JEAS
Journal of Economics and Administrative Sciences
E-ISSN: 2148-1792 P- ISSN: 1302-2024
Volume 5, Supplement Issue 1
www.jeasweb.org

Risk classification and ranking in construction projects

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ABSTRACT

As one of the largest industries in the world, the construction industry is associated with a high turnover. Despite the long history of the construction industry and numerous experiences from the execution of construction projects worldwide, most risk management processes remain neglected when implementing construction projects. It is essential under such circumstances to facilitate the implementation of risk management processes in construction projects to increase their likelihood of success. Accordingly, this study comprehensively reviewed the literature on methods for classifying the collected risks and compared risks collected by different scholars to take a step toward organizing, identifying, and discovering the root causes of construction project risks. Moreover, due to multiple risks in construction projects and the need for focusing on the most significant risks, efforts were also made to introduce such risks in construction projects by reviewing studies and surveys made by different scholars and organizations in this area. Given the scope of this study, namely the construction industry and the distinctive features of the construction industry compared with other industries, these specific features were studied in compliance with the implementation of risk management processes.
Keywords: Construction projects, Risk classification, Risk groups, Risk prioritization

1.Introduction

Risks are identified, classified, and prioritized as part of project risk management activities. Risks are classified to be better organized and to identify of all risks and discover their root causes. On the other hand, risks are prioritized to concentrate limited project resources to deal with those risks with the most significant impact on the construction project.

This study comprehensively reviews the literature to identify various methods used by different scholars for classifying construction project risks. By comparing these classification methods, some approaches are suggested for classifying construction project risks. These results can be used for identifying and organizing construction project risks in which risk management processes are not mainly implemented.

Considering extensive experiences from the implementation of construction projects, the most important construction project risk groups can be determined through surveying experts' opinions and reviewing completed projects. A list of the most significant risk groups is prepared through reviewing the literature and analyzing the points of agreement and disagreement of experts to obtain a correct understanding of significant risks in construction projects.

It is noteworthy that risk management in construction industry has unique features. These features should be recognized to review the literature and the express results in the framework of requirements for this industry.

2. Construction Project Risk management

The construction industry is among the largest industries around the world. According to statistics published in 2006, it accounts for nearly 3.5 trillion dollars, i.e., about 10% of the global gross domestic product (GDP) [1]. The construction industry is considered a highly heterogeneous and complicated industry. There are different sectors in this industry, including construction, renovation, reconstruction, and destruction [2]. Except for residential projects, construction projects do not produce a product but provide the infrastructure for the production or maintenance of products or service facilities such as dams, highways, and parks. Construction projects are dealing with different geographies, natural events, and environmental impacts. These projects involve teams and multiple stakeholders, especially from different social and environmental groups, which is not the case in most other types of projects. Besides, most construction projects need a high volume of materials and physical tools for handling or changing those materials. [3]

Cultural diversity due to the geographical extent of construction projects and the ethnic diversity of teams involved in such projects is among the unique features of construction projects. Cultural diversity is of particular importance when the owner uses services provided by a foreign contractor. Accordingly, a team consisting of native employees of the owner and staff of the foreign contractor should be formed. Such a team combination of different cultures should be identified as a limitation for the success of construction projects [3].

Safety and environmental issues are among the other specific features of construction projects. These issues are of particular importance to the extent that two separate chapters have been allocated to “project safety management” and “project environmental management” in Construction Extension to PMBOK Guide released by Project Management Institute (2016) in addition to what is published in PMBOK Guide.

Safety management includes processes to ensure the prevention of events causing damages to staff or equipment during the implementation of construction projects. Human damages, deaths, and relevant direct and indirect costs are among the great concerns in the construction industry. According to the literature, a dollar consumed for developing a proper safety plan causes a 4-8 dollar reduction in accident causalities. It is noteworthy that the outcome of some construction project risks is so severe that construction workers are respectively three times and two times more likely to be killed and injured in comparison with workers in other industries. [2, 3].

Project environmental management includes processes to ensure the impact of a project on its surroundings within limits specified in legal permits. The aim is not to prevent environmental impacts but is to keep these impacts within limits specified in legal permits because construction projects are intrinsically associated with such impacts [3].

Implementation of projects at the international level is another feature of this industry. Most organizations involved in the construction industry earn profits mainly through international projects. Higher contract amounts, more extended turnover periods, complex financing, exchange rate variations, and the governance of laws in the host country are among the hazards faced by international construction projects [4].

Some factors causing the significance of construction project risk management in compliance with the scope of this industry include [2, 5, 6]:

- The low potential of construction projects to achieve their predetermined objectives based on the existing experiences
- The possibility to earn incomes through unconventional projects against the complexity and high dependence of their activities
- The increase in the number of competitors and thereby efforts made by firms to promote efficiency and reduce costs
- The long-term implementation of construction projects
- The high volume of financial activities
- The need for a dynamic organization structure for implementing construction projects

Accordingly, risk management is critical to achieve construction project objectives in five areas of time, cost, quality, safety, and environmental stability [5].

As explained by Walewski et al. (2006), projects which are complex, large and new, demand a high amount of resources, have a long schedule, involve multiple organizations and have critical political issues, require a more detailed risk management process than other projects. Notably, most construction projects have these features [1].

To study the significance of construction project risk management, it is notable to consider some statistics on the failure of construction projects in achieving their predetermined objectives. According to surveys implemented by McGraw Hill Construction (2011), 35 active companies in the construction industry were analyzed to provide strategies to reduce risks and increase profitability. The analysis of results revealed that: [7]

- 35% of projects delayed over 15% of the permissible duration of the project implementation.
- 26% of projects exceeded the cost over 15% of the initial budget.
- 18% of projects had changed over 20% of their scope.

Other studies to reveal the failure of construction projects to achieve their predetermined goals reviewed by Mehdizadeh (2012) are as follows: [8]

- Odeck (2004) analyzed 620 road construction projects and found that the total cost exceeded the allocated budget in more than 50% of projects.
- IPA (2011) reviewed more than 1000 projects implemented by 100 construction companies worldwide and found that only 37% of these projects meet all criteria for the success of projects.
- Flyvbjerg et al. (2002) statistically analyzed construction projects in the transportation sector in 70 years and found that 90% of these projects exceeded the budget by 20 to 45%.
- Baloi and Price (2003) analyzed 1178 projects executed by the World Bank in 14 years and showed that 63% of the projects significantly exceeded the costs.
- Morris and Hough (1991) reviewed 3500 construction projects in different countries and found 40 to 200% violation of the predetermined budget in the projects.

It is crucial who implement the risk management processes because of differences in the focus on the processes and judgment on parameters. A customer focuses on the final quality of the project product, final costs, and delays. In contrast, a contractor mainly focuses on the correct financial results, staff safety, following projects in the future, and its reputability in society [8]. Consequently, various stakeholders involved in a project, such as customers, main contractors, sub-contractors, and state agencies, consider different values for the probability and impact of a specific risk [3]. Some studies on this area are reviewed below:

- Surveys conducted by McGraw Hill Construction (2011) revealed that risk assessment is carried out centrally in the construction companies in the tender phase indicating the special attention of these companies to risk assessment before being committed to a project. Moreover, project owners mainly assess project risks in the design phase, indicating their efforts to hold contractors accountable for most risks during the construction phase [7].

- Kangari (1995) indicated a relatively straightforward pattern in allocating construction project risks to contractors and project owners by the results obtained from reviewing eight articles and surveying 50 major construction contractors. For example, risks caused by natural disasters are allocated to the owner, whereas those caused by defective materials to the contractor [9]. Notably, a stakeholder has a more significant share in managing risks caused by that stakeholder. Accordingly, in a classification method, the risks are classified based on the project stakeholders accountable for addressing those risks.

Despite the significance of the implementing risk management processes in construction projects, there has been less interest in this issue by those involved in the construction industry. The analysis of studies by McGraw Hill Construction (2011) showed that only 29% of companies desirably (for over 75% of risks) implement the risk assessment process and 18% the risk responding process [7]. This result clearly shows the low level of implementation of risk management processes in the construction industry. Nowadays, risk management is an integral part of construction project management for successfully implementing of such projects [2]. Accordingly, some standards such as Construction Extension to PMBOK Guide published by Pm, I. (2016) and some scholars such as Del Cano & De La Cruz (2002) have made efforts to develop a specific model for construction projects. However, these efforts seem insufficient to meet requirements in the construction industry. Improper risk management in construction projects necessitates more effort to meet this requirement. Accordingly, the risk groups introduced by different scholars are studied to facilitate the identification and classification of risks as one of the first risk management activities made by construction project managers.

3. Risk classification

Classification of construction project risks is a crucial step in construction project risk management. Accordingly, efforts are made to organize these risks and better identify factors causing such risks. Numerous studies have been conducted on the classification of construction project risks; some of them are reviewed below [5, 8, 11]:

- Pipattanapiwong (2004), Aleshin (2001), and El-Sayegh (2008) classified risks into internal and external risk groups.

- Cooper and Chapman (1987) classified risks into main and sub-risks groups based on nature and size.

- Tam (2007) classified risks based on their significance into the upper, middle, and lower groups.

- Chapman (2001) divided risks into industry, customer, project, and environmental groups.

- Shen (2001) classified risks into financial, legal, management, market, political, and technical groups based on nature.
- Perry and Hayes (1985) classified 29 major construction project risks in 9 groups including physical, environmental, design, logistics, financial, legal, political, construction, and operation. They also classified the risks into three groups of contractors, consultants, and customers based on the person in charge of addressing and monitoring risks.
- Chan and Kumaraswamy (1996) classified 83 risks causing delays in construction projects into eight groups of customer-related factors, project, design team, contractor, work, project site and equipment, materials, and external factors.
- Mustafa and Al-Bahar (1991) identified 32 construction project risks and classified them into six groups of natural events, physical, financial, economic, design, and project site.

Multiple other methods have also been suggested by other scholars:

- Rezakhani (2012) classified risks into project execution, project management, engineering, financial, and external groups [12].
- Han (2001) divided the construction project risks into political, financial, cultural/legal, technological/construction, and other risks [13].
- Ravanshadnia et al. (2010) classified construction project risks based on the project lifetime into the study period, contract period, design period, logistics and equipment period, and construction and operation period groups [6].
- Mehdizadeh (2012) classified construction project risks based on risk breakdown structure (RBS) and a multifaceted view to risk features such as the time of occurrence, the affected objectives, and the person in charge. Accordingly, construction project risks are divided into three branches at the highest level. The first branch includes two groups of project management risks and other stakeholder-related risks, formed based on stakeholders. The second branch includes two groups of internal (inside the project) and external (outside the project) risks, formed based on the origin of risk occurrence. Furthermore, the third branch includes six groups of the feasibility study, contract period, design period, execution period, operation, and management risks, formed based on the project lifetime.
- Abd Karim et al. (2012) classified a set of 25 significant construction project risks into construction, financial, political and contractual, design, and environment groups [14].
- Teixeira et al. (2009) classified construction project risks into construction operation, financial and economic, performance and effectiveness, political and social, legal and contractual, and safety and physical conditions [15].
- Walewski et al. (2006), through a comprehensive literature review and structured interviews with those involved in the construction industry, classified construction project risks into four groups reflecting the project lifetime, including the financial (including the business plan and financial/investment groups), regional (including legal, political, cultural, tariff/tax groups), facilities (including the project scope, resources and demand, design/engineering, construction, and startup groups) and production and operation (including individuals, rules, and technical groups) [1].

Construction project risks are also classified based on static or dynamic, independent or dependent, positive or negative, acceptable or unacceptable, insurable or non-insurable [8]. The risk groups have been specified in some studies based on the risk impact areas. This classification allows the identification of areas where more risks exist and responding better to them [16]. Some studies, in this case are as below: [5,11]

- Chen (2004) classified 15 significant risks affecting the railway project costs into three groups.
- Shen (1997) identified and ranked eight significant risks for delays in construction projects using a questionnaire designed for this purpose.
- Tam (2004) classified the most critical factors affecting project safety into four groups.
- Azhar (2008) classified 43 cost overrun risks into three groups, including major economic, management, and business and legislation environment groups merely based on financial objectives.

As mentioned earlier, projects executed by construction companies are not limited to a region or a country where their organizations are located. However, these companies are looking for international markets to gain more profits. As a result, these companies face a set of risks such as unawareness of social conditions of the region, new political and economic issues, and unknown processes. As a result, a different method for classifying construction project risks was developed. Some studies, in this case are as below:

- According to Wang (2004), construction project risks are mainly classified depending on local or international [2].
- Zhi (1995) divided risks into the project, organizational, construction industry, and location/nationality groups [17].
- Tah & Carr (2000) divided risks into internal and external groups. The external risks are related to the national and regional market or the local construction industry. In contrast, internal risks are uncertainties originating from the nature of the project or organizations involved in that project [18].

As previously discussed, there is no consensus or standard for classifying construction project risks [8]. Models derived from different statistical populations and environments classify construction project risks by different methods. Each classification method has been developed in compliance with a specific management requirement, and thus none of these methods can be prescribed.

4. Risk ranking

Numerous studies have been conducted on ranking and determining the most crucial construction project risks to reduce the number of assessed risks, concentrate limited resources to respond to the most crucial risks, and implement the risk assessment process more precisely. Some studies in this area are reviewed below:

- Abd Karim et al. (2012) used comments of a 50-member population consisted of different construction contractors, classified 25 significant construction project risks in 5 groups, and then ranked [14].
- Zou et al. (2006) distribute a questionnaire among 60 actors in the construction industry, separately ranked 20 significant construction project risks based on their impact on the cost, time, quality, environment, and project safety [5].

- The comments by 35 managers of construction companies on the significance of project risks were collected by McGraw Hill Construction (2011), and seven risks were ranked as the most critical construction project risks [7].
- Banaitiene & Banaitis (2012), according to information extracted from three surveys from 2008 to 2010 from 101 construction companies, calculated the probability and impact of occurrence for 20 most important construction risks on a semi-qualitative scale and obtained the values of the relative risk by multiplying the probability and impact values [2].
- Kangari (1995) surveyed nearly 50 major construction contractors in the US to estimate the significance of 23 risk groups of construction projects determined by ASCE (1979) [9].

Table 1 lists the ranks of the most critical construction project risks reported in the literature. In order to make a comparison of the risk values in different studies possible, a value of unity (1) assigned to the most critical risk in each article, then the relative value of other risks was determined as a ratio of the value of the most critical risk (a range from 0 to 1).

Table 1: Ranking the construction project risks reported in the literature

Banaitiene & Banaitis (2012)		
Code	**Risk**	**Value**
BB-01	Design errors and omissions	1
BB-02	Scheduling errors, contractor delays	0.8
BB-03	Construction cost overruns	0.8
BB-04	The design process takes longer than anticipated	0.6
BB-05	Failure to comply with contractual quality requirements	0.6
BB-06	Stakeholders request late changes	0.45
BB-07	Failure to carry out the works under the contract	0.45
BB-08	Inexperienced workforce and staff turnover	0.45
BB-09	Delayed deliveries	0.45
BB-10	Project team conflicts	0.45
BB-11	New stakeholder emerge and request changes	0.4
BB-12	Environmental analysis incomplete	0.4
BB-13	New alternatives required to avoid, mitigate or minimize environmental impact	0.4
BB-14	Lack of protection on a construction site	0.4
BB-15	Technology changes	0.4
BB-16	Contradictions in the construction documents	0.3
BB-17	Tax changes	0.2
BB-18	Expired temporary construction permits	0.2
BB-19	Public objections	0.15
BB-20	Laws and local standards change	0.15

Zou et al. (2006)		
Code	**Risk**	**Value**
ZZ-01	Tight project schedule	1
ZZ-02	Design variations	0.73
ZZ-03	Excessive approval procedure in administrative government departments	0.72
ZZ-04	Variations by the client	0.7
ZZ-05	Unsuitable construction program planning	0.67
ZZ-06	Inadequate program scheduling	0.63
ZZ-07	Occurrence of dispute	0.63
ZZ-08	Price inflation of construction materials	0.61
ZZ-09	Incomplete approval and other documents	0.58
ZZ-10	Bureaucracy of government	0.58
ZZ-11	High performance or quality expectations	0.57
ZZ-12	Variations of construction programs	0.57
ZZ-13	Incomplete or inaccurate cost estimate	0.57
ZZ-14	Low management competency of subcontractors	0.54
ZZ-15	Unavailability of sufficient amount of skilled labor	0.46
ZZ-16	General safety accident occurrence	0.45
ZZ-17	Lack of coordination between project participants	0.43
ZZ-18	Unavailability of sufficient professionals and managers	0.4
ZZ-19	Inadequate or insufficient site information	0.37
ZZ-20	Severe noise pollution caused by construction	0.34

McGraw Hill Construction (2011)		
Code	**Risk**	**Value**
MC-01	Design/ Project changes and scope creep	1
MC-02	Budget/ Cost overruns	0.82
MC-03	Project approval process	0.65
MC-04	Safety	0.65
MC-05	Site conditions	0.65
MC-06	Scheduling	0.53
MC-07	Utilities	0.35

Abd Karim et al. (2012)		
Code	**Risk**	**Value**
AM-01	Shortage of material	1.00
AM-02	Late deliveries of material	1.00
AM-03	Shortage of equipment	0.99
AM-04	Poor quality of artistry	0.96
AM-05	Cash flow difficulties	0.97
AM-06	Insolvency of subcontractors	0.95
AM-07	Inadequate planning	0.95
AM-08	Insolvency of suppliers	0.94
AM-09	Changes in law and regulation	0.94
AM-10	Bureaucracy	0.94
AM-11	Lack of financial resource	0.93
AM-12	Site safety	0.92
AM-13	Delay in payment for a claim	0.91
AM-14	Change scope of work	0.91
AM-15	Poor supervision	0.89
AM-16	Weather	0.88
AM-17	Compliance with government	0.86
AM-18	Delay in project approval and permits	0.85
AM-19	Land acquisition	0.84
AM-20	Inconsistencies in government policies	0.83
AM-21	Pollution	0.82
AM-22	Excessive contract variation	0.81
AM-23	Ecological damage	0.80
AM-24	Compliance with law and regulation for environmental issue	0.79
AM-25	Improper design	0.63

Kangari (1995)		
Code	**Risk**	**Value**
K-01	Safety	1.00
K-02	Quality of work	0.99
K-03	Defective design	0.96
K-04	Labor and equipment productivity	0.92
K-05	Contractor competence	0.90
K-06	Delayed payment on a contract	0.90
K-07	Financial failure- any part	0.88
K-08	Changes in work	0.83
K-09	Differing site condition	0.83
K-10	Contractor-delay resolution	0.82
K-11	Indemnification and hold harmless	0.78
K-12	Labor, equipment, and material availability	0.77
K-13	Change-order negotiation	0.77
K-14	Third-party delays	0.75
K-15	Actual quantities of work	0.70
K-16	Site access/ right of way	0.67
K-17	Labor disputes	0.66
K-18	Defective materials	0.61
K-19	Permits and ordinances	0.57
K-20	Inflation	0.57
K-21	Defensive engineering	0.55
K-22	Acts of god	0.53
K-23	Changes in government regulations	0.49

5. Conclusion

The main results are summarized below:

- Due to the unique feature of construction projects, the risk management processes in the construction industry are different and more critical than those in other industries.
- Based on the statistics, the risk management processes are implemented to a minimal extent in construction projects. While most construction projects fail to achieve their predetermined objectives. Accordingly, it is suggested to facilitate the implementation of risk management processes for construction project managers.
- The methods for classifying construction project risks are based on the needs recognized by the project manager, and there is no obligation to select a specific method for this purpose. However, identifying the risk groups helps better identification of risks and structured thinking on risks. By comparing 15 articles on the classification of construction project risks, a relatively same pattern was observed for classifying and determining construction project risk groups, as shown in Table 2. As seen in Table 2, some scholars have ignored the existence of some risk groups. In contrast,

some other scholars have considered risk subgroups instead of an overall risk group to provide more details.

Furthermore, the presence of common risk groups in the classifications reported in the literature indicates a consensus on the significance of these risk groups. According to the results, to implement construction projects and risk identification and assessment processes (especially at the beginning of the project when less information exists), it is suggested to use four risk classification methods including the origin of occurrence, project lifetime, person in charge of addressing risks, and the nature of risk. If there is a need for more details on construction project risks, they can be classified by other methods in the following stages.

Table 2: The conventional classes of construction project risks

Basis of classification	Groups	Articles						
		Pipattanapiwong (2004)	Aleshin (2001)	El-Sayegh (2008)	Tah & Carr (2000)	Mehdizadeh (2012)	Zhi (1995)	Chapman (2001)
Origin of occurence	Inside the project	✓	✓	✓	✓	✓	✓	✓
	Out of the project	✓	✓	✓	✓	✓	-	-
	Industry	-	-	-	-	-	✓	✓
	Customer/organization	-	-	-	-	-	✓	✓
	Surrounding environment	-	-	-	-	-	✓	✓

Basis of classification	Groups	Articles					
		Han (2001)	Abd Karim et al (2012)	Rezakhani (2012)	Shen (2001)	Teixeira et al (2009)	Perry & Hayes (1985)
The nature of risk	Financial and economic	✓	✓	✓	✓	✓	✓
	Legal	✓	✓	-	✓	✓	✓
	Political	✓	✓	-	✓	✓	✓
	Cultural	✓	-	-	-	✓	-
	Construction/technical	✓	✓	✓	✓	✓	✓
	Surrounding environment	-	✓	✓	-	-	✓
	Other	✓	-	-	-	-	-
	Engineering/design	-	✓	✓	-	-	✓
	Market	-	-	-	✓	-	-
	Management	-	-	✓	✓	-	-
	Efficiency	-	-	-	-	✓	-
	Physical	-	-	-	-	✓	✓
	Safety	-	-	-	-	✓	-
	Operation	-	-	-	-	-	✓
	Logistics	-	-	-	-	-	✓

Basis of classification	Groups	Articles: Mehdizadeh (2012)	Articles: Ravanshadnia et al (2010)	Articles: Zou et al (2006)
Project lifetime	Feasibility studies	✓	✓	✓
	Design	✓	✓	✓
	Logistics	-	✓	-
	Construction	✓	✓	✓
	Operation	✓	✓	✓
	Contract	✓	✓	-
	Management	✓	-	-

Basis of classification	Groups	Articles: Zou et al (2006)	Articles: Perry & Hayes (1985)
The person in charge	Customer	✓	✓
	Designer	✓	✓
	Contactor	✓	✓
	Supplier	✓	✓
	Government	✓	-
	External factors	✓	-

- Comparing five articles on ranking construction project risks showed the lack of consensus on the construction project risk with the highest significance. Accordingly, different risks have been introduced in different articles having the highest value and rank based on the method applied, project conditions, and surrounding environment.

- Through a comprehensive look at the most critical risks introduced by different scholars in the Risk Ranking section of this article, ten construction project risk groups with the highest significance are listed in Table 3, showing the risks introduced by each scholar. To implement construction project risks assessment and responding processes (especially at the beginning of the project when less information exists), it is recommended to focus more on these ten risk groups to resolve hazards and provide proper conditions for the success of projects. Table 4 lists these ten groups in the order of significance with descriptions.

Table 3: The most crucial risk groups in construction projects

Group \ Article	Zou et al (2006)	Nur Alkaf et al (2012)	Banaitiene & Banaitis (2012)	Kangari (1995)	McGraw Hill Con. (2011)
Management, supervision, and coordination	ZZ-07 ZZ-09 ZZ-12 ZZ-14 ZZ-17	N-06 N-08 N-15 N-19 N-22	BB-07	K-17	-
Financial and economical	ZZ-08 ZZ-13	N-05 N-11 N-13	BB-03	K-06 K-07 K-11 K-20	MC-02
Assessment, calculation, and design	ZZ-19	N-25	BB-01 BB-12 BB-16	K-03 K-09 K-15 K-16 K-21	MC-05
Planning and scheduling	ZZ-01 ZZ-05 ZZ-06	N-02 N-02 N-18	BB-02 BB-04 BB-09 BB-18	K-10 K-14	MC-06
Teams, materials, and equipment	ZZ-15 ZZ-18	N-01 N-03 N-04	BB-08 BB-10	K-04 K-05 K-12 K-18	MC-07
Safety and security	ZZ-16	N-12	BB-14	K-01	MC-04
Project scope and changes	ZZ-02 ZZ-04	N-14	BB-06 BB-11 BB-15	K-08 K-13	MC-01 MC-03
Society, government, and laws	ZZ-03 ZZ-10	N-09 N-10 N-17 N-20	BB-17 BB-19 BB-20	K-19 K-23	-
Environmental impacts	ZZ-20	N-16 N-21 N-23 N-24	BB-13	K-22	-
Quality	ZZ-11	-	BB-05	K-02	-

Table 4: Discerption of the most critical risk groups of construction projects

Risk group	Description
Financial and economical	Inaccurate cost estimation, increased material costs, cost overruns of the budget, problems in payment to suppliers and contractors, cash flow problems, insufficient financial resources, claim payment delays, bankruptcy.
Quality	Failure to meet qualitative requirements of the contract, high quality or performance expectation
Planning and scheduling	Insufficient scheduling, delays in receiving approvals and permits, expiration of construction permit, scheduling errors, delays caused by contractors or employers, delays in completion of processes, compressed schedule, inaccurate schedule
Teams, materials, and equipment	Unskilled labor, high labor turnover, contractor incompetency, inefficient contractors management, insufficient managers, specialists, and labor, insufficient equipment, inefficient equipment, insufficient materials
Management, supervision, and coordination	Failure to receive approvals, inadequate supervision on construction projects, the lack of coordination between people involved in the project, labor conflicts, stakeholder conflicts, inefficient management by contractors, the lack of coordination between contracts
Safety and security	Endangering security and safety of projects, the occurrence of accidents during construction
Scope and changes	Changing the work scope by the customer, the emergence of a new stakeholder requesting a change, technological changes
Environmental impacts	Weather changes, pollutions, and environmental damages, conflicts with environmental regulations
Assessment, calculation, and design	Incomplete assessment of the environment, inappropriate conditions of the project site, insufficient or inaccurate information on the project site, design defects, improper design, conflicts in construction documents
Society, government, and laws	The bureaucracy of administrative agencies, changing regulations and standards, conflicts with government agencies, inconsistent government policies, public disagreements

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