational risks can influence staff productivity, morale, public stress, and the overall health and educational experience of students (Mitchell, 1992). Despite the valuable insights provided by existing research, there is a need for more comprehensive strategies to address operational risks effectively. Future research should aim to develop robust frameworks for managing scheduling conflicts, logistics, and facility utilization issues, to minimize time and financial waste and ensure smoother operations within school environments.

Table 1 outlines the factors and variables related to Perceived Risk-Based Maintenance Management (PRBMM) for public schools. It categorizes risks into four types: Performance Risk (PR), Financial Risk (FR), Safety Risk (SR), and Operational Risk (OR), with specific variables listed under each type. It also includes a section on Responses (RES), which focuses on decision-making and budget management. This table helps to understand and evaluate the different aspects of risk and their impact on school maintenance.

Table 1. The Variables and Abbreviations

Factor	Variables	Abbreviations
Performance risk (PR)	Learning environment	PR1
	Facility functionality	PR2
	Equipment and infrastructure	PR3
	Maintenance response time	PR4
	Impact on educational outcomes	PR5
Financial risk (FR)	Budget adequacy	FR1
	Funding stability	FR2
	Cost efficiency	FR3
	Resource availability	FR4
	Impact on long-term availability	FR5
Safety risk (SR)	Physical hazards	SR1
	Structural integrity	SR2
	Health and sanitation	SR3
	Emergency preparedness	SR4
	Security and safety measures	SR5
Operational risk (OR)	Disruption to daily operations	OR1
	Staff productivity and morale	OR2
	Student experience	OR3
	Operational efficiency	OR4
	Stakeholder satisfaction	OR5
Responses (RES)	Effective decision-making	RES1
	Effective budget allocation	RES2
	Effective prioritisation of maintenance activities	RES3

Source: Author

METHODOLOGY

The objective of this study is to identify the determinant factors of perceived risk in risk-based maintenance management. The study was conducted in Petaling, Selangor, Malaysia, involving a total of 147 government primary schools. To determine the appropriate sample size for the study, the Raosoft sampling size calculator was used. This tool helps ascertain the minimum sample size needed to ensure that the results are statistically valid and representative of the population. For a population of 147 government primary schools, the calculator indicated that a sample size of 107 was required to achieve reliable and valid results.

Primary data were collected through a web-based, self-administered questionnaire survey and analyzed using SPSS Statistics, Version 29. Factor analysis was employed to identify and understand the underlying structures and dimensions of perceived risk variables. This method helps reduce the number of variables into a smaller set of factors, simplifying complex data and revealing patterns that may not be immediately apparent. By identifying core risk dimensions, factor analysis facilitates a clearer understanding of the key determinants impacting risk-based maintenance management.

Factor Analysis

- Reliability Test: The reliability of the data was assessed using Cronbach's alpha to ensure internal consistency of the variables. A Cronbach's alpha value of 0.70 or higher was considered acceptable for the scale's reliability.
- Validity Test: Construct validity was evaluated through exploratory factor analysis (EFA). This included assessing the adequacy of the data for factor analysis using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. A KMO value of 0.60 or higher was deemed adequate for factor analysis.
- Preliminary Analysis: Prior to conducting factor analysis, the data were checked for missing values, outliers, and normality. Descriptive statistics were used to summarize the data and identify any issues that could impact the factor analysis.
- Factor Extraction: Principal Component Analysis (PCA) was used for factor extraction to identify the underlying structure of the data. The

extraction criterion was based on eigenvalues greater than 1, which indicates the factors that explain a significant amount of variance.

•Factor Rotation: To enhance interpretability, factor rotation was applied using Varimax rotation. This orthogonal rotation method helps to simplify the factor structure by maximizing the variance of factor loadings, making it easier to interpret the results.

RESULTS AND FINDING

Respondent's Profile

A total of 137 web-based questionnaires were completed with a 100% response rate from public school building maintenance experts. Table 2 provides a detailed demographic profile of the respondents.

Table 2. Demographic Profiles of the Respondents

	Profiles	Frequency	Percent	Valid Percent	Cumulative Percent
Age	21 - 30	9	6.6	6.6	6.6
	31 - 40	58	42.3	42.3	48.9
	41 - 50	55	40.1	40.1	89.1
	51 - 60	15	10.9	10.9	100.0
	Total	137	100.0	100.0	
Gender	Male	75	54.7	54.7	54.7
	Female	62	45.3	45.3	100.0
	Total	137	100.0	100.0	
Qualification	Certificate	5	3.6	3.6	3.6
	Diploma	43	31.4	31.4	35.0
	Bachelor	61	44.5	44.5	79.6
	Master	26	19.0	19.0	98.5
	PhD	1	0.7	0.7	99.3
	Others	1	0.7	0.7	100.0
	Total	137	100.0	100.0	
Experiences	None	10	7.3	7.3	7.3
	0 – 1	8	5.8	5.8	13.1
	2 – 4	32	23.4	23.4	36.5
	5 – 7	15	10.9	10.9	47.4
	8 - 10	10	7.3	7.3	54.7
	More than 10	62	45.3	45.3	100.0
	Total	137	100.0	100.0	
Position	Facilities Manager	2	1.5	1.5	1.5
	Assistant Facilities Manager	1	0.7	0.7	2.2
	Building Surveyor	14	10.2	10.2	12.4
	Quantity Surveyor	11	8.0	8.0	20.4
	Engineer (civil, electrical, Mechanical)	39	28.5	28.5	48.9
	Architect/Landscape Architect	1	0.7	0.7	49.6
	Assistant Engineer/Architect	52	38.0	38.0	87.6
	Assistant Quantity Surveyor	3	2.2	2.2	89.8
	Administrative and Diplomatic Officer	3	2.2	2.2	92.0
	Assistant Diplomatic Officer	4	2.9	2.9	94.9
	School Administrative	4	2.9	2.9	97.8
	Others	3	2.2	2.2	100.0
	Total	137	100.0	100.0	

Source: Author

The majority of respondents were aged 31–40 years (42.3%), followed by 41–50 years (40.1%), 21–30 years (6.6%), and 51–60 years (10.9%). The gender distribution was 54.7% male and 45.3% female. Educational qualifications included Bachelor's degrees (44.5%), Diplomas (31.4%), Master's degrees (19.0%), Certificates (3.6%), and PhDs (0.7%). In terms of work experience, 45.3% had more than 10 years, 23.4% had 2–4 years, and 10.9% had 5–7 years. The most common job roles were Assistant Engineer/Architect (38.0%), Engineer (28.5%), Building Surveyor (10.2%), and Quantity Surveyor (8.0%). This profile highlights the diverse qualifications, experience levels, and professional roles of the participants.

Reliability Test

A Cronbach's alpha reliability test was conducted to evaluate the consistency of the questionnaire responses (Cavana, Delahaye, & Sekeran, 2001; Comrey & Lee, 2013). Cronbach's alpha measures the reliability of items within a questionnaire, with values closer to 1.0 indicating higher reliability. Generally, a Cronbach's alpha score below 0.6 suggests weak reliability, a score around 0.7 is acceptable, and a score above 0.8 is considered good. The results, presented in Table 3, show that all variables had strong reliability: performance risk (PR) at 0.843, operational risk (OR) at 0.821, safety risk (SR) at 0.866, financial risk (FR) at 0.842, and response (RES) at 0.898. All values are above the 0.8 threshold, confirming the strong reliability of the questionnaire items.

Table 3. Cronbach's Alpha Value of Variables

	Variables	Number of items	Cronbach's Alpha
IV	Performance Risk (PR)	5	.843
IV	Operational Risk (OR)	5	.821
IV	Safety Risk (SR)	5	.866
IV	Financial Risk (FR)	5	.842
DV	Response (RES)	3	.898

Source: Author

Validity Test

Validity tests are essential for ensuring that questionnaire questions accurately measure the intended conceptual framework (Comrey & Lee, 2013). The suitability of factor analysis depends on both sample size and the strength of item correlations (Cavana et al., 2001). In this study, factor analysis was conducted with five primary factors and 23 variables. To avoid computational issues, (Comrey & Lee, 2013) recommend a minimum number of observations per variable: very poor (50), poor (100), fair (200), good (300), very good (500), and excellent (1,000+). Nathan (2009) suggests repeating the factor analysis process until the Kaiser-Meyer-Olkin (KMO) measure exceeds 0.60, discarding variables with communalities below 0.60, and ensuring the mean value is above 0.07. The Kaiser strategy and Scree plot were used to eliminate factors with fewer than three variables, applying a loading size cut-off of 0.60. Principal component analysis identified four factors with 20 independent variables and one factor with three dependent variables. With 137 samples and five factors, the dataset is sufficient for comprehensive factor analysis, ensuring the validity of the questionnaire.

Preliminary Analysis

During the preliminary analysis, two key statistical tests were conducted: Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy. For factor analysis to be valid, the KMO value should exceed 0.60, and Bartlett's Test should be statistically significant ($p < 0.05$) (Pallant, 2020). As shown in Table 4, which presents the results for the independent and dependent variables, the KMO value was 0.631, surpassing the 0.60 threshold established by (Kaiser, 1974). Additionally, Bartlett's Test of Sphericity was statistically significant ($p < 0.00$), indicating that the data are appropriate for factor analysis (Bartlett, 1954; Meyers, Gamst, & Guarino, 2013).

Table 4. KMO and Bartlett's Test for Independent Variables

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.806
Bartlett's Test of Sphericity	Approx. Chi-Square	1692.520
	df	253
	Sig.	<.001

Source: Author

The subsequent analysis evaluated the correlation matrix for anti-images, retaining only items with diagonal elements greater than 0.50 (Hair, Black, Babin, & Anderson, 2013). As detailed in Table 5, which shows the Anti-image summary for independent variables, all items met this criterion. The diagonal values were as follows: Learning environment (0.909), Facility functionality (0.750), Equipment and infrastructure (0.751), Maintenance response time (0.806), Educational outcomes (0.872), Budget adequacy (0.804), Funding stability (0.784), Cost efficiency (0.763), Resource availability (0.803), Long-term availability (0.691), Physical hazards (0.693), Structural integrity (0.565), Health and sanitation (0.652), Emergency preparedness (0.652), and Security and safety. These values confirm the suitability of all items for factor analysis.

Table 5. Anti-image Summary for Independent Variables

Anti-image Matrices		
Anti-image Correlation		
PR1	Learning environment	.909[a]
PR2	Facility functionality	.750[a]
PR3	Equipment and infrastructure	.751[a]
PR4	Maintenance response time	.806[a]
PR5	Impact on educational outcomes	.872[a]
FR1	Budget adequacy	.804[a]
FR2	Funding stability	.784[a]
FR3	Cost efficiency	.763[a]
FR4	Resource availability	.803[a]
FR5	Impact on long-term availability	.691[a]
SR1	Physical hazards	.693[a]
SR2	Structural integrity	.565[a]
SR3	Health and sanitation	.652[a]
SR4	Emergency preparedness	.652[a]
SR5	Security and safety measures	.905[a]
OR1	Disruption to daily operations	.845[a]
OR2	Staff productivity and morale	.843[a]
OR3	Student experience	.821[a]
OR4	Operational efficiency	.878[a]
OR5	Stakeholder satisfaction	.922[a]
RES1	Effective decision-making	.894[a]
RES2	Effective budget allocation	.827[a]
RES3	Effective prioritisation of maintenance activities	.827[a]

a. Measures of sampling adequacy (MSA)
Source: Author

Factor Extraction

Following the preliminary analysis, factor extraction was performed, focusing on communalities. A communality value of 1.000 in the "Initial" column indicates that factors explain all variance (Bartlett, 1976). Variables with "extraction" values above 0.50 were retained due to their sufficient representation of variance. As shown in Table 6, the extraction values for key variables included: Educational outcomes (0.778), Budget adequacy (0.921), Funding stability (0.539), Cost efficiency (0.585), Resource availability (0.761), Long-term availability (0.737), Physical hazards (0.600), Structural integrity (0.941), Health and sanitation (0.888), and

Emergency preparedness (0.735). These values confirm that all variables are suitable for factor analysis.

Table 6. Communalities for the Variables

Variables		Initial	Extraction
PR1	Learning environment	1.000	.525
PR2	Facility functionality	1.000	.587
PR3	Equipment and infrastructure	1.000	.780
PR4	Maintenance response time	1.000	.641
PR5	Impact on educational outcomes	1.000	.778
FR1	Budget adequacy	1.000	.921
FR2	Funding stability	1.000	.539
FR3	Cost efficiency	1.000	.585
FR4	Resource availability	1.000	.761
FR5	Impact on long-term availability	1.000	.737
SR1	Physical hazards	1.000	.600
SR2	Structural integrity	1.000	.941
SR3	Health and sanitation	1.000	.888
SR4	Emergency preparedness	1.000	.735
SR5	Security and safety measures	1.000	.563
OR1	Disruption to daily operations	1.000	.831
OR2	Staff productivity and morale	1.000	.628
OR3	Student experience	1.000	.725
OR4	Operational efficiency	1.000	.632
OR5	Stakeholder satisfaction	1.000	.729
RES1	Effective decision-making	1.000	.727
RES2	Effective budget allocation	1.000	.819
RES3	Effective prioritisation of maintenance activities	1.000	.842

Extraction Method: Principal Component Analysis.

Source: Author

Factor Rotation

In factor extraction, significance is determined by loadings of 0.40 or higher (Bartlett, 1976; Hair et al., 2013). Loadings below this threshold were excluded from further analysis. As shown in Table 7, the analysis revealed that the first six components together account for approximately 70% of the total variance. Notably, the fifth component alone explains about 65.3% of the variance. Researchers typically retain the first five components, as they collectively exceed the common threshold of 60% for retaining substantial and relevant information, thus simplifying the analysis while preserving critical data (Hair et al., 2013).

Principal Component Analysis (PCA) with Varimax rotation, as detailed in Table 8, identified five significant components that account for the majority of the dataset's variance, grouping 23 items into these determinant factors. Component 1 encompasses variables related to the learning environment, facility functionality, equipment and infrastructure, maintenance response time, and educational outcomes, explaining 30.735% of the variance with an eigenvalue of 1.915.

Table 7. Total Variance Explained for Variables

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.915	30.735	30.735	1.915	30.735	30.735	.706	11.329	11.329
2	.822	13.196	43.931	.822	13.196	43.931	.851	13.659	24.988
3	.549	8.817	52.748	.549	8.817	52.748	.830	13.315	38.303
4	.413	6.635	59.383	.413	6.635	59.383	.579	9.291	47.594
5	.368	5.910	65.293	.368	5.910	65.293	.891	14.297	61.891
6	.293	4.709	70.001	.293	4.709	70.001	.430	6.901	68.792
7	.281	4.506	74.507	.281	4.506	74.507	.356	5.715	74.507
8	.252	4.048	78.555						
9	.217	3.488	82.043						

Extraction Method: Principal Component Analysis.
a. When analysing a covariance matrix, the initial eigenvalues are the same across the raw and rescaled solutions.

Source: Author

Component 2 includes budget adequacy, funding stability, cost efficiency, resource availability, and long-term availability, accounting for 13.196% of the variance with an eigenvalue of 0.822. Component 3 focuses on safety and risk variables, such as physical hazards, health, and sanitation, explaining 8.817% of the variance with an eigenvalue of 0.549. Component 4, associated with resource effectiveness variables like decision-making, budget allocation, and maintenance prioritization, explains 6.635% of the variance with an eigenvalue of 0.413. These components collectively highlight critical aspects of physical, financial, safety, operational, and resource management, providing a comprehensive understanding of the key determinants in risk-based maintenance management.

Table 8.Rotated Component Matrix for Independent Variables

		Component				
		1	2	3	4	5
PR1	Learning environment	.733				
PR2	Facility functionality	.725				
PR3	Equipment and infrastructure	.855				
PR4	Maintenance response time	.733				
PR5	Impact on educational outcomes	.859				
FR1	Budget adequacy		.520			
FR2	Funding stability		.672			
FR3	Cost efficiency		.651			
FR4	Resource availability		.656			
FR5	Impact on long-term availability		.709			
SR1	Physical hazards			.731		
SR2	Structural integrity			.491		
SR3	Health and sanitation			.559		
SR4	Emergency preparedness			.733		
SR5	Security and safety measures			.629		
OR1	Disruption to daily operations				.647	
OR2	Staff productivity and morale				.788	
OR3	Student experience				.900	
OR4	Operational efficiency				.855	
OR5	Stakeholder satisfaction				.729	

RES1	Effective decision-making					.909
RES2	Effective budget allocation					.911
RES3	Effective prioritisation of maintenance activities					.919

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalisation.
a. Rotation converged in 6 iterations.

Source: Author

CONCLUSION

In conclusion, the study identifies four critical factors determining perceived risk in risk-based maintenance management for public schools: Performance Risk (PR), Financial Risk (FR), Safety Risk (SR), and Operational Risk (OR). These factors are critical in understanding how perceived risks influence maintenance management responsiveness and effectiveness. The analysis confirms that each risk category significantly impacts maintenance practices. This insight underscores the need for a well-rounded approach to risk management in public school maintenance, integrating strategies to address performance, financial, safety, and operational risks comprehensively. By acknowledging and addressing these risks, school maintenance programs can enhance their effectiveness, ensuring better resource allocation, improved safety, and optimal operational performance. This study's findings advocate for a structured risk-based maintenance model that not only anticipates and mitigates risks but also improves overall management practices, thereby contributing to the sustainable and safe upkeep of public school facilities.

For future research in risk-based maintenance management within public schools, it is essential to address key factors influencing maintenance effectiveness and operational stability. To advance understanding in this field, the following hypotheses are proposed:

- Hypothesis 1: Performance risk (PR) positively influences the effectiveness of risk-based maintenance management in public schools. This hypothesis suggests that as performance risk increases, the effectiveness of maintenance practices may decrease, highlighting the need for timely and strategic interventions.
- Hypothesis 2: Financial risk (FR) significantly impacts the sustainability of risk-based maintenance management practices. This hypothesis suggests those higher levels of financial risk correlate with difficulties in maintaining budget adequacy and resource availability, potentially

undermining long-term maintenance efforts.

- Hypothesis 3: Safety risk (SR) affects the overall safety and operational reliability of public school facilities. According to this hypothesis, increased safety risks are associated with a higher incidence of safety-related issues and reduced effectiveness of implemented safety measures.
- Hypothesis 4: Operational risk (OR) influences the operational efficiency and effectiveness of maintenance management. This hypothesis suggests that greater operational risks lead to disruptions in daily school operations and decreased staff productivity, affecting overall maintenance effectiveness.

These hypotheses aim to guide future research by providing a structured approach to understanding how various perceived risks impact maintenance management in public schools. They focus on critical aspects of performance, financial stability, safety, and operational efficiency, offering a foundation for further investigation and improvement in maintenance practices.

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AUTHOR CONTRIBUTIONS

All authors discussed the presented idea, developed the theory, performed computations, verified the analytical methods and supervised the findings of this research, provided critical feedback, helped shape the research, and contributed to the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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