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Article

Holistic Risk Assessment Across the Construction Project Life Cycle for Sustainable Project Delivery

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Abstract

Risk management is a critical process for achieving construction project objectives and supporting more sustainable project delivery. However, most existing research focuses on isolated aspects of risk, lacking an integrated approach that examines how risks evolve across the entire project life cycle. This study addresses this gap by identifying and assessing key risks affecting construction projects in the United Arab Emirates (UAE), with attention to how improved risk understanding can contribute to more resilient and sustainable project outcomes. Through a literature review, fifteen critical risks involving various stakeholders were identified. A questionnaire survey was conducted to evaluate the probability and impact of these risks on project cost. The study analyzes how these risks manifest across the project life cycle and affect different stakeholders. Using a coordinate system, it visualizes risk behavior across phases, offering a dynamic view of risk exposure. Findings show that the construction phase was the riskiest, followed by the handover, design, and feasibility phases. Additionally, delayed payments by owners emerged as the most significant risk, followed by poor contractor management. The study proposes a modified probability–impact matrix to account for multi-phase risks. These findings provide valuable insights for construction firms, helping improve stakeholder risk allocation, inform contract negotiations, and enhance project delivery in the UAE context while contributing to more efficient, responsible, and sustainable project management practices.

Keywords: risk management; lifecycle; stakeholders; cost objective; construction management; United Arab Emirates

1. Introduction

Risk is defined as an unpredictable occurrence that if realized, it has an impact on one or more project objectives. Risk management is the process of identifying and assessing all potential risks that a company or project may face, enabling informed decision-making to effectively address and control those risks [1]. As economies continue to grow, construction projects are becoming more complex, leading to a significant rise in the risks associated with construction. Given the large financial investments, long project durations, advanced technical requirements, and challenging construction environments, it is essential to enhance risk management practices within the construction industry [2]. Looking back at the history of risk management in construction, it emerged in the 1990s, with contractors relying on informal “thumb rules” that often failed to meet time, cost, and quality objectives [3]. Early systematic approaches aimed to identify risk sources, assess their impact, and develop control measures, leading to models such as Probability-Impact assessment, Fuzzy Set Theory, and Monte Carlo Simulation [4,5]. By the early 2000s, research highlighted the lack of structured frameworks, prompting categorization of risks into groups based on their nature or source, such as environmental, financial, management, and resource-related factors [6,7]. Post-2010, risk assessment research expanded significantly, introducing more sophisticated and integrated

methods. Techniques such as risk workshops combining brainstorming, checklists, probability-impact matrices, and registers became prominent for improving identification and analysis. For instance, Gondia et al. [8] applied machine learning algorithms to enhance the accuracy of project delay risk analysis and prediction by leveraging objective data sources. Chatterjee et al. [9] employed a hybrid multi-criteria decision-making (MCDM) approach to support risk management in construction projects. Hatefi and Tamošaitienė [10] proposed an integrated fuzzy DEMATEL–fuzzy ANP model to assess overall construction project risks by accounting for the interdependencies among risk factors. Meanwhile, Siraj and Fayek [11] examined widely used tools and techniques for risk identification, classification methods, and typical risks encountered in construction projects.

However, the aforementioned studies highlight the fact that previous research has largely overlooked the dynamic nature of risks throughout the project life cycle, focusing instead on their impacts within specific phases or on isolated aspects of projects [12]. Most studies have assessed risks using static approaches that neglect how risk probabilities and impacts evolve over time [13]. This is a critical gap, as the dynamic behavior of risks across project phases increases the complexity of effective management [14]. To address this, the concept of dynamic risk assessment has been introduced, improving upon traditional static methods by allowing for ongoing updates of risk inputs [15]. Despite its importance, risk management is rarely integrated across all phases of the project life cycle. For example, while many professionals recognize the value of risk management, its application during the feasibility stage remains limited [16]. Research shows the construction phase to be the riskiest, followed by the feasibility stage, underscoring the need for early-stage risk consideration [13]. Moreover, the design phase plays a pivotal role, as neglecting risks at this stage can significantly disrupt later project phases [17].

Effective risk management requires addressing risks across multiple stages and stakeholders. Studies recommend adopting a proactive approach, starting from project inception, to reduce adverse impacts and enhance benefits [18]. This calls for moving beyond static frameworks to dynamic systems that consider project complexity, objectives, and environment [15]. However, practitioners often hesitate to adopt mathematical models like system dynamics and simulation, even though robust risk analysis should reflect the evolving nature of risks [19]. A risk's life cycle aligns with the period during which it affects the project, and its intensity may fluctuate over time. Despite the interconnectivity of risks across stakeholders, most research has treated project risks as static, ignoring the changing risk network as the project progresses [20]. Zou et al. [13] emphasized that risk management is most effective when applied across the full project life cycle. Comprehensive assessment must account for both short- and long-term impacts, ensuring that decision-making is well-informed. Therefore, risk strategies should be embedded from project initiation through to completion, providing appropriate responses at each stage [21]. While past studies have often examined single phases, such as the conceptual or construction phases, there remains a lack of holistic research assessing risks from the perspective of all stakeholders across the entire life cycle [2,16,22,23]. According to the PMBOK [24], a standard project life cycle includes the following phases: (1) feasibility, (2) planning and design, (3) construction, and (4) handover. Therefore, this paper aims to identify and map the most significant risks across different stakeholders throughout the project lifecycle as well as assess and prioritize the identified risks impacting the cost in the UAE.

2. Methodology

To begin with, fifteen risks were identified through a comprehensive review of literature. The identified risks were then grouped into different project phases: feasibility, design, construction and handover phases. Additionally, the identified risks were also allocated to the responsible project stakeholder, such as the owner, designer and contractor. Furthermore, a questionnaire for risk assessment was developed and sent to UAE construction industry professionals. The questionnaire was divided into two phases. The first phase gathered general information about the respondents' profile, while the second phase assessed the cost impact and the likelihood of risks in each phase based on a five-point Likert scale. Where "1" represented very low impact and likelihood and "5"

represented very high impact and likelihood. Sixty-six responses were collected. Table 1 illustrates the respondents’ profile. The Relative Importance Index (RII) for each risk was determined using Equation (1). Separate RII values were computed for the probability, impact, and overall rating. The risk rating itself was obtained by multiplying the probability and impact associated with each risk.

$$RII = \frac{\sum_{i=1}^5 W_i X_i}{\sum_{i=1}^5 W_i} \tag{1}$$

where
Wi weight assigned to ith response; Wi = 1, 2, 3, 4 and 5 for i = 1, 2, 3, 4 and 5, respectively
Xi frequency of the ith response
i response category index = 1, 2, 3, 4 and 5 for very low, low, moderate, high and very high, respectively

To monitor the evolving behaviour of specific risks over time, a coordinate system model was also used. This model establishes the relationship between risk exposure and the various phases of the project life cycle. By mapping risks across the timeline, the coordinate system provides insight into how their significance fluctuates throughout the project, enabling more informed and proactive risk management.

Table 1. Respondents’ profile.

Category	Type	Number of Respondents (Total 66)	Percentage of Respondents (%)
Current Role	Owner	12	18.2%
	Designer	15	22.7%
	Contractor	39	59.1%
Company	Local	17	25.8%
	International	49	74.2%
Level of Experience	<5 years	25	37.9%
	5-10 years	21	31.8%
	11-20 years	13	19.7%
	>20 years	7	10.6%

3. Risk Identification and Mapping

3.1. Feasibility-Related Risks

As the initial phase of the project lifecycle, the feasibility phase sets the foundation, determining project viability, scope and strategic alignment before significant resources are committed. Six feasibility related risks were identified through literature review including: owners unreasonably imposed tight schedule, owner’s lack of funding, owner’s changes, owner’s improper interventions, delays in approvals and inaccurate cost estimates. The first four mentioned risks are solely the responsibility of the owner. Contractors rely primarily on payments from owners as their main source of revenue. When these payments are delayed, contractors face significant financial strain. In addition, owners frequently enforce aggressive construction timelines that may be unrealistic or unfeasible [25]. Furthermore, improper interventions by owners during the construction phase are also common, along with frequent design change requests. These changes often stem from poorly defined project scopes or shifts in the owner’s preferences. Moreover, often driven by time and cost pressures, owners may push the project forward without fully defining the scope of work. This lack of clarity can ultimately hinder the achievement of project goals [23]

The fifth risk is a dual responsibility between the owner and the designer. Indeed, timely approvals depend on several factors, namely, proper communication between owner and designer, owner’s responsiveness and the designer’s ability to produce accurate, complete, and compliant documentation [26]. Whereas the last risk ‘inaccurate cost estimates’ is the responsibility of all three

stakeholders: owner, designer and contractor. This is mainly because clear and well-documented estimate reports require active contribution and coordination from all three stakeholders as well as mutual understanding among all parties: owners to define clear requirements and provide timely decisions, designers to prepare precise and comprehensive designs, and contractors to offer practical cost data and execution insights [27] (Dell'Isola, 2002).

3.2. Design-Related Risks

The design phase translates the project's feasibility findings into detailed technical and contractual documents, serving as the blueprint for execution. The aforementioned six risks in the feasibility phase are also available in the design phase along with six other risks which are: inadequate planning and scheduling, noncompliance with local standards and legislation, design changes, inadequate site information, delays in issuing drawings and documents, deficiencies in drawings and specifications. Inadequate planning and scheduling is jointly the responsibility of both the designer, who must provide complete and timely design information to enable accurate scheduling, and the contractor, who must develop and manage a realistic program that reflects resource, sequencing, and logistical constraints. The remaining five risks are the sole responsibility of the designer. Nibbelink et al. [28] suggested that design risks can be effectively examined by analysing the sources of information that support the design process. They argued that the quality of this input information is the primary factor influencing both the likelihood and magnitude of design risks. In fact, previous research in design-related risks has concluded that this is critical strategic phase in a project, which is exposed to a broad spectrum of risks, making it challenging to identify their primary sources. Such complexity has led design-related issues to be classified as "wicked" problems; those that are inherently ill-defined, poorly structured, and therefore significantly more difficult to resolve [29].

3.3. Construction-Related Risks

The construction phase marks the transition from planning to execution, where all designs, resources and strategies are deployed on-site. In fact, this research highlights that all fifteen risks extracted from the literature review are related to the construction phase. This is mainly because the construction phase is the most execution-intensive stage of the project life cycle, involving the highest level of resource mobilization, and the greatest volume of activities. Even if some of the risks originally lie in feasibility or design stages such as inaccurate cost estimates or design deficiencies, they often materialize during construction as this is when plans are implemented and discrepancies become apparent [30]. Further, the dynamic nature of this phase and the multiple interdependencies make it highly susceptible to the escalation of risks such as owner interventions, funding and approval delays [31]. Along with the surfacing of planning and design weaknesses, other operational risks also emerge during the construction phase which include: contractor's poor management ability, owner's delayed payments to contractors, shortage in labor and equipment availability. Where the contractor's poor management ability and shortage in labor and equipment availability are the responsibility of the contractor, while the delayed payments are the responsibility of the owner. In fact, Taghipour et al. [32] explained that delays in settling contractors' claims and payment statements, not only impose financial strain on contractors but also increase the owner's payable amount due to fines and inflation adjustments. Moreover, the significance of the labor shortage risk was emphasized in a study done by Karimi et al. [33] who included that construction projects that experienced craft shortages underwent significantly higher growth in cost overruns compared with projects that did not. Additionally, in a recent study by Iyre et al. [34], they highlighted that contractor abilities in managing different risk scenarios should be one of the top prequalification criteria in contractor screening to ensure project success.

3.4. Handover-Related Risks

The handover phase serves as the pivotal transition between construction and operation. This research indicates ten risks that are in the handover phase namely: owner’s unreasonably imposed tight schedule, owner’s lack of funding, owner’s changes, owner’s improper interventions, delays in approvals, inadequate planning and scheduling, noncompliance with local standards and legislation, contractor’s poor management ability, owner’s delayed payments to contractors, shortage in labor and equipment availability. These echo Schultz et al.[35] who explain that some of the risks that complicates the handover phase in construction is the lack of planning of budgetary conditions, proper time schedules as well as early and continuous quality control to ensure compliance with standards. Shirkavand et al. [36] also added that one of the main reasons for an increase in handover risks is poor design which is a direct effect of the unreasonably tight schedule imposed by owners and the inadequate planning. Additionally, during the handover phase, the risk of damage is typically transferred from the contractor to the client/owner; this shift in responsibility often contributes to delays in final approvals and payments as additional inspections and documentations may be required [37]

Table 2 illustrates the mapping of the identified risks from literature to the different project lifecycle phases and the responsible project stakeholder. Figure 1 is a fishbone diagram that shows the relationship between the risks, different project lifecycle phases and the responsible stakeholders.

Table 2. Mapping of risks.

Acronyms	Risk Statement	Risk Source (stakeholder)		Likelihood Phases		References
OUIITS	Owner’s unreasonably imposed tight schedule	•	Owner	4	• Feasibility	[13,17,23,25,38,39]
					• Design	
					• Construction	
					• Handover	
OLF	Owner's lack of funding	•	Owner	4	• Feasibility	[17,22,38–42]
					• Design	
					• Construction	
					• Handover	
OC	Owner's changes	•	Owner	4	• Feasibility	[13,23,25,39,41,43–46]
					• Design	
					• Construction	
					• Handover	
OII	Owner's improper interventions	•	Owner	4	• Feasibility	[25,41]
					• Design	
					• Construction	
					• Handover	
DA	Delays in approvals	•	Owner Designer	4	• Feasibility	[17,25,40,41,43,47]
					• Design	
					• Construction	
					• Handover	
ICE	Inaccurate cost estimate	•	Owner Designer Contractor	3	• Feasibility	[13,17,23,39,41,48,49]
					• Design	
					• Construction	
					• Handover	
IPS	Inadequate planning and scheduling	•	Designer Contractor	3	• Design	[13,17,23,38,39,41–43,46,50]
					• Construction	
					• Handover	
					• Handover	
NLSL	Noncompliance with local standards and legislation	•	Designer	3	• Design	[17,38,41,48,49]
					• Construction	
					• Handover	
					• Handover	

DC	Design changes	• Designer	2	• Design • Construction	[13,23,25,39,42,46,47,50]
ISI	Inadequate site information	• Designer	2	• Design • Construction	[13,17,23,38,39]
DIDD	Delays in issuing drawings and documents	• Designer	2	• Design • Construction	[25,40]
DDS	Deficiencies in drawings and specifications	• Designer	2	• Design • Construction	[17,22,25,41,42,44,45,47,49]
CPMA	Contractors' poor management ability	• Contractor	2	• Construction • Handover	[13,17,23,40,42,49,50]
ODPC	Owner' delayed payments to contractors	• Owner	2	• Construction • Handover	[22,25,39,40,42–44,50]
SLEA	Shortage in labor and equipment availability	• Contractor	2	• Construction • Handover	[13,17,22,23,40,42–44,47–49]

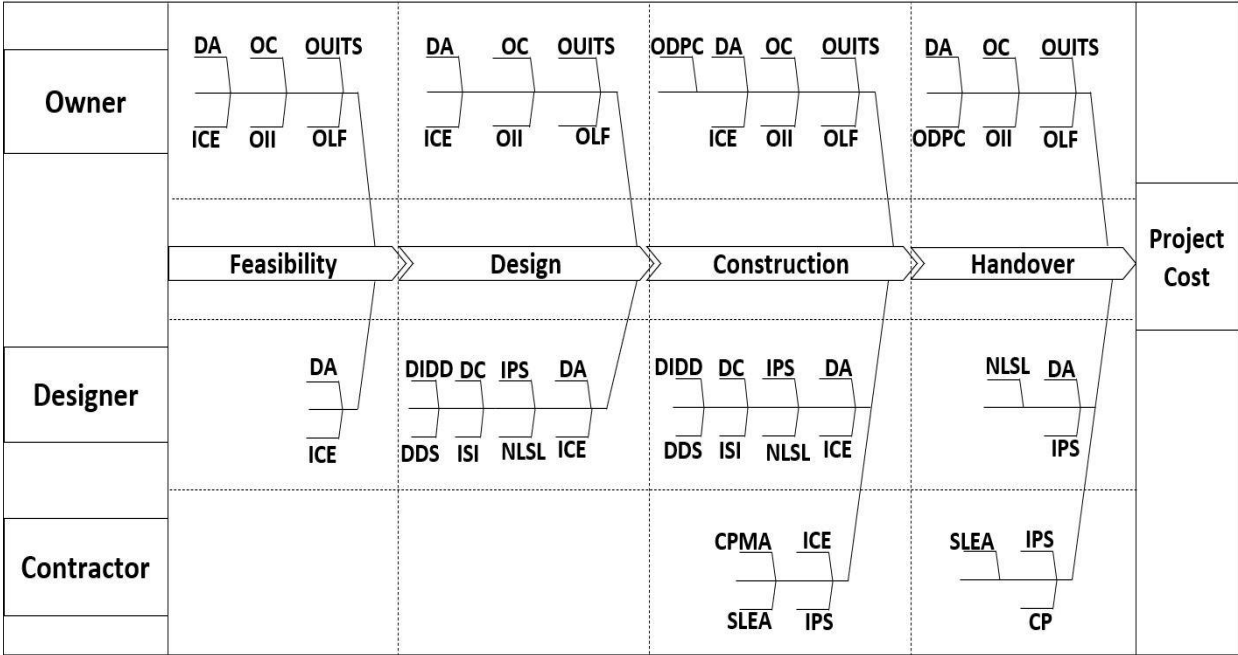


Figure 1. Fishbone Diagram.

4. Results and Analysis

4.1. Risk Behavior Across Lifecycle Phases

The results indicate that the top five significant risks were: owner’s delayed payments to contractors, contractors’ poor management ability, shortage in labor and equipment availability, design changes and owner’s unreasonably imposed tight schedule. Even though there are only four contractor-related risks addressed in this research, they are considered the most severe with an average RII of 11.59, followed by the owner-related risks and designer-related risks in very close proximity with RII average of 10.78 and 10.56 respectively. Indeed, this is an important observation, because although contractors are not the primary source of most risks, they often bear a significant share of the associated risks and uncertainties. Consequently, contractors tend to increase their costs to account for risks originating from other stakeholders. A shared understanding of risks from both

a lifecycle and stakeholder perspective could enable more effective joint risk management and help reduce the contractor’s financial burden.

Table 4 illustrates the risks’ significance through different lifecycle phases. The results show that the level of risk significance rises from the feasibility phase to the design phase, reaches its highest point during the construction phase, and then declines in the handover phase. This trend is expected, as the construction phase typically presents the most critical risks. It has been identified as the most vital phase due to the involvement of numerous stakeholders, the intensity of construction activities, and the substantial resource demands. The handover phase ranks as the second most important, followed by the design phase. Interestingly, a considerable number of risks emerge during handover, highlighting the need for stakeholders to monitor risks both before and after construction not just during it to prevent cost implications. Conversely, the feasibility phase is deemed the least significant, as it involves fewer stakeholders and minimal resource requirements. This is further illustrated in Figure 2.

Table 3. Risks average rating and stakeholder source.

DDS	Risk ID	Risk Significance Average	Rank	Risk Source
Owner’s delayed payments to contractors	ODPC	13.39	1	owner
Contractors’ poor management ability	CPMA	12.90	2	contractor
Shortage in labor and equipment availability	SLEA	12.44	3	contractor
Design changes	DC	11.08	4	designer
Owner’s unreasonably imposed tight schedule	OUIITS	11.04	5	owner
Inadequate planning and scheduling	IPS	10.92	6	Designer/contractor
Delays in issuing drawings and documents	DIDD	10.89	7	designer
Deficiencies in drawings and specifications	DDS	10.83	8	designer
Inadequate site information	ISI	10.44	9	designer
Delays in approvals	DA	10.33	10	Owner/designer
Owner’s changes	OC	10.29	11	owner
Owner’s lack of funding	OLF	10.28	12	owner
Inaccurate cost estimate	ICE	10.09	13	Owner/designer/contractor
Owner’s improper interventions	OII	10.04	14	owner
Noncompliance with local standards and legislation	NLSL	9.87	15	designer

Table 4. Risks significance through different lifecycle phases.

Risk Statement	Risk ID	Risk Significance			
		Feasibility	Design	Construction	Handover
Owners unreasonably imposed tight schedule	OUIITS	9.95	10.35	12.17	11.70
Owner’s lack of funding	OLF	8.44	8.00	13.64	11.06
Owner’s changes	OC	7.53	9.67	12.83	11.12
Owner’s improper interventions	OII	8.14	9.71	11.71	10.59
Delays in approvals	DA	7.86	9.09	12.05	12.32

Inaccurate cost estimates	ICE	9.05	9.44	11.77	
Inadequate planning and scheduling	IPS		9.79	12.06	10.91
Noncompliance with local standards and legislation	NLSL		8.71	10.45	10.44
Design changes	DC		10.17	12.00	
Inadequate site information	ISI		9.48	11.39	
Delays in issuing drawings and documents	DIDD		10.30	11.48	
Deficiencies in drawings and specifications	DDS		10.39	11.27	
Contractors' poor management ability	CPMA			13.14	12.67
Owners delayed payments to contractors	ODPC			13.18	13.59
Shortage in labor and equipment availability	SLEA			13.20	11.68
Average		8.49	9.59	12.16	11.61

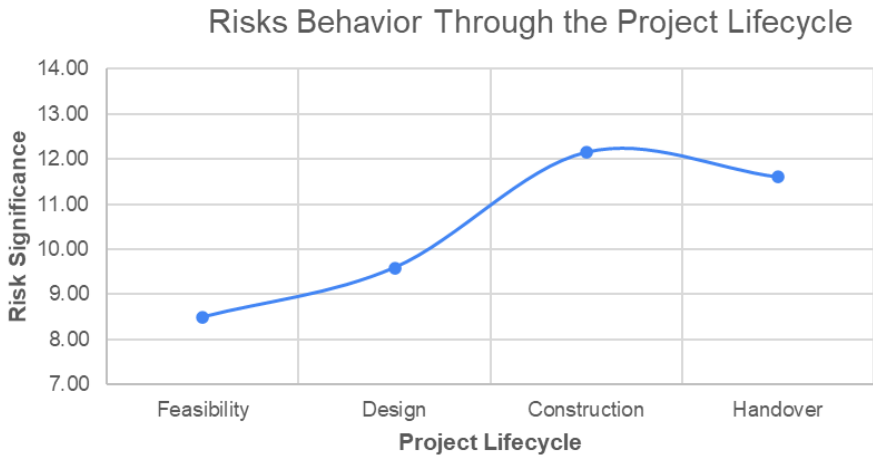


Figure 2. Risks General Behavior in all Lifecycle phases.

Five risks are present across all four phases of the project lifecycle, each of them varies in probability and cost impact depending on the phase, resulting in 20 distinct probability-impact combinations. These risks include: *owner's tight schedule*, *lack of funding*, *owner changes*, *improper interventions*, and *delays in approvals*. When viewed from a lifecycle perspective, the significance and ranking of these risks may differ from phase-specific assessments. Figure 3 illustrates their dynamic behavior, showing, for example, that the "delays in approvals" risk (DA) has minimal impact early on but becomes highly significant during the construction phase. This shift emphasizes the need to understand risk evolution over time. Ignoring this could lead to inadequate preparation and unexpected cost increases. Therefore, risks must be evaluated holistically from the start, using tools like the coordinate system to anticipate behavioral changes. For instance, the "owner changes" (OC) risk grows in importance during the design and construction phases but lessens in the handover phase. This implies that risk management strategies and resource allocation should adapt accordingly, rather than remaining fixed throughout the lifecycle, to improve cost efficiency and control.

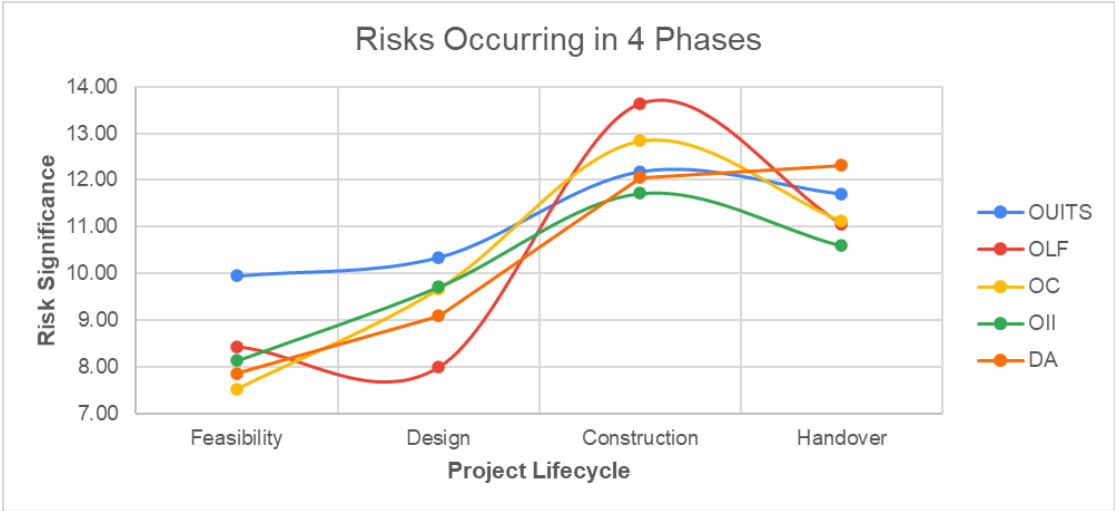


Figure 3. Risks behavior in 4 lifecycle phases.

The risks of “inaccurate cost estimate”, “inadequate planning and scheduling”, and “noncompliance with local standards and legislation” are observed across three project phases. Their behavior and revised rankings are illustrated in Figure 4. The *inaccurate cost estimate* risk first appears in the feasibility phase, intensifies during the design phase, and then rises sharply in the construction phase due to the complexity and volume of execution activities, making cost forecasting more difficult. The *inadequate planning and scheduling* risk follows a typical risk progression; emerging in the design phase when planning activities begin, peaking during construction, and then declining during the handover phase. In contrast, *noncompliance with local standards and legislation* exhibits an unusual trend. It originates in the design phase, escalates during construction, and remains nearly constant into the handover phase. This persistent risk level is due to the potential discovery, late in the project, that certain components fail to meet local regulations, making corrections difficult and costly after construction is complete.

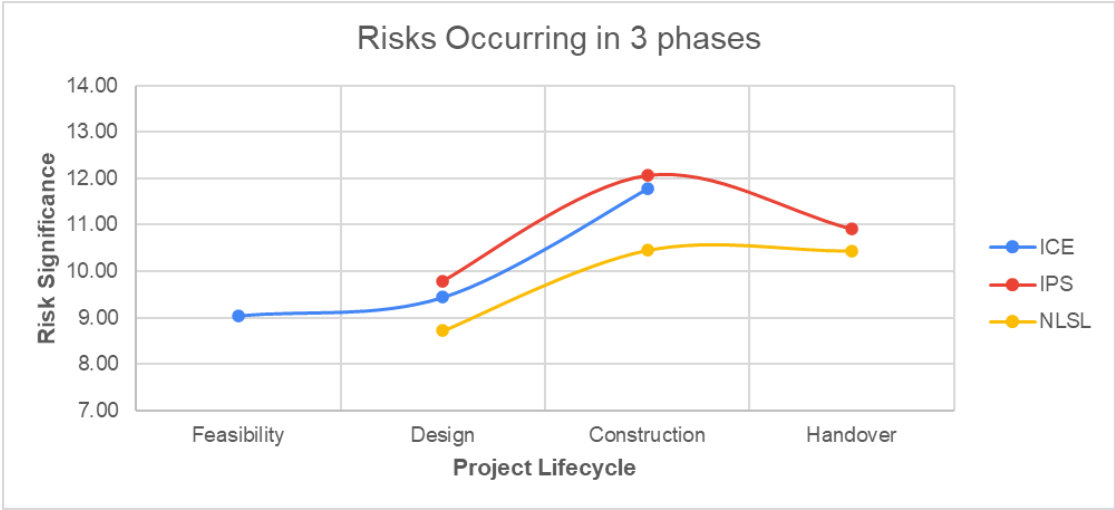


Figure 4. Risks occurring in three lifecycle phases.

Seven risks were identified to occur across two phases of the project lifecycle, as illustrated in Figure 5. From the coordinate system, it is evident that the risks of *design changes*, *inadequate site information*, *delays in issuing drawings and documents*, and *deficiencies in drawings and specifications* display similar trends across the design and construction phases. While these issues emerge during the design phase, their impact is relatively minor at that stage due to the flexibility for adjustments.

However, they become significantly more critical during construction, as changes to drawings and specifications are much harder to implement and can greatly affect project costs.

The remaining risks occur in the final two phases: construction and handover, and follow a different trajectory. These include *contractors' poor management ability*, *labor and equipment availability*, and *owner's delayed payments to contractors*. While all three exhibit comparable importance during the construction phase, their behavior diverges during handover: the impact of poor management decreases slightly, the significance of labor and equipment shortages drops sharply, and the risk of delayed payments by the owner rises considerably toward the project's end.

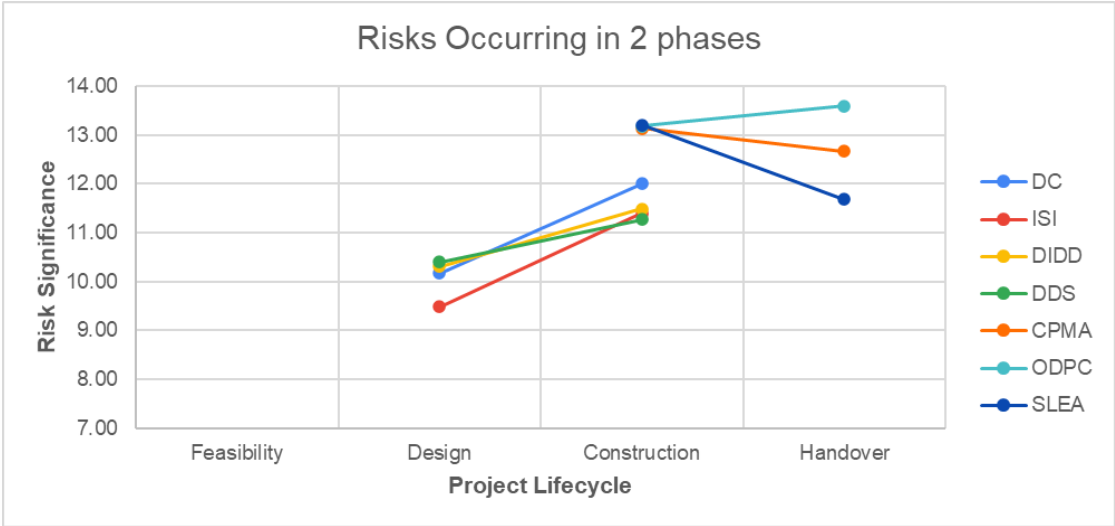


Figure 5. Risks behavior in 2 lifecycle phases.

A more accurate comparison of risks requires evaluating all parameters, including the number of lifecycle phases in which each risk appears. To achieve this, a three-dimensional bubble chart (Figure 6) is used to summarize the risks by incorporating probability (y-axis), cost impact (x-axis), and lifecycle occurrence (represented by bubble size). Large bubbles represent risks spanning four phases, medium-sized bubbles represent those appearing in three, and small bubbles indicate risks limited to two phases. This visualization enhances risk management by offering a more comprehensive and realistic perspective. Risks positioned in the top-right corner with large bubbles are particularly concerning, as they combine high probability, high impact, and frequent occurrence throughout the project. Such risks should be prioritized in the risk management process. However, determining which risks to prioritize isn't always straightforward, practitioners may weigh the variables differently based on their project context. Some may focus on risks with the most repetitions across phases rather than those with the highest probability or impact alone. For instance, in the bubble chart, the risk of *owner's unreasonably imposed tight schedule* (OUIITS) might attract more attention than *owner's delayed payment to contractors* (ODPC), even if the latter has a lower Relative Importance Index (RII). This is because OUIITS appears in all four phases and carries both high probability and impact. This example highlights how incorporating the lifecycle dimension can shift risk prioritization strategies, offering valuable insight tailored to the project's nature and criticality.

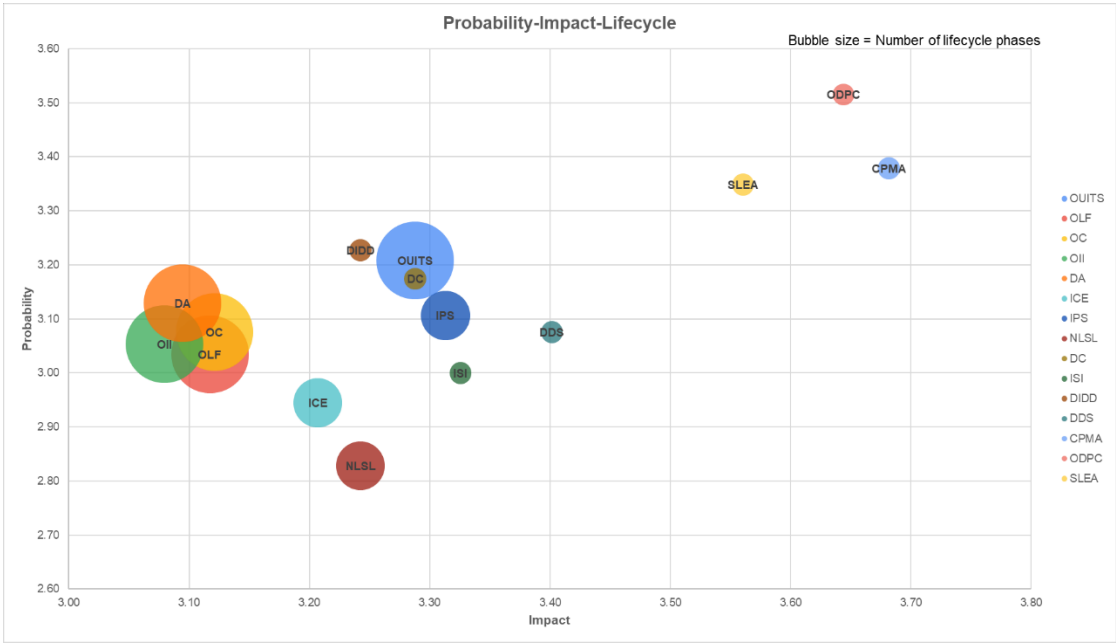


Figure 6. Probability, cost impact and lifecycle phases bubble chart.

4.2. Phase-by-Phase Risk Recommendations

4.2.1. Feasibility Phase

The most significant risks in this phase are owner’s unreasonably imposed tight schedule, inaccurate cost estimates and owner’s lack of funding. These are mainly owner-driven, stemming from unrealistic expectations and lack of financial clarity. Some of the main recommendations to tackle these risks include strengthening feasibility studies. In fact, several researchers have advocated for integrating risk and uncertainty analysis as well as optimization approaches within feasibility studies for more robust project financial assessments [51,52]. Further, involving the contractors early on will help bring a practical and execution-focused insight into the planning and feasibility phase. This can help provide realistic cost inputs based on market rates, labor conditions and constructability [53]

4.2.2. Design Phase

The three most significant risks in this phase include: deficiencies in drawings and specifications, delays in issuing drawings and owner’s unreasonably tight schedule. All these risks stem from poor documentation quality and information flow in the construction projects. Therefore, it is crucial to hire an experienced and qualified design team as well as permitting them an adequate timeframe for design development. In some construction projects, it might even be essential to implement a partial design freeze to help streamline and enforce the design process, regulate modifications, and ensure that design milestones are completed within the planned timeframe [54]. Research has also shown that BIM–Lean approach can be highly effective. By combining 4D simulation with look-ahead planning, quantity take-off, and clash detection during both the look-ahead and weekly work planning stages, potential design conflicts can be identified and resolved early. This proactive process reduces costly rework, minimizes schedule disruptions, and ensures greater alignment among stakeholders. The enhanced BIM–Lean workflow facilitates seamless design coordination during the construction phase, enabling timely decision-making and delivering additional value to the owner [55]

4.2.3. Construction Phase

This is the risk epicenter with all fifteen risks occurring in this phase. Many risks from earlier phases materialize during construction, amplified by poor execution readiness, stakeholder misalignment and site logistics. Risks that rank the highest in severity in this phase include: owner's lack of funding, shortage in labor and equipment available, owner's delayed payments and contractors' poor management ability. There is no denying that payment serves as the lifeblood of construction operations, as the successful execution of any activity relies on a continuous flow of funds[56]. However, such steady cash flow is highly uncommon, and disruptions can severely impact businesses, with the most serious cases escalating into legal disputes. Many of the mechanisms to ensure prompt payment already exist within legal and contractual frameworks, but the real solution lies in shifting the mindset of upstream stakeholders. Timely payment should be treated as a core project obligation rather than a negotiable leverage point [57]. Furthermore, contractors should prioritize training in cashflow management [58]. Beyond payment risks, the construction phase is highly sensitive to productivity risks as well. Shortages in labor and equipment often result from poor resource forecasting or fragmented subcontractor management [59]. This can be mitigated by robust procurement planning, early engagement with subcontractors, and continuous workforce monitoring to anticipate and address shortages before they affect critical activities. Ultimately, the construction phase demands the most intensive risk monitoring and rapid mitigation response, as delays and inefficiencies here have the most direct and costly effect on overall project performance.

4.2.4. Handover Phase

This phase shows that residual risks from construction and final approvals can still cause significant cost impact. The three most critical risks in this phase include: owner's delayed payments, delays in approvals and contractor's poor management ability. In fact, risks like 'delays in approvals' peaking in handover strongly suggest that unresolved compliance issues arise late in construction projects. Too et al. [60] explain that delays in approvals during the handover phase are often caused by the overwhelming volume of documentation and inspections required at the project's closeout stage, a situation that can be described as a "tsunami of information." This surge in submittals, authority inspections, compliance checks, and snag lists can easily exceed the reviewing capacity of stakeholders, resulting in bottlenecks. To mitigate this, breaking the project into mini-handover packages, each representing a defined, self-contained portion of work, can significantly streamline the approval process.

5. Conclusions

This study presents a comprehensive approach to risk management by examining the dynamic behavior of construction risks across all phases of the project life cycle in the UAE. Unlike traditional methods that evaluate risks statically within isolated phases, this research emphasizes a holistic perspective, accounting for how risk probabilities and impacts evolve from feasibility through to handover. By identifying fifteen critical risks and categorizing them based on stakeholder responsibility and life cycle occurrence, the study offers a deeper understanding of their changing significance and interrelationships. Key findings reveal that while risks such as *owner's delayed payments* and *contractor management deficiencies* ranked highest overall, risks like *owner's unreasonably imposed tight schedule* gained greater prominence due to their presence across all four phases. The use of tools such as the coordinate system and bubble charts allowed for a visual analysis of risk fluctuations, enabling stakeholders to prioritize mitigation strategies more effectively. The construction phase emerged as the most risk-intensive, yet the importance of risk monitoring during handover was also evident, highlighting the need for continuous assessment beyond active construction. The study's integrated risk mapping, combining probability, cost impact, and frequency of occurrence, provides valuable insights for more adaptive and targeted risk management practices. These findings are particularly relevant for project managers, consultants, and

policymakers seeking to improve cost efficiency and stakeholder collaboration. Ultimately, the research underscores the need to shift from phase-based risk assessments to dynamic, lifecycle-oriented strategies. By doing so, construction professionals can proactively address emerging risks, optimize resource allocation, and enhance overall project success in complex environments like the UAE construction industry.

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