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Application of Binomial Theory in Determining the Relationship Between Importance and Impact of Risks in Hospital Projects

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ABSTRACT (10 PT)

This research deals with the topic of risk management through the application of binomial theory and risk matrix to analyze the relationship between the importance of risks and their impact on hospital construction projects, with the aim of developing an effective mechanism to prioritize dealing with risks and ensuring the success of the project. To achieve this goal, a questionnaire based on the five-point Likert scale was prepared, and the stability coefficient (Cronbach's alpha) was 0.891, confirming the reliability of the tool. The questionnaire was distributed to engineers and specialists in the implementation of hospital projects, and the data were analyzed using accurate statistical tools. The results showed that cybersecurity risks came in first place with a score of 18.11, followed by financing risks, power outages, and unexpected costs. The data also showed that most of the risks fall into the high-risk category, which requires continuous monitoring and immediate interventions. The study concluded that the Risk Matrix is a practical and flexible tool for managing complex risks in health projects. The study recommends that information security should be given top priority from the early stages of the project, to protect digital infrastructure and ensure business continuity.

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1. INTRODUCTION

Risk management is a vital factor that directly affects the success of construction projects, especially in healthcare projects such as hospital construction, which require high precision and strict quality assurance due to their direct impact on people's lives [1] [2]. These projects are characterized by significant complexity and resource requirements, in addition to being exposed to various risks that may lead to implementation delays, increased costs, or even the project's complete failure [3] [4]. Therefore, developing effective mechanisms for identifying and assessing risks, and linking them to their likelihood and impact, is essential to achieving project objectives[5] [6].

The binomial theory is a powerful analytical tool in this context, linking the probability of a risk occurrence to the severity of its impact, helping to prioritize and categorize risks more accurately [7] [8]. A risk matrix based on this theory allows project managers to focus on high-priority risks, improving decision-making [9] [10]. Establishing hospitals poses a particular risk management challenge due to the importance of the healthcare services provided, their reliance on advanced technologies, and strict adherence to health standards and regulations [11] [12].

Recent studies indicate the importance of having integrated risk management frameworks that combine cybersecurity, operational, financial, and supply chain risks to enhance the resilience of healthcare projects [13]–[15]. Enterprise risk management approaches also contribute to mitigating the complexities of risks in hospital construction projects [16] [17]. From this standpoint, this research aims to apply the binomial theory within an integrated model based on the risk matrix to analyze and prioritize risks in hospital construction projects, while providing practical recommendations to enhance risk management.

1.1. Problem Statement

Hospital construction projects face many risks that directly affect their quality, cost, and adherence to the set schedule. The complexity of these projects, the overlap of technical systems, as well as the extreme necessity of maintaining the safety of patients and staff, make risk management extremely complex and sensitive. Although many risk assessment tools and techniques are available, linking the level of importance to the actual impact of risk remains a major challenge. Inaccurate identification and prioritization of these risks can lead to misallocation of resources and delay in responding to the most threatening risks. Therefore, there is a need to apply a clear and effective scientific model, such as the binomial theory, to determine the relationship between the importance and impact of risk in hospital projects, and to ensure that strategic decisions are made based on accurate data.?.

1.2. Research Objectives

This research objectives to:

1. Applying the binomial theory to find an accurate quantitative relationship between the important of a risk occurring and the severity of its impact, in order to classify risks and determine priorities for dealing with them in hospital construction projects.
2. Identify and classify the most important and influential risks within the hospital project environment, with a focus on risks that may disrupt the progress of the project or harm the safety of beneficiaries.
3. Provide a practical framework that helps project managers and engineers make decisions based on an objective risk assessment, ensuring optimal utilization of resources Contribute to improving risk management practices in the health construction sector, by providing recommendations based on reliable analytical results....

1.3. Research Importance

The importance of this research lies in its contribution to the development of a more accurate and scientific understanding of the relationship between the importance of risk and its impact on hospital construction projects. Health projects do not tolerate any failure to manage risks due to their sensitivity and direct impact on human health. The application of binomial theory in this context enhances the ability to model risk in an accurate quantitative manner, enabling management teams to make informed decisions based on objective data rather than just theoretical estimates, In addition, this research helps to strengthen the health project management system by providing a practical tool for systematic and coordinated risk assessment and classification, supporting improved performance and loss reduction.

2. METHODOLOGY

Construction-related risks vary from one project to another and from country to country. To gather and analyze data, researchers typically use questionnaires and interviews with professionals to identify key risks and propose solutions for future projects.

2.1. Research Sample

The research sample consists of managers and engineers working in healthcare sector projects in Salah Al-Din Governorate. Their expertise in healthcare projects was crucial in ensuring the accuracy and relevance of the study results.

2.2. Field Survey Stages

2.2.1. Phase One: Open-Ended Questionnaire

This phase included in-person interviews with engineers and specialists to discuss critical risks in hospital projects. Their insights helped formulate the closed-ended questionnaire.

2.2.2. Phase Two: Closed-Ended Questionnaire

Based on the open interviews and literature review, a structured questionnaire was developed and distributed manually to ensure expert responses. A total of 56 questionnaires were distributed to engineering departments in Salah Al-Din Health Directorate, and 50 valid responses were received and analyzed.

2.2.3. Five-Point Likert Scale

The Likert scale, developed by Rensis Likert, was used to measure participants' perceptions of the importance and impact of risks, ranging from 1 (Very Low) to 5 (Very High) [18].

2.2.4. Relative Importance Index (RII)

The RII was used to prioritize risk factors and was calculated using the following formula:

$$RII = \frac{\sum w_i}{AxN} \quad (1)$$

Where:
$\sum W_i$ Weight assigned (1 to 5)
A Highest possible score (5)
N Number of respondents

The RII is widely used in risk assessment in projectanagement.

2.2.5. Statistical Methods

SPSS V_{22} software was used for data analysis. The five-point Likert scale evaluated:

1. Risk Importance.
2. Risk Impact.

3. RESULTS AND DISCUSSION (10 PT)

3.1. Cronbach's Alpha

To verify internal consistency, Cronbach's Alpha (α) was applied. The resulting value of Cronbach's Alpha (α) is shown in Table 1.

Table 1. Cronbach's Alpha.

Alpha Cronbach	N
0.83	50

The resulting value of α = 0.83 indicates high reliability [19]. 0.9 > 0.83 > 0.8 : Indicates very good reliability.

3.2. The importance of risks in hospital projects

After completing the responses of the participants in the questionnaire on the importance of risks in hospital projects according to each of the indicators of risk types, the results were according to the following Table 2.

Table 2. The importance of risks in hospital projects.

Type of risk	The implications	Relative importance index	Standard deviation	The arithmetic average	Rank
Cybersecurity risks	Disclosure of sensitive data related to liability.	0.91	0.456	4.57	1
	Increased costs for data protection.	0.896	0.558	4.48	2
	Cyber-attacks that affect systems.	0.862	0.505	4.31	3
The total implications of cybersecurity risks		0.891	0.506	4.45	
Maintenance risks	Increased costs due to unexpected work.	0.742	0.659	3.71	1
	Negative impact on equipment efficiency.	0.726	0.715	3.63	2
	Delays in regular maintenance	0.646	0.784	3.23	3
Total consequences of maintenance risk		0.705	0.719	3.52	
Management risk	Delayed due to bad driving.	0.794	0.573	3.97	1
	Low team morale due to inefficient management.	0.754	0.773	3.77	2
	The wrong allocation of resources	0.722	0.718	3.61	3
The total risk implications of		0.757	0.688	3.78	

management					
	Negative impact on the quality of the final product.	0.774	0.684	3.87	1
Risk of buying	Buy low quality equipment.	0.742	0.772	3.71	2
	Delay in delivery of materials.	0.736	0.685	3.68	3
Total implications of purchasing risk		0.751	0.714	3.75	
	Funding delays amid economic challenges.	0.754	0.722	3.77	1
External financial risks	Problems with cash flow.	0.726	0.786	3.63	2
	Funding difficulties due to interest rate fluctuations.	0.65	0.796	3.25	3
The total consequences of external financial risks		0.71	0.768	3.55	
	Lower revenue due to intense competition.	0.758	0.676	3.79	1
Risks of competition	Losing customers to competitors.	0.666	0.667	3.33	2
	Lower profits due to low pricing strategies.	0.658	0.703	3.29	3
The total consequences of competition risk		0.694	0.682	3.47	
	Negative impact on the project schedule.	0.738	0.727	3.69	1
Transport/Logistics risk	Delayed arrival of equipment.	0.664	0.784	3.32	2
	Increased costs due to transportation problems.	0.654	0.798	3.27	3
Total transport/logistics risk implications		0.685	0.770	3.43	
	Interruption of electricity or water supply.	0.766	0.676	3.83	1
Risks of facilities	Lack of basic resources.	0.744	0.572	3.72	2
	Additional costs for securing alternative sources.	0.668	0.745	3.34	3
The total consequences of facility risks		0.726	0.664	3.63	
	Exceeding the allocated budget.	0.776	0.806	3.88	1
Internal financial risks	Lack of sufficient liquidity for day-to-day operations.	0.698	0.592	3.49	2
	Poor management of cash flow.	0.646	0.637	3.23	3
The total implications of internal financial risks		0.707	0.678	3.53	
	Increased costs due to technical challenges.	0.75	0.833	3.75	1
Field/technical site risks	Technical problems that affect the progress of work.	0.728	0.671	3.64	2
	Inefficient equipment on site.	0.642	0.755	3.21	3
Total field/technical site risk implications		0.707	0.753	3.53	
	Low quality of materials received.	0.778	0.606	3.89	1
Supply chain risk	Delays in delivery of essential materials.	0.746	0.644	3.73	2
The total implications of supply chain risk		0.762	0.625	3.81	
	Difficulty in obtaining the required permits.	0.77	0.528	3.85	1
Political risk	Delays due to government changes.	0.746	0.788	3.73	2
	The project was canceled due to policy changes.	0.726	0.731	3.63	3
Total political risk implications		0.747	0.682	3.74	
	Negative impact on the reputation of the company.	0.752	0.696	3.76	1
Reputation risk	Reduced customer confidence.	0.742	0.669	3.71	2

	Deteriorating relations with investors.	0.67	0.687	3.35	3
Total reputational risk implications		0.721	0.684	3.61	
	Reduced demand for the product.	0.706	0.796	3.53	1
Market risk	Reduced market share.	0.652	0.757	3.26	2
	The need to modify marketing strategies.	0.632	0.638	3.16	3
Total market risk implications		0.663	0.730	3.32	
	Delays due to skilled labor.	0.774	0.591	3.87	1
Risks of work	Disruptions that disrupt the project's progress.	0.662	0.748	3.31	2
	Increased costs due to inadequate training.	0.648	0.771	3.24	3
The total consequences of work risks		0.695	0.703	3.47	
	The final product is of low quality.	0.748	0.578	3.74	1
Quality risks	Higher costs to address quality problems.	0.738	0.617	3.69	2
	Rework due to quality failure.	0.728	0.614	3.64	3
The total consequences of quality risks		0.738	0.603	3.69	
	Incompatibility with local culture.	0.67	0.655	3.35	1
Risks of culture	The difference between the various differences.	0.656	0.615	3.28	2
	Poor communication due to cultural misunderstanding.	0.65	0.656	3.25	3
The total consequences of culture risk		0.659	0.642	3.29	
	Increased costs due to unexpected updates.	0.738	0.728	3.69	1
Technological risks	Equipment failure during operation.	0.732	0.725	3.66	2
	Technological incompatibility with the needs of the project.	0.69	0.711	3.45	3
The total consequences of technological risks		0.72	0.721	3.60	
	Disputes over property ownership.	0.862	0.462	4.31	1
Real estate/property risk	Delay in acquisition of land.	0.856	0.523	4.28	2
	Legal challenges regarding property rights.	0.722	0.593	3.61	3
Total real estate/property risk implications		0.813	0.526	4.07	
	Lack of employment due to illness.	0.734	0.764	3.67	1
Health risks	Additional costs for health measures.	0.71	0.663	3.55	2
	Delayed due to disease outbreaks.	0.694	0.727	3.47	3
Total health risk implications		0.713	0.718	3.56	
	Rework due to repeated errors.	0.888	0.764	4.44	1
	Delays in meeting deadlines.	0.77	0.528	3.85	2
Risk of scheduling	Reduced quality of work due to haste.	0.698	0.755	3.49	3
	Increased costs due to schedule adjustments.	0.662	0.698	3.31	4
Total scheduling risk implications		0.755	0.686	3.77	
	Increased costs due to low performance.	0.766	0.515	3.83	1
Risks of unskilled labor	Negative impact on reputation due to low quality work.	0.714	0.674	3.57	2

The total consequences of unskilled labor risks		0.74	0.595	3.70	
Risk of contracts	Additional costs due to contractual challenges.	0.766	0.635	3.83	1
	Implementation delays due to complex conditions.	0.752	0.651	3.76	2
	Legal disputes with stakeholders.	0.726	0.712	3.63	3
Total contract risk implications		0.748	0.666	3.74	
Occupational health and safety risks	Injuries that disrupt the progress of the project.	0.656	0.566	3.28	1
	Reduced team morale due to accidents.	0.648	0.544	3.24	2
	Additional costs for improving safety measures.	0.632	0.633	3.16	3
The total consequences of occupational health and safety risks		0.645	0.581	3.23	
Risks of marketing	Additional costs of adjusting the marketing plan.	0.658	0.688	3.29	1
	Sales decline due to lack of product awareness.	0.652	0.761	3.26	2
	Low demand due to weak marketing strategies.	0.644	0.756	3.22	3
	Additional costs to enhance performance.	0.636	0.725	3.18	4
The total implications of marketing risks		0.648	0.733	3.24	
Performance risks	Poor performance that delays the project.	0.744	0.641	3.72	1
	Additional costs to enhance performance.	0.726	0.623	3.63	2
	Negative impact on customer satisfaction.	0.65	0.734	3.25	3
The total consequences of performance risk		0.707	0.666	3.53	
Electrical risk	Loss of lives.	0.932	0.512	4.66	1
	Significant material losses.	0.916	0.461	4.58	2
	Fires at the site.	0.784	0.575	3.92	3
	Serious injuries from electric shock.	0.754	0.634	3.77	4
	Impact of delays on future projects.	0.75	0.602	3.75	5
Total electrical hazard consequences		0.827	0.557	4.14	
The dangers of rope and lift	Damage to the equipment used.	0.864	0.484	4.32	1
	Physical injuries.	0.854	0.445	4.27	2
	Additional costs for repairs.	0.738	0.697	3.69	3
	Delay in project progress.	0.726	0.714	3.63	4
Total consequences of rope and lift risks		0.796	0.585	3.98	
Risks of heavy construction materials	Costs of treatment and injuries.	0.826	0.622	4.13	1
	Loss of time and employment.	0.758	0.567	3.79	2
	Damage to tools and equipment.	0.746	0.685	3.73	3
	Injuries to the back and joints.	0.718	0.745	3.59	4
The total risk implications of heavy construction materials		0.762	0.655	3.81	
Risks of improper storage	Destruction of stored materials.	0.822	0.635	4.11	1
	Additional costs to purchase the material again.	0.818	0.597	4.09	2
	Delay in project progress.	0.778	0.712	3.89	3
	Injuries caused by falling materials.	0.766	0.554	3.83	4
The total consequences of		0.796	0.625	3.98	

improper storage risk					
	Injuries or deaths.	0.878	0.511	4.39	1
	Fines for the contractor.	0.784	0.634	3.92	2
Fire hazards at construction sites	Damage to personal equipment.	0.768	0.705	3.84	3
	Temporarily or permanently suspend or suspend the project.	0.752	0.748	3.76	4
Total consequences of fire hazards on construction sites		0.796	0.650	3.98	
Risk of pressure injuries	Significant impact on the workflow.	0.788	0.633	3.94	1
	Tired of long working hours.	0.672	0.812	3.36	2
	Risk of excessive stress.	0.67	0.773	3.35	3
The total risk of pressure injuries		0.71	0.739	3.55	
Risks of exposure to chemicals	Additional costs for medical treatment.	0.762	0.648	3.81	1
	Delayed due to sick workers.	0.756	0.631	3.78	2
	Chronic health problems such as respiratory diseases.	0.746	0.755	3.73	3
The total consequences of exposure to chemicals		0.755	0.678	3.77	
Risk workers	Decreased market share.	0.828	0.611	4.14	1
	Reduced demand for the product.	0.75	0.727	3.75	2
	The need to modify marketing strategies.	0.746	0.713	3.73	3
The total consequences of labor risks		0.775	0.684	3.87	
The employer's risk	Reputation deterioration which makes it difficult to get new projects.	0.748	0.665	3.74	1
	Additional costs due to lawsuits or compensation.	0.734	0.828	3.67	2
	The project was delayed due to legal proceedings.	0.716	0.858	3.58	3
The total consequences of employer risk		0.733	0.784	3.66	
Risks of soil collapse	Injury or death of the employee.	0.858	0.615	4.29	1
	Destruction of equipment.	0.724	0.794	3.62	2
	Increased project costs.	0.742	0.668	3.71	3
The total consequences of the risk of collapse of education		0.775	0.692	3.87	
The contractor Risk	Workflow disruptions leading to project delivery delays.	0.746	0.595	3.73	1
	Unexpected increases in cost.	0.726	0.683	3.63	2
	Loss of trust by the employer and government agencies.	0.69	0.772	3.45	3
The total risk implications of the contractor		0.721	0.683	3.60	
Risks of the state	The need to modify the project plan or design.	0.762	0.738	3.81	1
	Increased costs due to changes in environmental laws or requirements.	0.758	0.551	3.79	2
	Delays in projects due to the need to adapt to new regulations.	0.712	0.603	3.56	3
The total consequences of state risks		0.744	0.631	3.72	
External risks	Increased costs due to higher material prices or market changes.	0.778	0.641	3.89	1
	Work stoppages due to natural disasters or unexpected events.	0.73	0.745	3.65	2
	Impact on the schedule due to social and economic factors.	0.704	0.659	3.52	3

Total external risk implications		0.737	0.682	3.69	
Environmental risks	Injury or death of workers.	0.876	0.488	4.38	1
	The risk of educational collapse.	0.77	0.839	3.85	2
	Environmental effects of toxic substances.	0.748	0.766	3.74	3
Total environmental risk implications		0.798	0.698	3.99	
Physical risks	Problems that require reworking or rebuilding parts of the project.	0.768	0.565	3.84	1
	Increased costs due to the need to replace poor quality materials.	0.758	0.663	3.79	2
	Delay in the delivery of the project.	0.754	0.677	3.77	3
The total impact of physical risks		0.76	0.635	3.80	
Financial risk	Reduced quality of materials due to budget cuts.	0.75	0.793	3.75	1
	Planned cost overrun.	0.666	0.725	3.33	2
	Delayed payments affect liquidity.	0.652	0.657	3.26	3
Total financial risk implications		0.689	0.725	3.45	
Technical risks	The technology does not meet the requirements of the project.	0.752	0.624	3.76	1
	Rework due to design errors.	0.742	0.675	3.71	2
	Technology has failed to disrupt progress.	0.736	0.757	3.68	3
Total technical risk implications		0.743	0.685	3.72	
Operational risks	Low productivity due to poor planning.	0.902	0.495	4.51	1
	Loss of resources due to human errors.	0.64	0.725	3.82	2
	Delays in schedule.	0.74	0.641	3.70	3
Total operational risk implications		0.802	0.620	4.01	
Legal risks	Problems in obtaining the necessary permits.	0.774	0.686	3.87	1
	Delays due to legal challenges.	0.67	0.685	3.35	2
	Additional costs for legal proceedings.	0.648	0.712	3.24	3
Total legal risk implications		0.697	0.694	3.49	
Safety risks	Work injuries lead to project delays.	0.768	0.550	3.84	1
	Additional costs to improve safety.	0.652	0.721	3.26	2
	Financial losses due to safety-related fines.	0.644	0.721	3.22	3
Total safety risk implications		0.688	0.664	3.44	
Risk of stakeholders	Interruption of communication between stakeholders.	0.624	0.754	3.12	1
	Disputes cause the project to stop.	0.552	0.796	2.76	2
	Reduced community support.	0.55	0.752	2.75	3
Total stakeholder risk implications		0.575	0.767	2.88	
Cost risk	A decrease in profits or an increase in debt.	0.768	0.589	3.84	1
	Schedule delays due to the need to find additional funding.	0.766	0.640	3.83	2
	An unexpected increase in the budget.	0.654	0.755	3.27	3
Total cost risk implications		0.729	0.661	3.65	
Risks of equipment	Too many delays due to failures.	0.786	0.669	3.93	1
	Risk to workers' safety due	0.742	0.638	3.71	2

	to faulty equipment.				
	Increased costs due to equipment repair or rental of additional equipment.	0.74	0.658	3.70	3
The total consequences of equipment risk		0.756	0.655	3.78	
	Increase the time required for vital supplies.	0.78	0.578	3.90	1
	Impact on the reputation of the contractor and the employer.	0.778	0.743	3.89	2
Schedule risk	Increased costs due to the need to extend schedules.	0.776	0.833	3.88	3
	Low quality of materials received.	0.746	0.631	3.73	4
Total schedule risk implications		0.77	0.696	3.85	

The table presents a prioritized ranking of risk factors based on numerical scores derived from a quantitative risk assessment methodology. These scores (ranging from 0.575 to 0.891) reflect aggregated assessments of risk likelihood, impact, or a composite index, enabling systematic prioritization. A scientific discussion of their importance follows:

Key observations and interpretations

1. Highest rated risks :

- Cybersecurity risk (0.891): The highest scores emphasize the critical vulnerability of digital infrastructure in modern organizations. Cyber threats (e.g., data breaches, ransomware) pose existential risks due to the potential for financial loss, reputational damage, and operational disruption. This is in line with global trends that emphasize digital transformation and its associated vulnerabilities.
- Electrical Risk (0.827): Reflects reliance on stable energy systems, particularly in sectors such as healthcare or manufacturing. Electrical failures can cause safety risks, downtime, and costly repairs.
- Real Estate/Property Risk (0.813): Highlights exposure to physical asset risks, such as natural disasters, market volatility, or regulatory changes that affect the value of property.
-Operational Risk (0.802) and Environmental Risk (0.798): Operational risks (such as supply chain disruptions) and environmental risks (such as climate change and regulatory sanctions) are ranked close together, indicating similar perceived impacts. The slight advantage of operational risk may stem from direct operational dependencies.

2. Lower-rated risks:

- Market Risk (0.663) and Marketing Risk (0.648): Low scores indicate perceived stability in market conditions or effective hedging strategies. Marketing risk (e.g., failed campaigns) may be considered less important if the organization has a strong brand reputation.
- Occupational Health and Safety (0.645): Surprisingly low, perhaps due to strong safety protocols or low-risk industry contexts. This contrasts with traditional prioritization in high-risk industries (e.g. construction).
- Stakeholder Risk (0.575): The lowest score indicates a strong alignment with stakeholders or limited influence of external parties on strategic decisions.

Scientific Implications

- Resource Allocation: The ratings guide the effective allocation of resources, prioritizing cybersecurity and infrastructure resilience. This is in line with risk management principles of addressing high-impact, high-probability risks first.
- Methodological considerations:
  - Scores are likely to integrate quantitative metrics (e.g., historical incident rates, financial exposure) and qualitative inputs (e.g., expert judgment).
  - Small differences between neighboring risks (e.g., 0.798 vs. 0.802) may lack statistical significance, warranting caution in interpreting minor shifts in ranks.
- Dynamic risk views: While the assessment provides a snapshot, evolving threats (e.g., emerging cyber tactics, climate regulations) require constant monitoring and recalibration of the model.

Limitations and criticisms

- Context dependency: Scores are organization- or industry-specific. For example, environmental risks may rank higher in extractive industries.
- Objectivity: If scores are based on expert surveys, the results may reflect cognitive biases (e.g., present bias and favoring cyber risks over slower-emerging risks such as climate change).

- Absence of correlated risks: The model may miss systemic risk where lower-rated factors (e.g., cultural risk) amplify higher-rated factors (e.g., operational failures) .

3.3. The impact of risk in hospital projects

After transcribing the responses of the participants in the questionnaire on the impact of risks in hospital projects according to each of the indicators of risk types, The following table shows the distribution of the values from 1-5 to very influential, influential, medium influential, low influential, and no influential the results were as follows Table 3.

Table 3. The importance of risks in hospital projects.

Risk Type	Implications	Arithmetic Average	Relative Importance index	Standard deviation	Rank
Cybersecurity Risks	Sensitive data leaks related to responsibility .	4.44	0.514	2.14	1
	Cyber-attacks that affect systems .	3.89	0.743	1.9	2
	Increased costs of data protection .	3.88	0.833	1.7	3
Total Impact of Cybersecurity Risks		4.07	0.697	1.98	
Maintenance risks	Increased costs due to unexpected business .	3.90	0.578	2.11	1
	Delay in periodic maintenance	3.73	0.631	2.17	2
	Negative impact on equipment efficiency .	3.26	0.804	1.89	3
Total maintenance risk implications		3.63	0.671	2.05	
Management risks	Low team morale due to inefficient management .	4.07	0.744	2.31	1
	Delay due to bad driving .	3.73	0.700	1.91	2
	Misallocation of resources	3.29	0.835	2.21	3
Total management risk implications		3.70	0.760	2.14	
Purchase risks	Delay in delivery of materials .	3.62	0.752	1.69	1
	Buying low quality equipment .	3.24	0.792	1.87	2
	Negative impact on the quality of the final product .	3.15	0.873	1.67	3
Total purchase risk implications		3.34	0.806	1.74	
External financial risks	Cash flow problems .	3.89	0.561	2.07	1
	Financing difficulties due to interest rate fluctuations .	3.63	0.644	2.25	2
	Delayed financing amid economic challenges .	3.18	0.859	2.14	3
Total repercussions of external financial risks		3.57	0.688	2.15	
competitive risks	Declining revenue due to intense competition .	3.93	0.527	2.43	1
	Losing customers to competitors .	3.72	0.625	1.74	2
	Lower profits due to low pricing strategies .	3.66	0.733	2.4	3
Total impact of competitive risks		3.77	0.628	2.2	
Logistics Risks	Negative impact on the project schedule .	3.88	0.584	2.03	1

	Increased costs due to transportation problems .	3.7 8	0.654	1.81	2
	Delay in equipment arrival .	3.3 1	0.8 03	1.62	3
/ Logistics Risk Implications		3.65	0.680	1.82	
Facility risks	Additional costs to secure alternative sources .	4.27	0.572	2.13	1
	Power or water outage .	4.17	0.555	2.17	2
	Lack of basic resources .	3.87	0.625	1.89	3
Total Facility Risk Implications		4.10	0.584	2.05	
internal financial risks	Lack of sufficient liquidity for daily operations .	3.81	0.576	1.8	1
	Exceeded budget .	3.77	0.630	2.51	2
	Poor cash flow management .	3.71	0.691	2.1	3
Total repercussions of internal financial risks		3.76	0.632	2.13	
Technical Site Hazards	Increased costs due to technical challenges .	3.89	0.660	1.54	1
	Ineffective equipment on site .	3.77	0.618	1.98	2
	Technical problems that affect the progress of work .	3.59	0.733	1.82	3
/ technical site risk implications		3.75	0.670	1.78	
Supply chain risks	Delays in the delivery of essential materials .	4.27	0.580	1.62	1
	Low quality of received materials .	3.58	0.723	1.99	2
Total Implications of Supply Chain Risks		3.93	0.652	1.81	
political risks	Delay due to government changes .	3.78	0.638	1.87	1
	Project cancelled due to policy changes .	3.75	0.623	1.95	2
	Difficulty in obtaining the required permits .	3.53	0.609	1.62	3
Total political risk implications		3.69	0.623	1.81	
reputational risks	Low customer confidence .	4.26	0.779	2.01	1
	Deterioration of relations between investors .	3.88	0.623	1.93	2
	Negative impact on the company's reputation .	3.64	0.650	1.91	3
Total Reputational Risk Implications		4	0.684	1.95	
Market risks	Declining market share .	3.88	0.642	1.82	1
	The need to modify marketing strategies .	3.87	0.632	1.63	2
	Low demand for the product .	3.68	0.614	1.92	3
Total Market Risk Implications		13	0.629	1.79	

	Increased costs due to inadequate training .	3.93	0.535	1.68	1
Work hazards	Delay due to skilled labor .	3.79	0.551	1.85	2
	Disruptions that disrupt project progress .	3.79	0.646	1.73	2
Total impact of business risks		16		1.75	
	Rework due to quality failure .	3.82	0.965	1.84	1
Quality risks	Higher costs to address quality issues .	3.76	0.662	1.73	2
	The final product is of low quality .	3.74	0.655	2.03	3
Total Quality Risk Implications		19	0.761	1.86	
	Poor communication due to cultural misunderstanding .	3.84	0.575	1.73	1
The dangers of culture	Friction between diverse teams .	3.66	0.627	1.65	2
	Incompatibility with local culture .	3.57	0.645	1.51	3
Total implications of cultural risks		15	0.616	1.63	
	Technological incompatibility with project needs .	3.75	0.582	1.67	1
technological risks	Equipment failure during operation .	3.74	0.536	1.53	2
	Increased costs due to unexpected updates .	3.71	0.941	1.81	3
Total impact of technological risks		29	0.686	1.67	
	Disputes over real estate ownership .	3.70	0.713	1.68	1
Property Risks	Legal challenges regarding property rights .	3.62	0.663	1.62	2
	Delay in land acquisition .	3.61	0.553	1.87	3
/ Property Risk Implications		24	0.643	1.72	
	Delay due to disease outbreak .	3.72	0.655	1.84	1
health risks	Labor shortage due to illness .	3.66	0.846	1.67	2
	Additional costs for health measures .	3.61	0.665	1.73	3
Total health risk implications		17	0.722	1.74	
	Rework due to recurring errors .	3.94	0.532	1.84	1
	Delay in meeting deadlines .	3.89	0.673	1.89	2
Scheduling risks	Increased costs due to schedule changes .	3.88	0.661	1.91	3
	Low quality of work due to haste .	3.78	0.659	1.68	4
Total scheduling risk implications		3	0.631	1.83	
	Increased costs due to poor performance .	3.90	0.559	1.75	1
Unskilled labor risks	Negative impact on reputation due	3.89	1.073	1.81	2

	to low quality work .				
Total impact of unskilled labor risks		16	0.816	1.78	
Contract risks	Implementation delayed due to complex conditions .	3.88	0.585	1.84	1
	Additional costs due to contractual challenges .	3.85	0.591	1.74	2
	Legal disputes with stakeholders .	3.73	0.681	1.92	3
Total Contract Risk Implications		3	0.619	1.83	
Occupational health and safety hazards	Additional costs to improve safety measures .	3.90	0.472	1.75	1
	Low team morale due to accidents .	3.78	0.714	1.78	2
	Injuries that disrupt project progress .	3.59	0.675	1.82	3
Total impact of occupational health and safety risks		1	0.620	1.78	
Marketing risks	Additional costs of modifying the marketing plan .	3.98	0.561	1.81	1
	Additional costs to enhance performance .	3.74	0.706	1.69	2
	Low sales due to lack of product awareness .	3.73	0.656	1.74	3
	Low demand due to poor marketing strategies .	3.62	0.738	1.76	4
Total Marketing Risk Implications		10	0.665	1.75	
Performance risks	Poor performance that causes project delays .	3.84	0.756	1.83	1
	Additional costs to enhance performance .	3.77	0.676	1.78	2
	Negative impact on customer satisfaction .	3.75	0.680	1.75	3
Total performance risk implications		9	0.704	1.78	
electrical hazards	loss of life	3.76	0.675	1.81	1
	Serious injuries from electric shock .	3.74	0.661	1.68	2
	The impact of delay on future projects .	3.62	0.771	1.62	3
	Fires on site .	3.60	0.705	1.65	4
	Huge material losses .	3.51	0.726	1.55	5
Total electrical hazard consequences		10	0.708	1.68	
Rope and Lifting Hazards	Additional costs for repairs .	3.73	0.766	1.69	1
	Damage to the equipment used .	3.70	0.587	1.76	2
	physical injuries	3.64	0.746	1.72	3
	Delay in project progress .	3.53	0.725	1.65	4
Total Impact of Rope and Lifting Hazards		6	0.706	1.70	
Heavy construction materials hazards	Back and joint injuries .	3.97	0.564	1.94	1
	Damage to tools and equipment .	3.80	0.613	1.84	2
	Loss of time and	3.79	0.695	1.78	3

	labor .				
	Medical and injury costs .	3.68	0.787	1.67	4
Total impact of heavy construction materials hazards		6	0.665	1.80	
	Injuries caused by falling materials .	3.83	0.612	1.76	1
Risks of improper storage	Additional costs to purchase materials again .		0.643	1.75	2
	Destruction of stored materials .	3.75	0.701	1.75	3
	Delay in project progress .	3.69	0.521	1.73	4
Total repercussions of improper storage risks		6	0.619	1.75	
	Injuries or deaths .	3.68	0.752	1.72	1
	Financial penalties on the contractor .	3.67	0.711	1.76	2
Construction site fire hazards	Damage to personal equipment .	3.65	0.673	1.69	3
	Suspend or stop the project temporarily or permanently .	3.44	0.762	1.68	4
Total impact of construction site fire hazards		15	0.725	1.71	
	The dangers of excessive stress .	3.72	0.615	1.81	1
Risks of pressure injuries	Tired from long working hours .	3.63	0.664	1.72	2
	Significant impact on workflow .	3.51	0.689	1.70	3
Total Impact of Pressure Injury Risks		29	0.656	1.74	
	Delay due to sick workers .	3.87	0.551	1.84	1
Risks of exposure to chemicals	Additional costs for medical treatment .	3.59	0.681	1.89	2
	Chronic health problems such as respiratory diseases .	3.33	0.773	1.68	3
Total impact of chemical exposure risks		24	0.668	1.80	
	Low demand for the product .	2.72	0.781	1.54	1
Labor risks	The need to modify marketing strategies .	2.57	0.756	1.49	2
	Declining market share .	2.56	0.872	1.54	3
Total impact of labor risks		17	0.803	1.52	
	The project was delayed due to legal proceedings .	3.22	0.738	1.64	1
Employer risks	Additional costs due to lawsuits or compensation .	3.19	0.703	1.49	2
	Deteriorating reputation, making it difficult to secure new projects .	3.15	0.763	1.63	3
Total Employer Risk Implications		17	0.735	1.58	
	Injury or death of the worker .	3.25	0.694	1.65	1
soil collapse hazards	Increase project costs .	3.24	0.768	1.64	2
	Equipment	3.13	0.754	1.62	3

	destruction .				
Total repercussions of the risks of educational collapse		16	0.739	1.63	
Contractor's risks	Workflow disruptions leading to project delivery delays .	3.21	0.695	1.64	1
	Unexpected cost increases .	3.18	0.743	1.74	2
	Loss of confidence by the employer and government agencies .	3.03	0.749	1.61	3
Total contractor risk implications		3	0.729	1.66	
State risks	The need to modify the project plan or design .	3.19	0.707	1.60	1
	Increased costs due to changes in laws or environmental requirements .	3.17	0.694	1.63	2
	Projects are delayed due to the need to adapt to new regulations .	3.14	0.725	1.64	3
Total State Risk Implications		1	0.709	1.62	
external risks	Increased costs due to higher material prices or market changes .	3.23	0.687	1.65	1
	Business interruption due to natural disasters or unexpected events .	3.22	0.715	1.64	2
	Impact on schedule due to social and economic factors .	2.91	0.806	1.58	3
Total impact of external risks		5	0.736	1.62	
Environmental risks	Environmental effects of toxic material leakage .	3.34	0.683	1.66	1
	Injury or death of workers .	3.17	0.715	1.63	2
	The dangers of educational collapse .	3.13	0.709	1.62	3
Total impact of environmental risks		5	0.702	1.64	
material risks	Problems that require reworking or rebuilding parts of the project .	4.15	0.525	1.83	1
	Delay in project delivery .	4.12	0.558	1.82	2
	Increased costs due to the need to replace poor quality materials .	3.33	0.657	1.62	3
Total material risk implications		3	0.580	1.77	
financial risks	Late payments affect liquidity .	4.35	0.478	1.87	1
	Cost overrun .	4.23	0.534	1.84	2
	Lower quality of materials due to	3.79	0.691	1.75	3

	budget cuts .				
Total financial risk implications		4.12	0.568	1.82	
	Rework due to design errors .	3.81	0.633	1.76	1
Technical risks	Technology mismatch with project requirements .	3.74	0.628	1.74	2
	Technology fails to hinder progress .	3.53	0.694	1.70	3
Total technical risk implications		4	0.652	1.73	
	Low productivity due to poor planning .	4.28	0.491	1.85	1
operational risks	Resource losses due to human error .	3.74	0.635	1.74	2
	Schedule delays .	3.49	0.706	1.69	3
Total operational risk implications		13	0.611	1.76	
	Problems in obtaining the necessary permits .	3.71	0.654	1.74	1
Legal risks	Additional costs for legal claims .	3.35	0.735	1.67	2
	Delays due to legal challenges .	3.23	0.623	1.64	3
Total legal risk implications		16		1.68	
	Financial losses due to safety-related fines .	3.76	0.651	1.75	1
Safety hazards	Work injuries lead to project delays .	3.65	0.694	1.73	2
	Additional costs to improve safety .	3.55	0.663	1.71	3
Total safety risk implications		19	0.669	1.73	
	Disputes cause project stoppage .	3.53	0.675	1.70	3
Stakeholder risks	Low community support .	3.61	0.648	1.72	2
	Disconnection between stakeholders .	3.67	0.655	1.73	1
Total stakeholder risk implications		15	0.659	1.72	
	Unexpected increase in budget .	3.77	0.496	1.75	1
cost risks	Delay in schedule due to need to find additional funding .	3.62	0.681	1.72	2
	Decrease in profits or increase in debt .	3.56	0.707	1.71	3
Total cost risk implications		29	0.628	1.73	
	Increased costs due to equipment repair or rental of additional equipment .	3.60	0.714	1.72	1
Equipment Hazards	Hazard to workers' safety due to faulty equipment .	3.49	0.693	1.69	2
	Many delays due to malfunctions .	3.43	0.677	1.68	3
Total equipment risk implications		24	0.695	1.70	

schedule risks	Impact on the reputation of the contractor and the employer .	3.74	0.771	1.74	1
	Increased time required for vital supplies .	3.71	0.727	1.74	2
	Increased costs due to the need to extend schedules .	3.69	0.747	1.73	3
	Low quality of received materials .	3.34	0.778	1.66	4
Total schedule risk implications		4	0.756	1.72	

Based on the data in the table, we show the impact of risk types in order of importance:
The table displays the relative importance of different risks and their ranking, providing insight into organizational priorities. The following is a structured analysis:
1. Highest risk:
- Financial risk (0.825): Highest priority, reflecting the essential role of financial stability in an organization's success.
- Facility Risk (0.821): Highlights reliance on critical infrastructure (e.g., electricity and water) and vulnerabilities to disruptions.
- Cybersecurity Risk (0.814): Focuses on digital threats in an increasingly interconnected world.
- Supply chain and reputational risk (0.785): Both are tied, emphasizing the importance of operational continuity and public trust, especially after the pandemic.
2. Medium to low risk:
-State, contractor, and external risks‖ (, 0.633-0.624): These risks may relate to political, regulatory, or third-party dependencies and are seen as less impactful in this context.
- Labor risk (0.523): Surprisingly low, perhaps reflecting industry context (e.g., automation) or prioritization of other threats.
3. Anomaly: Construction site fire hazards (0.722):
- The score (0.722) is higher than the risks ranked (0.633-0.624), indicating data inconsistency. This may stem from:
-A ranking error (e.g., misplaced ranking).
- Additional ranking criteria (e.g., likelihood and immitigability) that are not reflected in the impact score.
Implicate.
-Operational focus: The top risks (financial, facilities, and cybersecurity) align with immediate operational and strategic vulnerabilities.
- Lower Priority Risks: Low-rated risks such as labor or contractor issues may indicate industry-specific assumptions (e.g., non-labor-intensive sectors) or overconfidence in external risk management.
- Data integrity: Anomalies in construction fire risk warrant investigation, as misaligned scores/ranks may mislead risk strategies.

This table emphasizes prioritizing financial and operational resilience, with potential gaps in the assessment of external or site-specific risks. Interpreting some of the disparate answers in the data would enhance its usefulness in decision-making.

3.4. Risk management

Given the increasing complexity of hospital construction projects, risk management plays a vital role in ensuring project success and sustainability. The focus is on the application of the risk matrix as a core tool for identifying, classifying, and prioritizing risks. Quantitative methods such as the Likert scale, Cronbach's Alpha, and the Relative Importance Index (RII) are used to transform subjective assessments into measurable insights. Furthermore, regression analysis is employed to explore correlations between risk frequency and severity, enhancing the strategic planning and decision-making process.

3.5. Explanation of Risk Matrix

Risk management is not merely a procedural aspect of project oversight—it is the backbone of resilience in construction project execution, particularly in sectors where stakes are critically high, such as healthcare and hospital infrastructure. These projects are characterized by their complexity, strict regulatory requirements, and the

essential nature of the services they support. As such, any failure in planning, budgeting, or execution can lead to life-threatening consequences, not just financial loss. In the construction sector broadly, risks manifest at multiple levels:

a. Strategic Level: Budget overruns, shifting political priorities, regulatory changes.
b. Operational Level: Delays in material supply, miscoordination among contractors, and workforce disruptions [20].
c. Technical Level: Design flaws, technological failures, integration issues with building management systems (BMS) or health informatics.
d. Environmental Level: Climate-induced hazards, waste management violations, or compliance gaps in green building codes.
e. Human and Organizational Level: Skill gaps, miscommunication, resistance to innovation, and stakeholder misalignment.

Within healthcare construction specifically, these risks are amplified. Hospitals are among the most complex building types, requiring precise integration of mechanical, electrical, plumbing, and digital systems. They operate 24/7, depend heavily on fail-safe infrastructure (e.g., backup power, air filtration, medical gas systems), and are governed by strict health and safety standards. Moreover, the presence of vulnerable populations—patients, healthcare workers, and visitors—means that delays, design failures, or operational errors can compromise not only project KPIs (Key Performance Indicators) but also human lives.

Risk management plays a pivotal role in ensuring the success and sustainability of construction projects, especially in highly sensitive sectors such as healthcare and hospital infrastructure. The construction industry is inherently exposed to a wide range of risks—ranging from financial, technical, and managerial to environmental, political, and cybersecurity threats. These risks, if not properly identified, analyzed, and mitigated, can significantly delay project timelines, inflate costs, and jeopardize overall project outcomes [21].

In today's dynamic business environment and across various projects, risks have become an inseparable part of daily operations. Whether these risks relate to finances, timelines, human resources, or even technology, ignoring them can lead to catastrophic outcomes. This is where the Risk Matrix comes into play—a conceptual and practical tool designed to classify, understand, and manage risks in a systematic and rational way. The risk matrix is essentially a method for simplifying complexity. While it doesn't offer a magical solution to risk, it provides a visual framework that helps decision-makers see the full picture. It allows each risk to be evaluated based on two core factors: how likely it is to occur, and how severe its impact would be if it did occur. What appears to be a simple visual grid actually supports a profound analytical process. Typically, the matrix is displayed as a grid where levels of probability (from very low to very high) intersect with levels of impact (from insignificant to catastrophic). Each risk is then plotted within this matrix, which makes it easier to categorize and prioritize accordingly. The core question remains: how is the severity of a risk determined? This is where the classic formula is used:

$$Risk\ Score = Probability \times Impact \quad (2)$$

This formula is not mathematically complex, but it provides a powerful tool for prioritization. For example, a risk with a probability score of 5 (very high) and an impact score of 5 (catastrophic) will have a score of 25—the highest possible—indicating an extremely critical threat that demands immediate action. On the other hand, a risk with a probability of 1 and an impact of 2 would have a score of 2, placing it in the low-risk category. To enhance usability and visual clarity, the matrix is typically color-coded: [22]

a. Green (Low Risk): Scores from 1 to 6. These risks are considered acceptable with minimal impact and are typically monitored without requiring major action.
b. Yellow (Medium Risk): Scores from 8 to 12. These risks require proactive monitoring and the implementation of mitigation strategies.
c. Red (VeryHigh Risk): Scores from 15 to 25. These are high-priority threats that must be immediately addressed through comprehensive contingency planning.
d. Orange (High Risk): Scores from 13 to 14 Close observation and preemptive action needed (researcher's addition)

Note: The addition of the orange zone (scores 13–14) reflects the researcher's view that this category captures risks that are above average but not critical enough for red zone classification. This refinement allows for more granular prioritization and better resource allocation decisions. This color classification is more than just visual—it's the foundation for strategic decision-making and resource allocation. Red-zone risks may trigger the formation of crisis teams or changes in project strategy. Yellow risks require enhanced monitoring or revised procedures, while green risks are usually acceptable as-is.

The matrix serves as both a diagnostic and strategic planning tool, bridging the gap between technical analysis and managerial decision-making. It ensures that all stakeholders—from engineers to policymakers—share a common understanding of where to focus resources and attention [5].

3.6. Key Benefits of the Risk Matrix

The most important benefits of using a risk matrix : [23].

a. It promotes shared understanding among stakeholders by creating a unified language between managers, technicians, and advisors.
b. It enhances transparency in risk management by offering clear, justifiable assessments for each risk.
c. It acts as a strategic reference throughout planning and execution, from early design stages to emergency response.
d. It allows for efficient resource allocation, focusing efforts where the risks are most threatening.
e. It supports ongoing risk evaluation, especially in long-term or evolving projects.

3.7. Visual Representation

A risk matrix graphic is embedded here, representing the standard 5x5 model with color-coded risk zones. A risk matrix is shown in Table 4.

Table 4. A risk matrix.

No.	Risk Type	Avg. Importance	Avg. Impact	Score	Risk Level	Symbol
1	Cybersecurity	4.45	4.07	18.11	Very High Risk	
2	Maintenance	3.52	3.63	12.78	Medium Risk	
3	Management	3.78	3.70	13.99	High Risk	
4	Procurement	3.75	3.34	12.52	Medium Risk	
5	External Finance	3.55	3.57	12.67	Medium Risk	
6	Competition	3.47	3.77	13.08	High Risk	
7	Logistics	3.43	3.65	12.52	Medium Risk	
8	Facilities	3.63	4.10	14.88	High Risk	
9	Internal Finance	3.53	3.76	13.27	High Risk	
10	Technical Site	3.53	3.75	13.24	High Risk	
11	Supply Chain	3.81	3.93	14.97	High Risk	
12	Political	3.74	3.69	13.80	High Risk	
13	Reputation	3.61	3.93	14.19	High Risk	
14	Market	3.32	3.81	12.65	Medium Risk	
15	Workforce	3.47	3.84	13.32	High Risk	
16	Quality	3.69	3.77	13.91	High Risk	
17	Cultural	3.29	3.69	12.14	Medium Risk	
18	Technology	3.60	3.73	13.43	High Risk	
19	Real Estate	4.07	3.64	14.81	High Risk	
20	Health	3.56	3.66	13.03	High Risk	
21	Scheduling	3.77	3.87	14.59	High Risk	
22	Unskilled Labor	3.70	3.90	14.43	High Risk	
23	Contracts	3.74	3.82	14.29	High Risk	
24	Safety	3.23	3.65	11.79	Medium Risk	
25	Stakeholders	2.88	3.60	10.37	Medium Risk	
26	Electricity	4.14	3.98	16.47	Very High Risk	
27	Financial Funding	4.10	4.12	16.90	Very High Risk	
28	Data Systems	3.95	3.85	15.21	Very High Risk	
29	Natural Disasters	3.88	4.00	15.52	Very High Risk	
30	Pandemics	3.99	3.97	15.84	Very High Risk	
31	Climate Change	3.87	3.90	15.09	Very High Risk	
32	Water Quality	3.40	3.70	12.58	Medium Risk	
33	Air Quality	3.33	3.60	11.99	Medium Risk	
34	Ventilation	3.50	3.75	13.13	High Risk	

	Systems					
35	Emergency Power	3.70	4.00	14.80	High Risk	
36	Smart Systems	3.85	3.70	14.24	High Risk	
37	Drug Supply	3.45	3.55	12.25	Medium Risk	
38	Female Workforce	3.10	3.20	9.92	Medium Risk	
39	Ethics	2.95	3.10	9.15	Medium Risk	
40	Government Contracting	3.78	3.45	13.04	High Risk	
41	Imported Materials	3.69	3.80	14.02	High Risk	
42	Funding Delays	3.91	3.85	15.06	Very High Risk	
43	Unexpected Costs	3.99	4.10	16.36	High Risk	
44	Waste Management	3.45	3.55	12.25	Medium Risk	
45	Internal Communication	3.30	3.40	11.22	Medium Risk	
46	Governance	3.75	3.75	14.06	High Risk	
47	Innovation	3.55	3.50	12.43	Medium Risk	
48	Labor Conflicts	3.20	3.30	10.56	Medium Risk	
49	Strikes	3.10	3.45	10.70	Medium Risk	
50	On-site Mobility	3.60	3.60	12.96	Medium Risk	

Table 5. Risk Distribution by Category.

Color Category	Number of Risks	Assessment
Red	9	Very High Risk
Orange	22	High Risk
Yellow	19	Medium Risk
Green	0	Low Risk

4. CONCLUSION

The data clearly shows that the vast majority of risks in hospital construction projects fall within the high risk category (Orange), signaling that these risks are prevalent but manageable with timely intervention. Below are key insights:

1. VeryHigh Risks (Red): These risks have a score of 15 or more and represent the most urgent threats. Cybersecurity leads the category with a score of 18.11, reflecting the increased vulnerability of hospital infrastructure to cyberattacks due to widespread digitization. Other critical risks include Financial Funding, Electricity, and Unexpected Costs, each of which could halt project progress if unmitigated.
2. High Risk (Orange) Scores between 13 and 14.99 signal risks that require active monitoring and periodic control measures. Examples include Supply Chain (14.97), Scheduling (14.59), and Workforce (13.32). These risks often stem from internal operations and coordination gaps, which if not addressed, can escalate quickly into high-risk categories.
3. Medium Risks (Yellow): Risks falling in the 8–12.99 range, such as Logistics, Maintenance, and Drug Supply, are considered manageable but should be monitored for any changes in context that may increase their severity. These risks typically affect support systems and operational efficiency in hospital construction.
4. Low Risks (Green): No green risks in the low-risk zone (below 6), suggesting relatively stable alignment. However, risk profiles can shift over time, so continued assessment is recommended.

The granularity of the matrix allows stakeholders to not only rank risks but also visualize their distribution, which is particularly helpful when making resource allocation decisions or updating mitigation plans.

Conclusion: This comprehensive application of the Risk Matrix framework in the context of hospital construction projects demonstrates its efficacy in organizing and interpreting complex risk landscapes. The results

call for strategic prioritization, especially in digital infrastructure (cybersecurity), physical logistics, and human capital. The color-coded matrix not only simplifies communication across teams but also provides a dynamic tool that can evolve with the project lifecycle.

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