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Project Risk Management during Construction Stage According to International contract (FIDIC)

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Abstract: **Whereas the construction industry represents a significant proportion of national income in comparison with other industries, and project management during the construction stage has a very important role through which most of the project cost is spent out, therefore the project management team has to use the best techniques in project management to get the best results. Risk Management which requires more time and effort in the preliminary stage in order to avoid or mitigate risks that may occur during construction, all project stakeholders are taking responsibility for risks during the construction stage, so it is important to take care of risk management and allocation between client and contractor according to contractual terms and conditions to achieve the project. There are many types of contracts that govern the relationship between the contractual parties either locally or internationally, study proposed FIDIC contracts to govern the relationship during construction. Study proposed risk management process to Plan Risk Management, Identify Risks, Risk Allocation, Perform Qualitative Risk Analysis, Perform Quantitative Risk Analysis, Implement Risk Responses, and Monitor. Instead of Plan Risk Management, Identify Risks, Perform Qualitative Risk Analysis, Perform Quantitative Risk Analysis, Implement Risk Responses, Monitor Risks, as mentioned in PMBOK 6th edition. risk management flow chart for governance during the construction, and automate project risk management reports and interactive dashboard that demonstrate project progresses.**

Keywords: **construction industry, project management team, Risk Management.**

1. INTRODUCTION

the urgent need for developing countries to plan, which leads to long-term and short-term goals to meet the increasing demand for various services and provide a quality of life for citizens, so all organization involved are necessary developed. Whether it is a government, private or public-private partnership or investment, which includes the development of policies, methodologies, tools and technologies to achieve the growing demand for the provision of these services, which requires continuous improvement at all levels, Organizational management, Portfolio management, Program management, and Project management, to achieve goals and benefits. Increasing demand for the provision of these services, we see a significant development in the size of Organizational working on project construction from small to medium and large, each of which operates individually or jointly in the labor market, according to the size of the projects, whether they are small, medium or large, which are sometimes described as gigantic. In view of the growing increase in the size of projects, which leads to an increase in the budgets required to achieve these goals, the need for project management arose.

In addition, the FIDIC contract was selected to know the obligations and requirements of risk management for each of the contract parties. The risk management was compared with three of the contracts, namely the construction contract (the red book), the design and construction of stations contract (yellow book), and the engineering, procurement and construction contract / turnkey (silver book). In order to find out the commitment of each of the contracting parties in project risk management and its consequences. And since the construction stage is one of the most important stages where most of the work is carried out and most of the project budget is spent, the study focused on managing risks during construction, as well as automating follow-up reports during the work period in order to manage risks efficiently and effectively so that the project management can take the necessary measures to respond to risks in propar time.

2. RISK MANAGEMENT

Risk management means defining the possibility of risk occurrence, the extent and degree of impact of this risk on the project in the various stages of project work, and how to prioritize them given that they are in the world of uncertainty - in the sense of expecting occurrence - and choosing the methods, methodologies and tools that can be used to manage risks in their interrelated processes in terms of the methodology and policy of the organization to bear Or avoiding the risks and permissible limits in the various work of the organization since the beginning of the first stage of developing the action plan for risk management, through the definition of risks, then analyzing the risks, then assessing the risks, planning the response, applying the response plan when the risk occurs, and monitoring and controlling the processes of risk management, in order to avoid the problems arising such as the project outside Budget/forecast/estimate/bid, deadline for design, build and occupancy approvals, or failure to meet required technical standards for quality, function, fitness for purpose, safety and environmental conservation. Many project management organizations have been interested in developing systems and standards for risk management, including ISO 31000 issued by the International Standards and Metrology Organization and Australian and New Zealand standards.AS/NZS 4360 Risk Management and Project Risk Analysis and Management Guide issued by the Project Management Organization of England, Best Practices issued by PMI Project Management Body of Knowledge 6th edition. In this research, we will discuss a brief definition and comparison of five international risk management specifications.

3. CONTRACTING FOR PROJECTS CONSTRUCTION

Construction projects vary according to their nature - in terms of the accuracy of the design proposed for construction, the cost of the project, the expected time for project completion, the degree of employer intervention during the project period, and according to the responsibilities assigned to each of the parties to the contract, and according to the applicable laws and regulations. Therefore, contracting methods for construction differ. Projects, and accordingly, the levels of responsibility and the distribution of risks differ between each of employer and contractor. We present here a part of it. There is the traditional method of contracting, for which a detailed design is prepared by the employer, contracting with a contractor to carry out procurement work, appointing a contractor for construction and conducting the necessary tests for operation, and the end of the project is the success of the tests. Including integrated projects and the turnkey system in contracting, in which human resources, systems and investment structuring are integrated and integrated to complete a specific project. This method accommodates all stages of the project within the obligations of design, manufacture, supply, construction and tests in order to ensure obtaining the optimal cost for the project. Including the traditional method, but employer chooses the general contractor according to the criteria prepared in advance such as qualifications, previous experience and the best value, and the ability to carry out feasibility studies and design services and review the design in terms of the possibility of its construction and supply (GC), and with him a manager is appointed to implement the contract (CM), and because of his capabilities, contracting in this way reduces the potential risks of the contract to the employer, and given the qualifications and experience of the general contractor, when 60% to 90% of the design is completed, contractors specialized in manufacturing, supplying and construction can By starting to work on achieving the scope of work specified for each of them according to their competence. Including design-build (DB) in contracting, and the design and construction are evaluated through contracting with one party appointed by employer according to pre-established criteria such as previous qualifications and experience, the best value, and the ability to carry out feasibility studies, design and design review services and from In terms of the possibility of its construction and supply, and the business owner can appoint a consultant on his behalf in following up the work "Egyptian Code"

Table No. (01) Characteristics of types of contracts in the Egyptian code

S|N	properties	traditional	Design and construction	Management contractor	Construction management
1	Distribution of responsibility among the parties to the contract	middle	Limited	high	high
2	Available market size for cost selection	middle	Limited	middle	Big
3	timing of cost verification	middle	early	late	late
4	The need for early identification of the employer's requests accurately	No	yes	No	No
5	Having independent assistance in preparing a brief description of the design	yes	No	yes	yes
6	starting speed	slow	fast	fast	fast
7	Flexibility to make changes	Reasonable	limited	Reasonable	good
8	Provide standard documentation	yes	yes	yes	limited
9	Ability to prepare proposals in stages with limited commitments that build over time	Reasonable	limited	Reasonable	good
10	There are means of cost control	good	weak	Reasonable	good
11	Having experience in construction to assist design	Medium	good	good	good
12	Program management Preparation of designs	weak	good	good	good
13	The ability to influence the selection of competent contractors	limited	Nothing	good	good
14	Existence of means to control the quality of materials and labor	Medium	Medium	Medium	good
15	The existence of opportunities for contractor to benefit from liquid funds	yes	yes	yes	No
16	The existence of a financial incentive for contractor to increase the effectiveness of performance	strong	strong	Weak	rare
17	Possibility of disagreements	High	Medium	Medium	Rare

4. RISK MANAGEMENT IN SOME INTERNATIONAL STANDARDS AND CODES

4.1 The Egyptian Code for Construction Projects Management, Code No. 311-2009

I am interested in the Egyptian code for project management #20 Managing risks in the various phases of the project since the start of the studies for the project and passing through the construction of the project and the delivery of the project and the end of the guarantee period, as it included in the second chapter 2-6-5 risk management, which included the methodology followed by the Egyptian code for risk management by following the processes of planning, identification and analysis of both types And quantitative, as well as responding to it, following it up and monitoring it during the project stages, and that these operations do not take place once, but are repeated during work periods in the different stages of the project.

4.2 Australian and New Zealand Standards AS/NZS 4360 Risk Management

It stands for Australian/New Zealand specification #.23 By developing an integrated framework that the project is part of in the sense that it sets the general context for the organization and therefore it did not allocate risk management for projects, which is very similar in its approach to ISO 31000 of 2009 and includes the stages of risk management according to the Australian and New Zealand specifications, creating the context, identifying risks, and analyzing risks , risk assessment, risk treatment, monitoring and auditing, communication and advisory.

4.3 PMI Project Management Body of Knowledge 6th edition

The PMI concerned with risk management, as it devotes a separate chapter No. (11) to it in the Project Management Knowledge Guide, sixth edition #20, which includes in detail the processes, inputs, outputs, and tools used to manage project risks, and the ranks of risk management processes starting from risk management planning, risk definition, qualitative risk analysis, quantitative risk analysis, risk response plan development, risk response application, and risk follow-up.

4.4 Project risk analysis and management guide Second edition 2010

And he (Project Risk Analysis and Management Guide) the guide issued by the Project Management Organization in England (APM association for project management) #19, which placed risk management of great importance and devoted a complete and detailed guide to project risk management. Risk management processes include initiating risk management processes, risk definition, and risk assessment risks, risk response planning, response construction, and risk operations management.

4.5 ISO 31000 for the year2021

This standard is followed by the International Organization for Standardization and Metrology, which singled out risk management with a general framework between the principles of risk management and the framework and processes through which risks are managed. These processes harmonize together so that risks are managed efficiently and effectively by working together with the principles, general framework and risk management, as the principles include value creation, Part integration with organizational processes, part of decision-making, deals with uncertain events, systematic, organized and timely, based on the best available information, taking into account human and cultural factors, transparent and comprehensive, dynamic, iterative and responsive to change, and facilitates continuous improvement. It includes risk management processes in its various stages from inception and on an ongoing basis, establishing and establishing the context, risk definition, risk analysis, risk assessment, risk treatment, monitoring and review.

4.6 Comparison of risk management in the four sources

By comparing the selected methodologies, which are among the best international practices, the comparison was presented in Figure No. (01) According to the following:

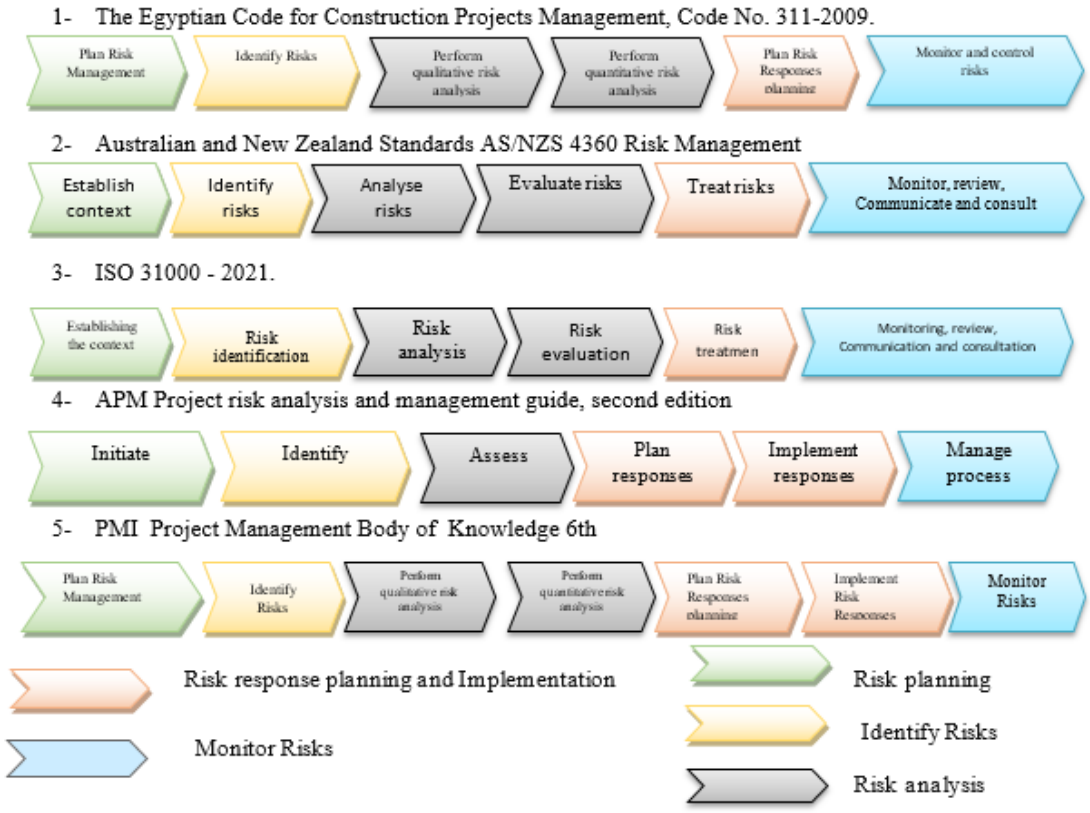


Figure No. (1) Comparison of risk management methodologies

It is clear from Figure No. (01) that the Australian and New Zealand standards AS/NZS 4360 for risk management and ISO 31000 for the year 2021 and through their operations in risk management they are concerned with the risk management of the organization and neither of them mentioned what is related to project risk management, and that risk management for the project in all its stages has been mentioned in the Egyptian code for managing construction projects Code No. 311-2009, and the guide issued by the Project Management Organization in England issued by (APM association for project management). It also came in the Project Management Knowledge Guide of the American Project Management Institute, and chapter eleven was devoted to it.

Since we are in the process of studying the risks during construction of the project, we will address them through the methodology of the Project Management Knowledge Guide of the PMI#20, because it contains details of project risk management, and it will be the methodology used until the completion of this study.

5. RISK MANAGEMENT DURING CONSTRUCTION

5.1 Introduction

Since the construction stage is an important and essential stage in construction projects, as the stages of construction projects begin with the initial design, then the final design, then the offering, awarding and contracting stage, then the construction stage, then the testing and operation stage, then the handover stage, and during the construction stage the project activities are completed, and this stage consumes the largest part time and cost of the project. It was very important to manage risks for construction.

Risk management is concerned with studying the risks that may occur in all activities, processes, resources, time, climate and location of the project, and all administrative aspects of the components of the project in construction, including project integration management, project scope management, time, cost, quality, resources, communications, procurement, stakeholders, finance, security, occupational safety, environment and finance. And if the procedures required for risk management are ignored or neglected in whole or in part, it may result in many problems that negatively affect the progress of operations during construction, because the management of all project inputs in construction must be done in an integrated manner to obtain the highest efficiency for managing the phase. .

5.2 Risk management processes during construction

Risk management processes during construction include the management of expected events - uncertain - that may affect the project with a positive or negative impact on the project objectives and the extent to which the organization accepts the impact resulting from the expected event during the implementation of risk management processes. It begins with the definition of risks, then risk analysis and risk assessment Response planning, construction of the response plan when a risk occurs, monitoring and control of risk management processes, and these processes are continuous and recurring and do not take place once throughout construction, but rather start from receiving the project site and continue repeatedly until project delivery.

5.3 Project risk management planning

Risk management planning is the process through which risks are known, and this process aims to ensure that the processes used are clear and appropriate to the nature of the project and its importance to the organization and stakeholders, and that risk management works clearly. This process is implemented once and reviewed again if it occurs. Significant change in the project, or if it is found that the plan is not working well, and this stage is concerned with obtaining a risk management plan, which is one of the plans that make up the project management plan, which includes how to prepare and implement risk management activities and includes a risk management strategy - and explains the general method of risk management in the project, and the methodology Risk management - which defines the methodology, method, sources of information, tasks and responsibilities of the risk management team and their roles, costs and includes how to spend on risk management activities and how to deal with project reserves, timing and answers how often we will repeat the risk management procedures Risks and the inclusion of risk data in the timetable, and risk classification - which is to create a specific mechanism for classifying risks in the project, which has been defined as the project risk segmentation structure, the degree of acceptance by those involved in taking risks, what are the dividing lines for risks and the degree of risk tolerance for the project as a whole, and setting a clear definition of the degrees of probabilities and vulnerability to risks It depends on the different objectives of the project and when do we move from one level to another, and it is usually divided into five levels in large projects: very weak, weak, medium, high, and very high, as shown in Figure No. (02), and these limits are often set by the organization and / Or those involved in managing the project so that it is agreed upon.

SCALE	PROBABILITY	+/- IMPACT ON PROJECT OBJECTIVES		
		TIME	COST	QUALITY
Very High	>70%	>6 months	>$5M	Very significant impact on overall functionality
High	51-70%	3-6 months	$1M-$5M	Significant impact on overall functionality
Medium	31-50%	1-3 months	$501K-$1M	Some impact in key functional areas
Low	11-30%	1-4 weeks	$100K-$500K	Minor impact on overall functionality
Very Low	1-10%	1 week	<$100K	Minor impact on secondary functions
Nil	<1%	No change	No change	No change in functionality

Figure No. (02) Example of definition for probability and impact

And the matrix of probability and impact, and this matrix also determines the degree of risk from the organization, whether it is a threat or an opportunity, and the ease of classification, as in Figure No. (03)

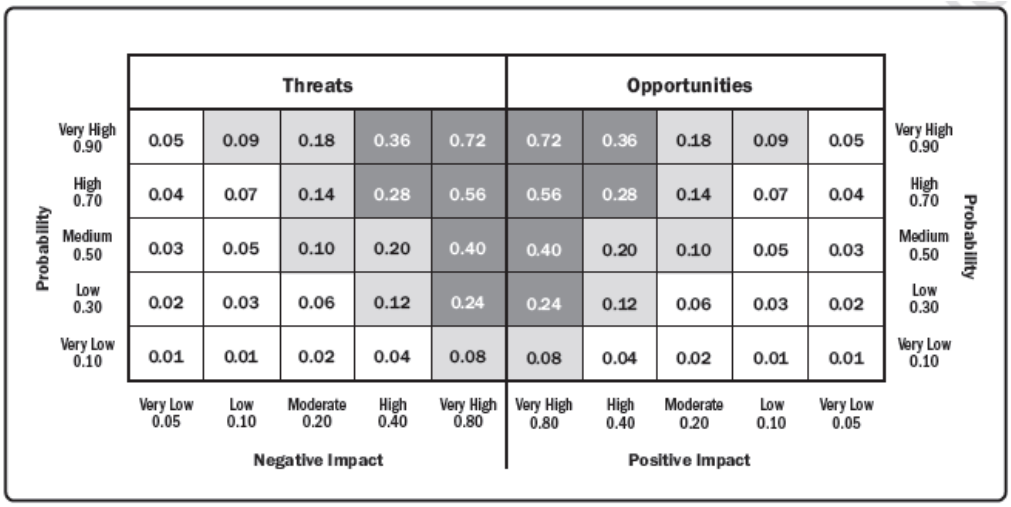


Figure No. (03) Example Possibility and Impact matrix with scoring scheme

And the models used in managing the various risks, such as a risk register, periodic reports, the risk response plan, the alternative plan, follow-up on the reserve, and how to follow up and audit risk management processes.

5.4 Defining project risks

This process is concerned with defining the risks that the project will be exposed to and the details available for each risk separately. This process results in a project risk register, which includes the definition of the risk, its classification, the probability of its occurrence, the degree of its impact on any project objectives, what is the strategy used to deal with it and , and it varies according to the size of the project. The project and its nature, and it also results in a project risk report, which shows the degree of risk for the project and the data on the sources of the total risks to be dealt with.

5.5 Qualitative assessment of project risks

This process includes the analysis of all the data reached on the risk, especially the probability of occurrence, the timing of occurrence and the degree of impact. This is done through the risk management team and the participation of stakeholders through meetings, data collection, data classification and personal interviews. Risks, which are of course reflected in the quality of risk management in the project, and this data includes, for example, evaluating the quality of risk data in terms of accuracy and reliability, evaluating the likelihood and impact of risks, strategic impact, evaluating the possibility of controlling the risk, the possibility of managing it easily, and the time of its occurrence in the project.This evaluation requires the skills of a team that has knowledge of this process, or the use of experts if they are unable to do so. In the first place, the team of workers or experts should have the first priority in front of them is the interest of the project without prejudice to personal opinions, and this stage results in updating the risk register and updating the hypothesis record. And update project problem log and risk report.

5.6 Quantitative assessment of project risks

It is a process in which a numerical (numerical) analysis of the joint impact of individual project risks on the overall project objectives that have been identified by qualitative analysis, and thus we can know the degree of total exposure to risks in the project. Note that this process is not required for all projects, according to the Knowledge Guide for Project Management. This process requires a baseline of project scope, schedule, and project cost. This type of analysis is suitable for large projects and/or with a high degree of complexity and/or strategic projects and/or for which quantitative analysis is requested as a contractual condition of the project contract. Where the quantitative analysis of the project is conducted before and after developing the project risk response plan to verify the effectiveness of the risk response plan.

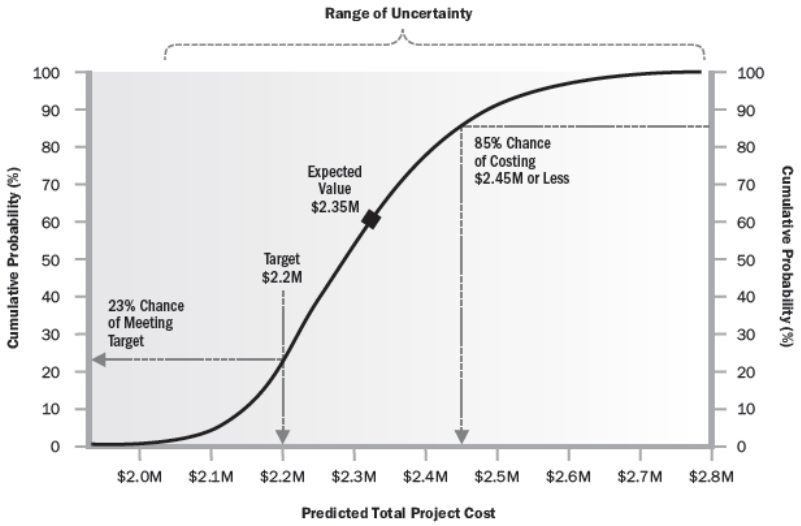


Figure No. (04) Example S-Curve from quantitative cost risk analysis

Sensitivity analysis is also used, through which the risks to which the project is exposed are arranged in terms of the greatest impact on the project objectives and results in a cyclonic chart as shown in Figure No. (05)

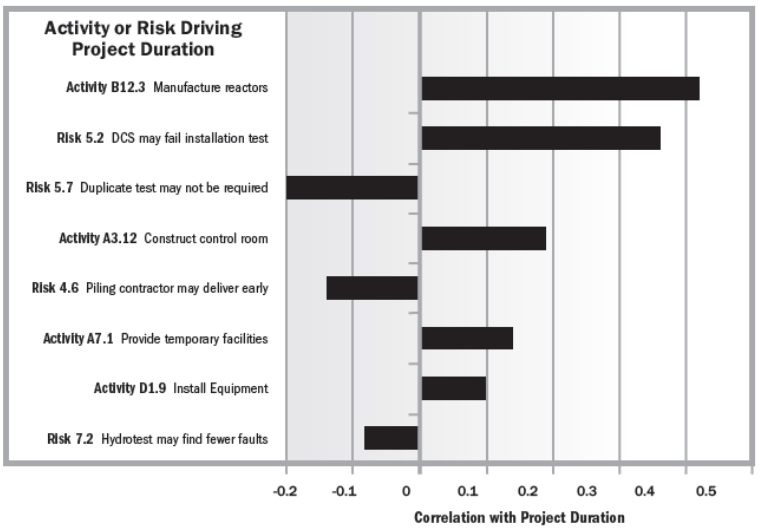


Figure No. (05) Example tornado diagram

Decision tree analysis is also used in the event that there are multiple options and the need to choose from them, using branches that represent the decisions taken for each option and the result thereof, where the path is chosen on the basis of the monetary value of each branch, and the end of each branch is the net value of the path. This process results in the degree of total exposure to risks in the project, which shows us the chances of success of the project, as well as the amount of total reserve that must be provided for the project to provide a certain level of confidence, and to obtain a list that determines the priorities of individual risks for the project. This information constitutes an important input for the next process of risk management, which is planning to respond to risks.

5.7 Planning the response to project risks

It is the process during which the options and strategies necessary to be taken to address the total and individual exposure to risks in the project and to determine the appropriate ways to provide resources as needed - to reduce or prevent threats that negatively affect the project, as well as to maximize the use of possible opportunities during the construction of the project, and many tools are used in this process On top of which is expert consultation and data collection by various means, as well as strategies for confronting risks. These are mentioned in Table No. (2) and when they are used, whether for threats, opportunities, and/or overall risks for the project.

Table No. (02) Risk Response Strategies

	Strategy name	Description of the strategy	threats	opportunities	total risk
1	Escalate.	suitable for events in which decisions must be taken at higher administrative level than the powers of the project manager, such as the program manager, or at the institutional level, and therefore the project manager must determine who will make the decision according to the organizational structure and direct him to take the decision in the strategy that will be implemented in the project and who Then it is ascended.	yes	yes	yes
2	Avoidance	used when the project team works to avoid the potential threat, by changing the goal, canceling part of the project scope, or extending the project schedule to completely avoid the threat, which reduces the probability of its occurrence to zero.	yes		yes
3	Transfer	used to transfer the threat to a third party to manage the potential impact of the threat and the famous method of transferring the impact of the threat to insurance and guarantees.	yes		yes
4	Mitigat	used to reduce the probability of induction and /or mitigate the impact resulting from the threat, and examples of mitigation include planning at a more detailed level, conducting more tests, and redesigning more than once to mitigate the threats that are likely to occur.	yes		yes
5	Accept	which the work team decides to accept the threat with one of two types of acceptance, either positive or active acceptance, by providing a financial or time reserve to be used in the event of a threat. Passive acceptance is acceptance without taking any precautionary action.	yes	yes	yes
6	Exploit	used in high-priority opportunities, and the organization wants to ensure the realization of this opportunity, in order to achieve the benefit arising from the opportunity by ensuring its occurrence by raising the probability of occurrence to 100%. One of the most popular ways is to refer the project management to a talented project manager to reduce the time		yes	yes

	Strategy name	Description of the strategy	threats	opportunities	total risk
		and/or use one of the modern technologies that reduce the duration and time of the project.			
7	Share	includes sharing the opportunity with a third party who shares the benefit accrued from the opportunity. Examples of the methods used are the establishment of a partnership from a specialized company, or the appointment of a subcontractor.		yes	yes
8	Enhance	used to try to increase the probability of occurrence and/or the impact resulting from the opportunity. The opportunity can be improved by focusing on its causes. One of the methods used is to increase resources to finish the project earlier than the original end.		yes	yes

5.8 Decision making

One of the most important benefits that we gain from effective risk management is taking precautionary measures and formulating the decisions required to be taken before the risk occurs, and thus to formulate good and effective decisions. In a way that leads to choosing the appropriate and effective decision, and the decisions taken to choose the different response methods result in several outputs, the most important of which are the required changes to the project management plan, and the required change in the project documents.

5.9 Project risk response plan implementation

This process is concerned with managing the response that has been chosen and according to what has been planned, to the expected total or partial risk in order to increase the expected benefit from the opportunities as well as reduce or avoid the negative effects expected from the threats. In order to ensure the success of the risk response application process, the project work team, the project manager, and the person responsible for implementing the risk response plan must communicate and communicate in a dynamic and effective manner, to verify the construction of the response plan as planned.

5.10 Monitoring and controlling project risk management processes

One of the most important processes at all is the process of monitoring and controlling the risk management processes in the project. During this process, new risks are constantly monitored, re-evaluated, response plans are drawn up, the construction of response plans is followed up and their effectiveness, and the risks with low probability and impact are monitored, and are they on the watch list? The same inputs during the planning period, whether the probability of occurrence and the amount of impact change by increase, then it is planned, or decreased or ended, and it is removed from the watch list, and during this process the project reserve and the senior management reserve related to the project are followed up, as well as the allocated resources from the work team, subcontractors and insurance companies, are followed up. And continuous updating of the risk register. This process results in reports of project risk performance and its impact on project performance reports, and what this requires in terms of change orders and updating of the project construction management plan and subsequent updates of project documents, as well as updating the procedures and models of the organization and the risk segmentation structure.

6. ALLOCATION OF RISK IN FIDIC CONTRACTS

6.1 Types of FIDIC Contracts:

The FIDIC organization has different forms of contracts that suit the nature of the projects, the requirements of the employer, the responsibilities that will be borne by each of the contracting parties, and the obligations of each party. We will discuss the risks in construction and how the different formulas of FIDIC contracts dealt with them in the three books (Red, Yellow, and Silver). Therefore, a brief definition of each formula must be briefly defined as follows:

6.2 Red Book (Construction Contracts), 2nd 2007

It is the traditional contract model #25 in which employer prepares the designs through his team or his representative for the project, and in this type of contract employer appoints the engineer to manage and supervise the contract whose work has been awarded to contractor in accordance with the conditions. This form of the contract is suitable for projects in which an accurate description of the components of the project and the activities to be implemented is available, such as building projects and other projects that meet the same conditions, including electromechanical works. The cost calculation in this form of contracting is often based on the engineering measurement of the executed works. It is called a balanced contract in which both employer and contractor share the risks in their respective areas.

6.3 Yellow Book (Station Design and Construction Contracts) 2nd 2007

It is the form of the contract in which contractor performs the design and construction works of the project#26, and employer appoints the engineer for the purposes of the contract, and this form of the contract is suitable for projects that need expertise in a specific field and have specialized companies, and employer does not have sufficient knowledge of the requirements of the project. Civil as well, and this form of contracting can also be used in projects in which employer desires that contractor be responsible for the design and construction works, whatever the nature of the works in the project. The cost calculation is often rigorous due to the lack of full clarity of the scope of work when contracting, and contractor bears the bulk of the project risks given that he is responsible for most of the contracting requirements.

6.4 Silver Book (Engineering Business Contracts, Supplies, Execution / Turnkey) 2nd 2007

It is the form of the contract for integrated projects (design, procurement works, and construction), and it is called turnkey # 27, in which contractor is responsible for all works (design, procurement works, and construction) and in it, employer appoints a representative to follow up on the project work. This form of contracting is suitable for power plant projects, infrastructure, factories, development and development projects, and the cost calculation is often linear due to the lack of full clarity of the scope of work when contracting, in which contractor bears the bulk of the project risks given that he performs most of the contracting requirements.

6.5 Choose the appropriate contract type from FIDIC contracts

the volume of work within the scope of work specified for the project in terms of being small, medium or large, as projects in the modern era have reached gigantic sizes, in which the project reaches several billion, in various fields of development such as infrastructure work and the development of cities and various stations, which requires With him, new types of contracts or the development of existing contract formulas to suit and meet the needs of managing these projects, as the FIDIC organization has given special attention to this because of its long-standing experience in drafting and designing contracts that suit projects and various contractual relationships based on the obligations and responsibilities of each employer And contractor. If employer wishes to contractual relationship, it may contain part of the work in the contract according to the need of the contract, so the appropriate choice for the contract is the red book. But if the business owner wishes to be present continuously to follow up on the work in the project, then he appoints only the engineer and contracts with contractor on the design and construction works to reduce the costs he bears, so the appropriate contract is the design and construction contract, which is the yellow book, and often the price for this contract by the syllabus. But if employer desires to place most of the responsibility on contractor and he is not fully present, then he appoints an engineer as his representative only and contracts with contractor on the design, supply and construction works (turnkey) to reduce the costs incurred by him, and thus the appropriate contract is the design, supply and construction contract (Key delivery) which is the silver book, and the price for this contract is often fixed.

6.6 Risks in FIDIC Contracts

The FIDIC contract formulas took care of the risks during construction of the project their great importance in the project life cycle, as it unites the efforts of the project participants from the employer, the engineer and contractor in order for all of them to achieve the goal because of for which the project was established through managing the responsibilities and duties of each party in the project during the various steps in construction The project and by applying the controls of the contract formula signed between the two parties to overcome the risks that may occur to the project by following up well on the plans that have been developed and applying a consistent and clear methodology for all participants in construction to reduce problems that may occur as a result of the inability to overcome these risks and limit the delay in the schedule For the project as well as limiting changes and claims that negatively affect the project objectives in terms of time, cost and quality. This was evident from allocating the FIDIC contract formulas as a chapter on the risks of the project in its various

stages. We specifically mention construction in the different contract formulas in the three books (Red, Yellow, and Silver) according to the nature of the work and the responsibilities that both parties to the contract undertake. I singled out a chapter for it on the general conditions. (Chapter XVII) entitled Risks and Liability, and it includes six paragraphs, which are compensation contractor's care of the works And Employer risks and employer risk consequences Intellectual and industrial property rights and limitation of liability

6.7 Selected FIDIC contracts comparison in terms of allocate risk

By the FIDIC contract, how are these risks distributed between each of employer or Contractor separately during construction , and what are the risks that employer and contractor share during construction , and according to the type of contract used to complete the works, the tasks and responsibilities vary, and through researching the references that dealt with this aspect, it was mentioned in the International Construction Law # 29, which classified the risks and the consequences of their occurrence, whether it was time, direct costs, indirect costs, or profits during the expected chapters of the contract. The share of each employer and contractor was distributed according to the red, silver and yellow FIDIC contracts according to Table No. (03).

Table No. (03) shows a comparison of the risk tolerance of employer and contractor in the FIDIC contract formats

E: Employer C: Contractor S : Sharing

Clause	Identification of risk	Red Book	Yellow Book	Silver Book
1.9 Red Book	Delayed Drawings or Instructions (by the Employer	E	-	-
1.9 Yellow Book	Errors in the Employer's Requirements	-	E	C
2.1	Right of access to the site	E	E	E
4.7	Setting out (of original points, lines and levels of reference)	E	E	C
4.12	Unforeseeable Physical Conditions	S Time = E Costs = E Overhead = E Profit = C	S Time = E Costs = E Overhead = E Profit = C	C
4.24	Fossils	S Time = E Costs = E Overhead = E Profit = C	S Time = E Costs = E Overhead = E Profit = C	S Time = E Costs = E Overhead = E Profit = C
7.4	Employer's Delay in Performing Tests	E	E	E
7.5	Rejection of Plant, Material or Workmanship	C	C	C
8.4	Extension of Time for Completion	S Time = E Costs = C Overhead = C Profit = C	S Time = E Costs = C Overhead = C Profit = C	S Time = E Costs = C Overhead = C Profit = C
8.4	Exceptionally Adverse Climatic Conditions	S Time = E Costs = C Overhead =	S Time = E Costs = C Overhead = C Profit = C	C
8.5	Delays Caused by Authorities	Time = E Costs = C Overhead = C Profit = C	Time = E Costs = C Overhead = C Profit = C	Time = E Costs = C Overhead = C Profit = C
8.6	Insufficient Rate of Progress	C	C	C

E: Employer C: Contractor S : Sharing

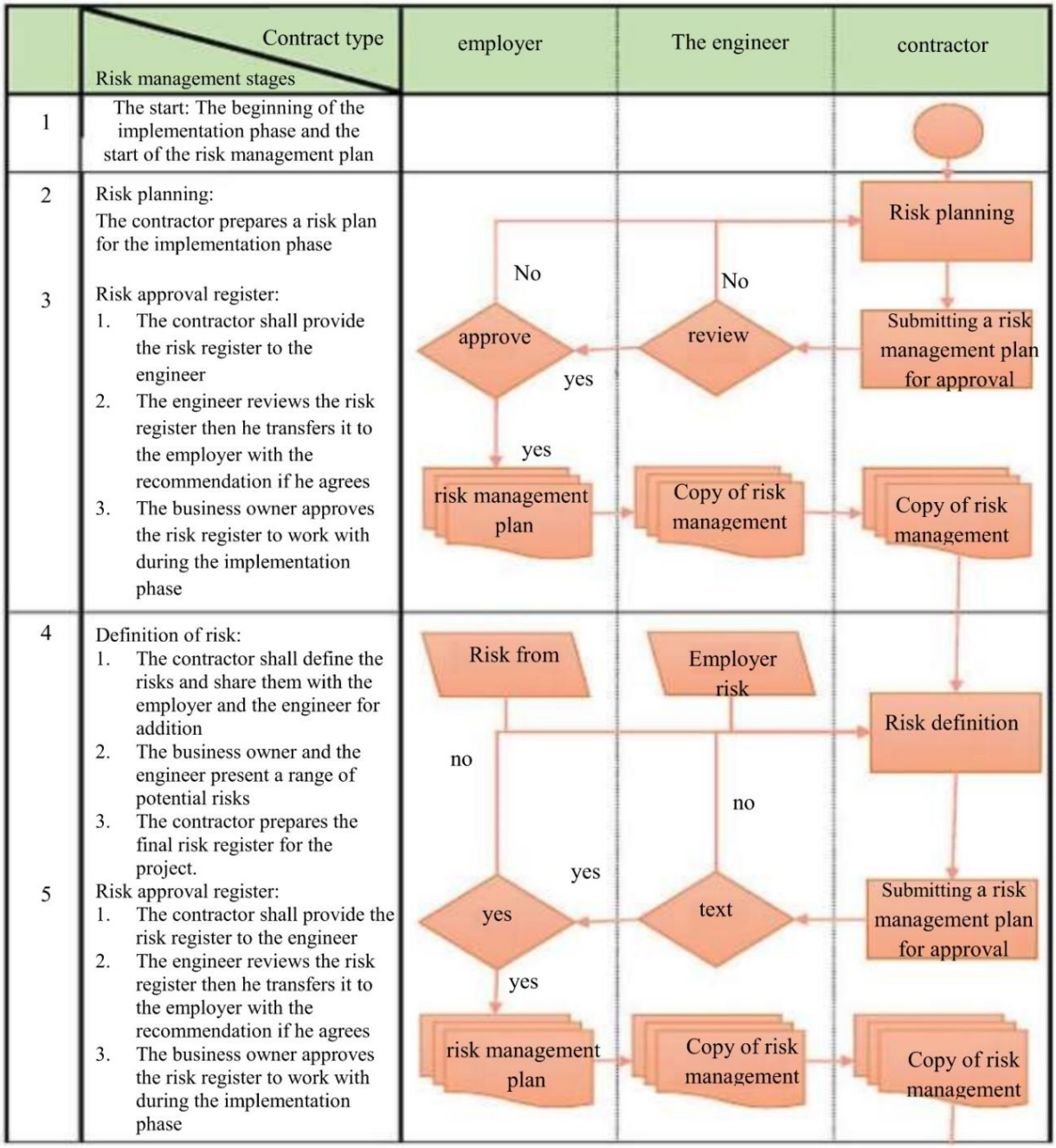
Clause	Identification of risk	Red Book	Yellow Book	Silver Book
8.9	Consequences of Suspension	S Time = E Costs = E Overhead = E Profit = C	S Time = E Costs = E Overhead = E Profit = C	S Time = E Costs = E Overhead = E Profit = C
9.4	Failure to Pass Tests on Completion	C	C	C
10.2	Taking Over of Parts of The Works	E	E	E
10.3	Interference with Tests on Completion	E	E	E
11.4	Failure to Remedy Defects	C	C	C
11.8	Contractor to Search for the Cause of any Defect	S Time = C Costs = E Overhead = E Profit = E	S Time = C Costs = E Overhead = E Profit = E	S Time = C Costs = E Overhead = E Profit = E
12.3	Evaluation	E or C	-	-
12.4 Red Book	Omission of any Work according to Variation	S Time = C Costs = E Overhead = E Profit = C	-	-
12.4 Yellow & Silver Book	Failure to Pass Tests after Completion	-	C	C
13.3	Variation Procedure	S Time = C Costs = E Overhead = E Profit = C	S Time = C Costs = E Overhead = E Profit = C	S Time = C Costs = E Overhead = E Profit = C
13.7	Adjustments for Changes in Legislation	S Time = E Costs = E Overhead = E Profit = C	S Time = E Costs = E Overhead = E Profit = C	S Time = E Costs = E Overhead = E Profit = C
13.8	Adjustments for Changes in Costs (Indexation)	E or C	E or C	C
14.8	Delayed Payment	E	E	E
15.4	Payment after Employer's Termination	C	C	C
16.1	Contractor's Entitlement to Suspend Work	E	E	E
16.4	Payment after Contractor's Termination	E	E	E
17.1	Indemnities	E or C	E or C	E or C
17.4	Consequences of Employer's Risks	E	E	E
19.4	Consequences of Force Majeure	S Time = E Costs = E Overhead = E Profit = C	S Time = E Costs = E Overhead = E Profit = C	S Time = E Costs = E Overhead = E Profit = C

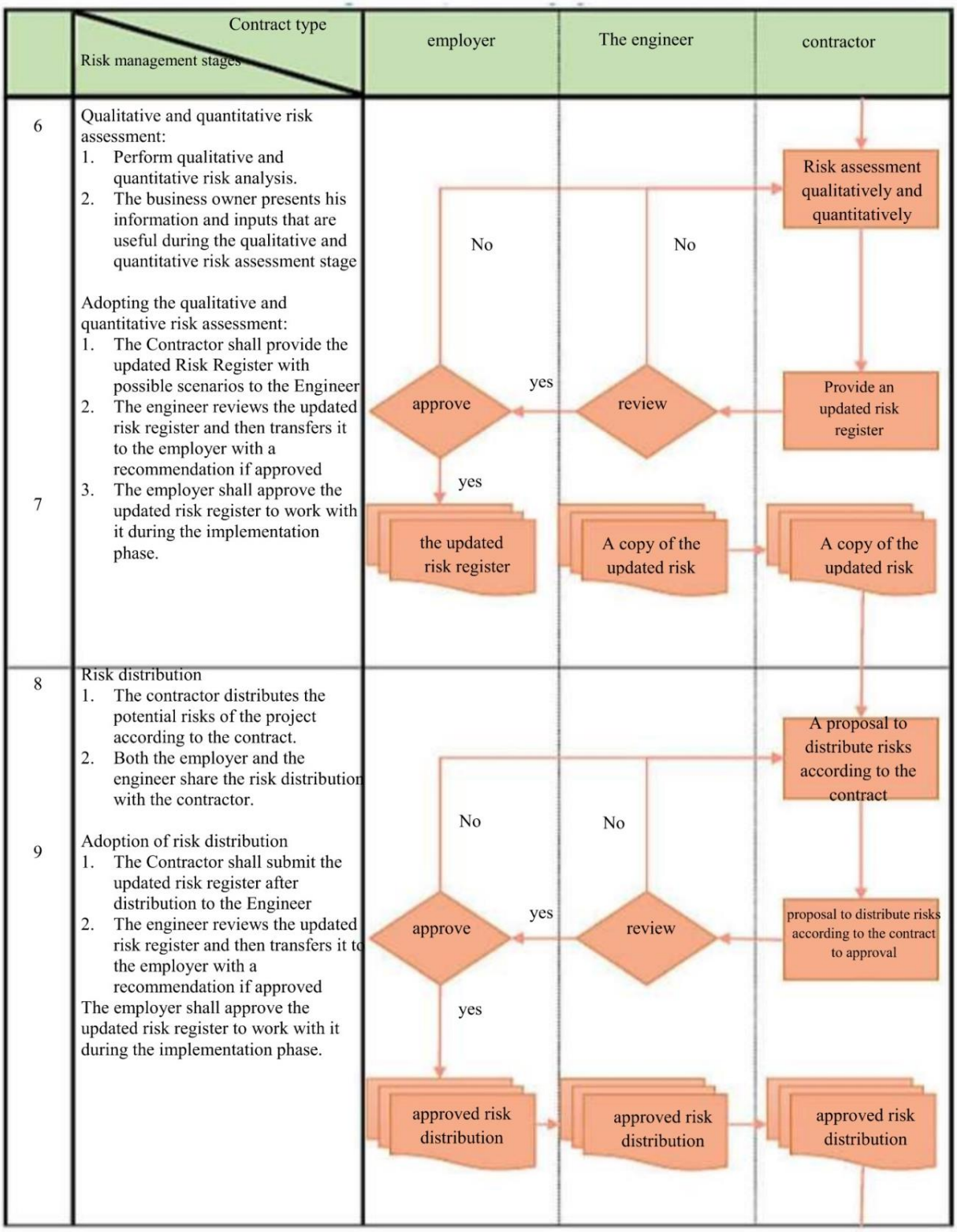
Thus, this table can be used as a guide in distributing risks between both employer and contractor, and these results in reducing the periods used to resolve disputes arising from the disagreement in estimating the risk outcomes. The researcher also suggests adding a process of risk distribution within the risk management processes to effectively complete the process of risk management governance between the two contracting parties.

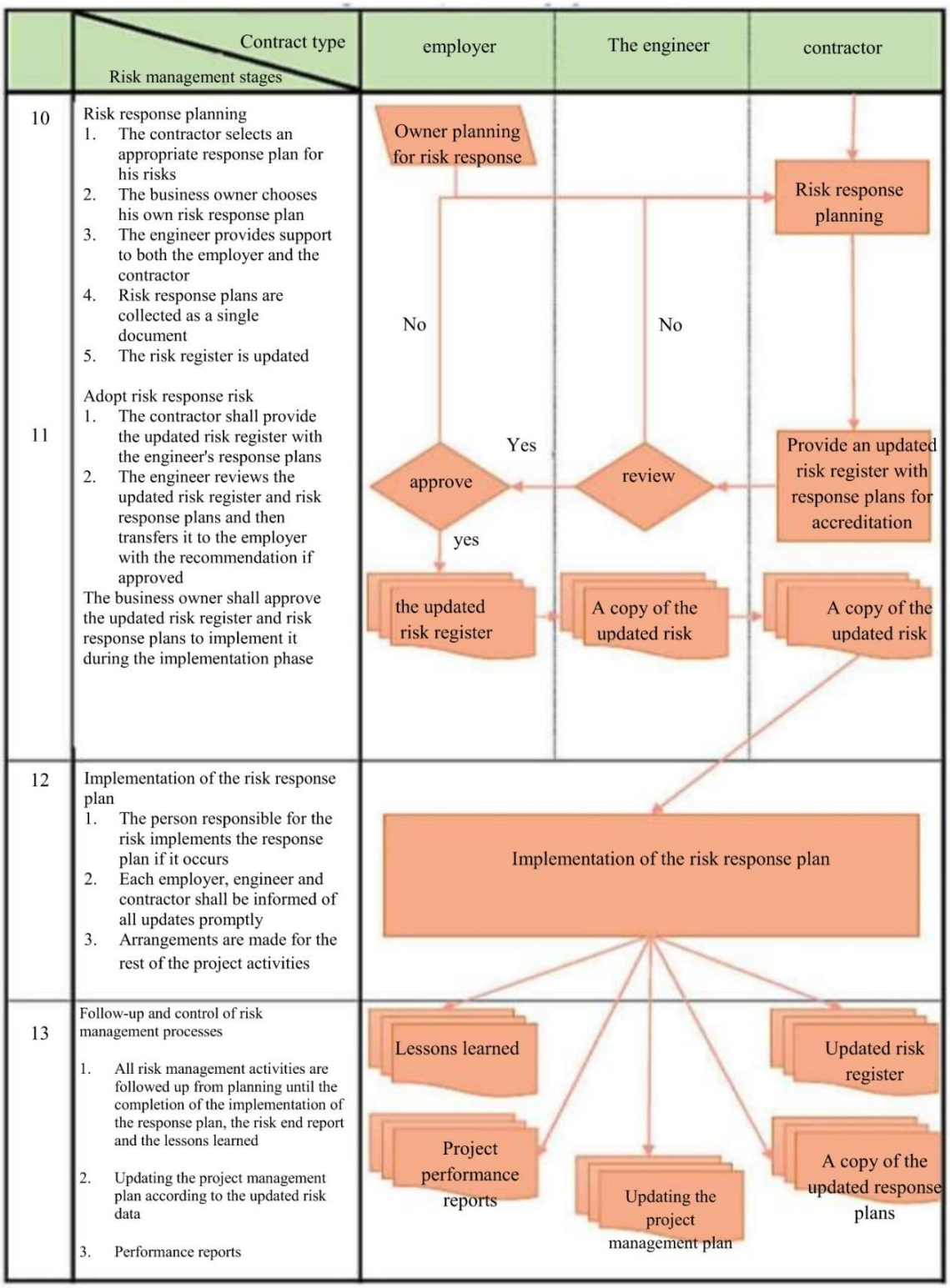
7. RISK MANAGEMENT PROCESSES GOVERNANCE

Recommending the use of the risk management processes flow chart, which regulates the relationship between each the employer, the engineer and contractor, as it includes the governance of the risk management operations and the necessary approvals from employer to know what the project faces of potential risks and what these risks can affect the objectives of the project and the plans required to respond to these risks and what should be done on each of the employer, contractor and engineer at every stage.

Figure No. (06) Process flow chart for managing risks in construction projects




Contract type
Risk management stages
employer
The engineer
contractor
6
Qualitative and quantitative risk assessment:
1. Perform qualitative and quantitative risk analysis.
2. The business owner presents his information and inputs that are useful during the qualitative and quantitative risk assessment stage
Adopting the qualitative and quantitative risk assessment:
1. The Contractor shall provide the updated Risk Register with possible scenarios to the Engineer
2. The engineer reviews the updated risk register and then transfers it to the employer with a recommendation if approved
3. The employer shall approve the updated risk register to work with it during the implementation phase.
7
Risk assessment qualitatively and quantitatively
No
No
yes
approve
review
Provide an updated risk register
yes
the updated risk register
A copy of the updated risk
A copy of the updated risk
8
Risk distribution
1. The contractor distributes the potential risks of the project according to the contract.
2. Both the employer and the engineer share the risk distribution with the contractor.
9
Adoption of risk distribution
1. The Contractor shall submit the updated risk register after distribution to the Engineer
2. The engineer reviews the updated risk register and then transfers it to the employer with a recommendation if approved
The employer shall approve the updated risk register to work with it during the implementation phase.
A proposal to distribute risks according to the contract
No
No
yes
approve
review
proposal to distribute risks according to the contract to approval
yes
approved risk distribution
approved risk distribution
approved risk distribution



8. RISK MANAGEMENT PROCESSES REPORT AUTOMATION

Automation of risk management follow-up reporting processes and presentation of results to the final dashboard (Dashboard) for departments at different levels in different geographical ranges using Microsoft BI software, which gives real-time data to decision-makers promptly and helps to make proper decisions to deal with project risks. As shown in figure numbers 07, 08, 09, and 10:

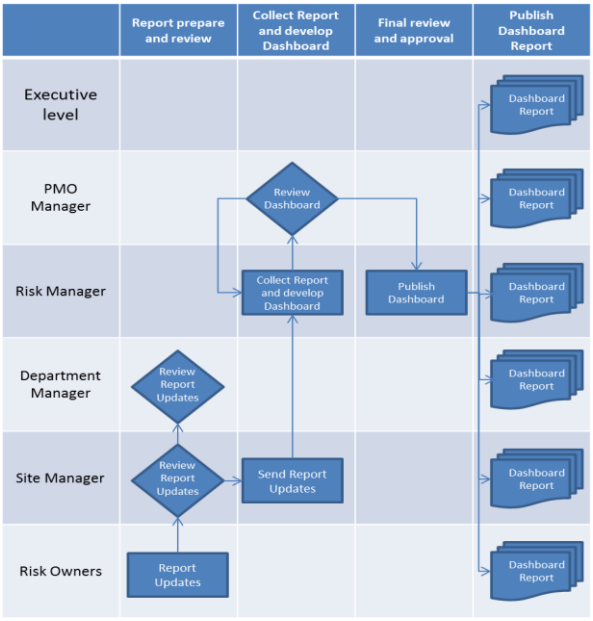


Figure No. (07) Roles and responsibility flow chart

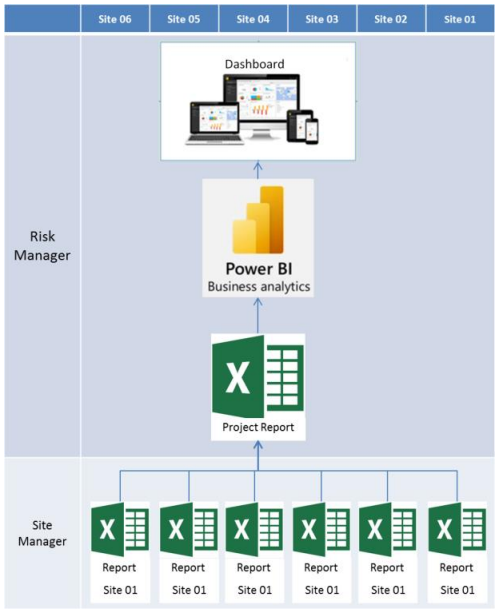


Figure No. (08) Programs used

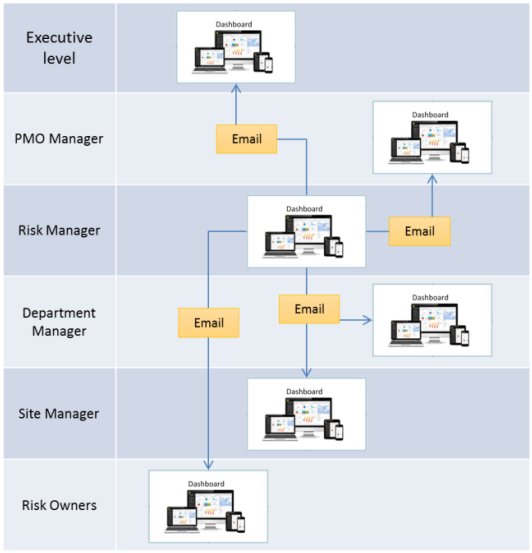


Figure No. (09) Dashboard distribution Flow chart

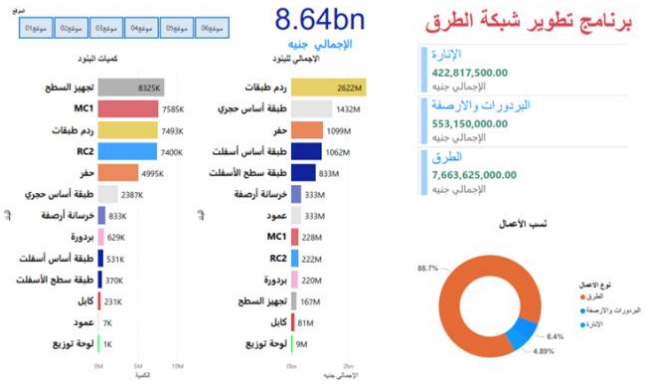


Figure No. (10) dashboard sample

9. CONCLUSION

Through the previous study and comparisons of the attempt to manage risks in construction according to international standards and best practices, the researcher concluded that for the work to be completed during the project construction phase with the required quality, the allocated cost, and within the specified period, risk management must be activated and the requirements of risk management should be integrated into the project contract and the risks of each owner should be identified. Work and contractor and make the necessary plans to manage them and define the processes of identifying and evaluating risks during the bidding phase of the project so that there is a future vision for construction before entering it, and then when starting construction , the expected risks during the phase have been defined in advance and the required reserve has been put in place to manage them in the event of their occurrence. The researcher recommends a proposal to add a process to the risk management processes, which is the distribution of risks between each of employer and contractor and the arrangement of risk management processes to be planning for risk management, risk definition, risk distribution, qualitative risk analysis, quantitative risk analysis, risk response plan development, and risk application. Responding to risks and following up on risks, instead of the arrangement included in the Project Management Knowledge Guide chosen

for the study, which is planning for risk management, defining risks, conducting a qualitative risk analysis, conducting a quantitative risk analysis, developing a risk response plan, applying risk response, and following up on risks, and thus it is practical Distributing risks between both employer and contractor is a proactive step to reduce change orders that occur in the project as a result of things or events that were not expected by both parties, and thus time, cost and quality are managed more efficiently than if the risk management had not been pre-distributed, and thus claims are reduced. Financial and temporal The operations chart presented by the researcher is one of the most important tools for the governance of risk management operations, which, once activated, shows the tasks and responsibilities of both employer and contractor, and thus the operations are managed efficiently and effectively. The automation of risk management follow-up reports and display of results is the final data dashboard (Dashboard) for departments at different levels in different geographical ranges using Microsoft BI and other programs used which gives real-time data to decision-makers early and contributes to rational decision-making dealing with project risks.

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