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Risk Response in Construction Project: A Review Study

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ABSTRACT

Construction projects are characterized as projects with multi phases and activities, complex, unique, and have many different parties and stakeholders. Risks could appear at one or more of the construction project stages and may affect the achievement of project objectives. Therefore, one of the key elements in the planning phase of any project is the risk management process (RMP). This study attempts to understand the terminology of risk in general, risk management, and response to risk in particular. This study is mainly a review of thirty-eight studies that have been published between 1997 and 2020 that demonstrate the importance of the crucial phase of risk response from the risk management process and its impact on the project objectives, as well as the tools and methodologies that project managers and decision-makers could use to handle the risks to reduce the negative effects of risks on the success of the construction projects. This study concludes that risk response should be considered an essential activity to complete the RMP, which will lead to minimizing the losses due to risks, maximizing the benefits due to opportunities, and achieving the objectives of projects.

Keywords: Risk, Risk Management, Risk Responses, Construction Projects.

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استجابة المخاطر في المشاريع الانشائية

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الخلاصة

تتميز المشـاريع الإنشـائية بكونها مشـاريع متعددة المراحل وألاطراف والانشـطة والفعاليات ومعقدة في ذات الوقت ويعتبر كل مشـــروع فريد من نوعه. يجب أن تؤخذ عملية إدارة المخاطر (RMP) في الاعتبار لتكون واحدة من الخطوات الحيوية اثناء مرحلة التخطيط لأي مشـــروع انشـــائي وذلك لوجود احتمالية عالية لظهور المخاطر في مرحلة أو أكثر من مراحل المشـــروع وظهور المخاطر بمختلف انواعها قد يؤدي بدوره الى عدم تحقيق هدف او اهداف المشروع الانشائي .

هدف البحث هو التوصل الى فهم شامل لمصطلح إدارة المخاطر والمخاطر بشكل عام والاستجابة للمخاطر بشكل خاص.هذا البحث في الأسـاس هو مراجعة لثمانية وثلاثون دراسـة تم نشـرها بين عامي 1997 و 2020 والتي توضـح أهمية مرحلة اسـتجابة المخاطر تحديدا من عملية إدارة المخاطر وتأثيرها على تحقيق أهداف المشـــروع ، وكذلك الأدوات والمنهجيات التي يمكن اسـتخدامها من قبل مدراء المشـاريع وصـانعي القرار للتعامل مع المخاطر من أجل تقليل الآثار السـلبية للمخاطر على نجاح المشـاريع الإنشـائية. يؤكد هذا البحث على اعتبار مرحلة اسـتجابة المخاطر فعالية اسـاسـية لا يمكن التقليل من اهميتها اثناء تنفيذ عملية ادارة المخاطر وذلك من اجل تقليل الخسـائر الناجمة عن المخاطر وتعظيم الفوائد الناتجة عن الفرص وتحقيق اهداف المشروع.

الكلمات الرئيسية: المخاطر ، ادارة المخاطر، استجابة الخاطر،المشاريع الانشائية.

1. INTRODUCTION

A project is a temporary endeavor to create a unique service or result. A project is a series of activities that should be done within an acceptable time, cost, and desirable quality. Project management is the use of specific knowledge, skills, tools, and techniques to deliver something of value to people **(PMI, 2022)** and that leads to all projects should be managed properly by using the right resources: equipment, material, different team members in all phases of any project.

Projects cannot be performed in a deterministic environment since risks and uncertainties could be generated and may affect the project objectives, parties, or even the project's success. Risk management should be planned tightly and equipped with the right skills and techniques to identify the potential risks, assess the risks quantitatively and qualitatively, and develop strategies to address the risks to reduce or eliminate the occurrence or the negative impacts of risk events.

Risk response strategies play a proactive role in either preventing the risks or making the project adapt to risks or both ways. The main objective of the risk responses stage is the success of the project and team members in confronting the risk with the right responses, so that would not be achieved without hiring experienced managers and trained team

members, using appropriate techniques to choose, implement, monitor, and control the proper responses to address the risks successfully.

To validate the hypothesis of this study, which believes in the importance of the risk response phase from the risk management process and how this phase must be given the attention it deserves during the planning and implementation of various types of construction projects. This work focuses on reviewing previous studies that dealt with the risk response stage and presenting the objectives and tools adopted in each study.

This work seeks to emphasize the importance of understanding the stage of risk response in risk management and give it sufficient attention in planning and implementing the risk management process in all types of construction projects. **Fig. 1** represents the systematic literature review used in the study.

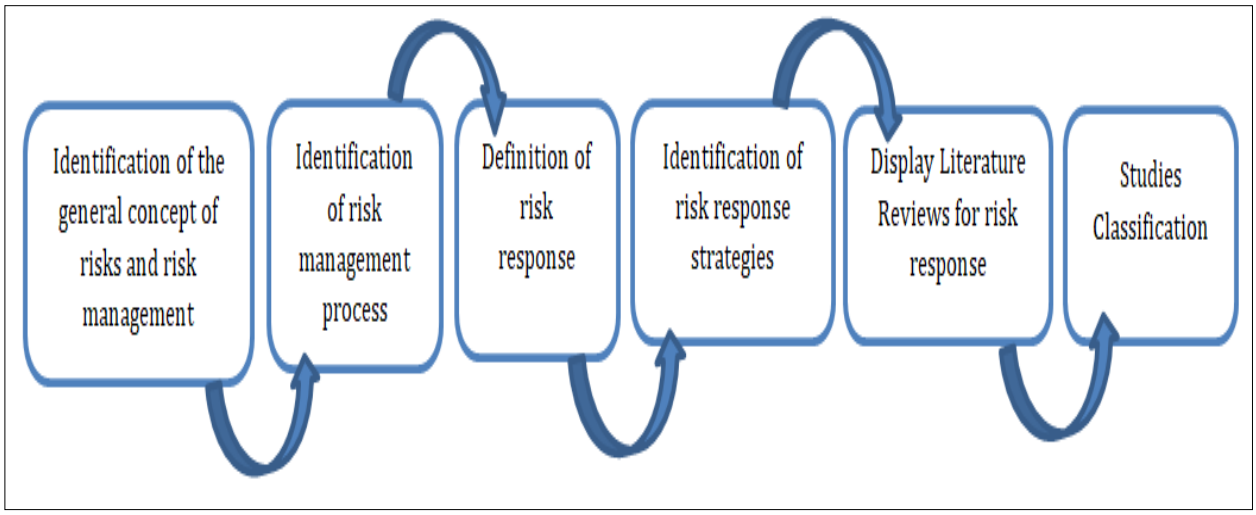

Figure 1. Research Methodology

Through the search process, it was found that there is a clear discrepancy between the number of research papers that dealt with the concepts, types, identification, and evaluation of risks, how to plan and implement the phases of the risk management process, and the research papers that concerned with the risk response phase. Studies about the risk response stage were less numerous compared to investigations related to risk identification and assessment stages**.** The keywords adopted in the selection of previous studies were: ”risk response in construction projects “to highlight this important stage which has a major role in the success of any project and achieving its goals.

The period for the selected papers is from 1997 to 2020. **Fig. 2** illustrates the growing interest in risk response through the increasing number of studies proposing new frameworks to plan, select, and evaluate risk responses.

To review what previous researchers have presented in the field of risk response in construction projects, Thirty-eight research papers were selected from different countries around the world, such as Australia, China, Canada, Egypt, Europe, Fiji, Iraq, Iran, Japan, Palestine, South Africa, Turkey, United Arab Emirates, United States of America and the United Kingdom.

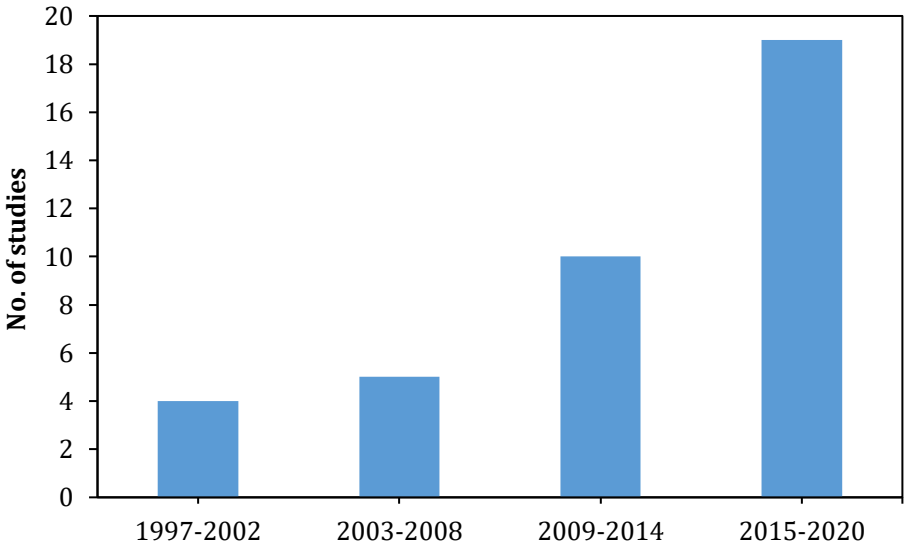

Figure 2. Period for literature reviews.

2. DEINITION OF RISK

Risks always accompany the execution of project phases. The risks could become more difficult according to the complexity degree of the project. Project complexity can be defined as the degree of differentiation between project components, the interdependence of project components, and the influence on project decisions **(Hossny et al., 2021)**. So project complexity depends on the type, characteristics, and project requirements.

Risks can be classified into different groups according to their sources, effect, and project activities such as: **(Burhan, 2003; Ehsan et al., 2010; Al-Ajmi and Makinde, 2018; Rasheed, 2015a; Al-Mukahal, 2020)**

- External and internal risks
- Acceptable and unacceptable risks
- Manageable and unmanageable risks
- Risk discipline; technical, logistical, environmental, financial, socio-political, and management-related risks

Because of the importance of understanding the concept of the term risk, many researchers have studied risks and defined them from their point of view, as shown below:

- Risk is the exposure to the potential of fiscal loss or gain, physical damage, or delay due to the uncertainty associated with a particular action. **(Perry and Hayes, 1985)**
- Risk is an obstacle to success**. (Hertz and Thomas, 1994)**
- Risk is the possibility of losses in a project. **(Jaafari, 2001)**
- Risk is the exposure to the chance that an event with negative consequences might happen. **(Ben-David and Raz, 2001)**
- Risk is the probability of occurring a detrimental event to the project **(Baloi and Price, 2003)**
- Risk is the event that may or may not happen and may lead to a rise in the project cost, failure to meet the project schedule, and the quality requirements of the organization. (**Van Well-stam et al., 2013)**
- Project risk is an uncertain event that positively or negatively impacts one or more project objectives, such as cost, scope, quality, and schedule **(PMBOK, 2013, as cited in Fukuda and Kuwano, 2017)**

- Risks are a combination of events that negatively affect the project objectives and can be associated with operational, technical, or commercial aspects of the project **(Singh et al., 2017)**
- Risks are uncertain events that adversely affect the project objectives and can occur at any phase in any construction project **(Abu Safayet et al., 2018)**
- Risk is the probability of any problem in the future that could affect the project plan, and then the project will deviate from the planned schedule **(Nassar, 2021)**
- A risk is an uncertain event that may impact one or more of the project objectives positively or negatively, and it must be handled to maximize the positives and minimize the negatives. **(Kadum, 2021)**

The researchers concluded that risk could be defined as an external or internal event that may occur in one or more of the construction project phases, and this event may negatively influence achieving project requirements and objectives.

3. RISK MANAGEMENT

3.1. Definition

Construction projects can be described as risky business**.** Confronting risks is a heavy burden for project managers and team members to deal with, and from this, the significant role played by risk management in construction projects appears. Project Management Body of Knowledge(PMBOK) puts risk management as one of its nine knowledge areas in project management; integration, scope, time, cost, quality, human resource, communication, risk, and procurement. Risk management has many different definitions according to the previous studies, as illustrated below:

- Risk management is a system to identify, evaluate, categorize risks and make the risks explicit **(Anthony, 1996, as cited in Abu Safayet et al., 2018)**
- Risk management is a critical element of any successful management process **(Chavas, 2004)**
- Risk management is an attempt to identify threats, the probability of their occurrence, appropriate responses to address them, and take the necessary actions to reduce their occurrence **(Mcnamara, 2008)**
- Risk management is a systematic approach to addressing unknown events by taking the necessary steps to protect the assets and objectives of the organization from being adversely affected by external or internal events **(Sharma and Swain, 2011)**
- Risk management is a process of risk identification assessment and implementing appropriate strategies to reduce them to an acceptable level. Risk management should be applied in projects to improve the project management process **(Banaitiene and Banaitis, 2012)**
- Risk management is an effective approach used in the Management of construction projects to maximize the probability of completing the project successfully **(Rasheed, 2015b)**
- Risk management means the entire process of managing project risks that cause adverse impacts on the project objectives **(Fukuda and Kuwano, 2017)**
- Risk management is a process consisting of negative risk identification, risk impact quantification, and implementation of actions to mitigate the impact of risks **(Singh et al., 2017)**
- Risk management is a process that aims to manage and decrease the risks facing an organization **(Nassar, 2021)**

- Risk management is a systematic process aimed at identifying and managing risks to achieve project objectives and improve communication between project parties **(Kadum, 2021)**

The researchers have defined risk management as one of the success elements for all types of construction projects that must be used to identify, analyze, and propose responses to eliminate negative impacts and increase positive impacts in achieving the objectives of projects.

3.2 Process

Many different processes are proposed for risk management according to the project phase's division. The number of risk management process stages differs from one study to another according to the perspective of researchers that have been presented in their research papers, as clarified:

The risk management process consists of the following:

1. Two phases
    - Risk assessment and risk control. **(Boehm, 1991, as cited in Bransah, 2020)**
2. Three phases
    - Risk identification, risk analysis, and risk response. **(Nassar, 2021)**
3. Four phases
    - Risks identification, assessment, response, monitoring, reviewing, and control. **(Nieto-Morote and Ruz-Vila, 2011)**
    - Risks identification, risk analysis and quantification, risk response development, and risk response control. **(Rasheed, 2015a**; **Singh et al., 2017)**
    - Risk management planning, identification, analysis, response, and monitoring. **(Kadum, 2021)**
4. Five phases
    - Establish context, risk identification, analyzing risk, risk response development, and risk response control. **(Larson and Gray, 2011)**
    - Identification and detection of risks, risk evaluation, choosing risk response strategy, implementation, and monitoring. **(Al-Geelawee and Mohammed, 2016)**
5. Six phases
    - Risk management planning, identification, qualitative risk analysis, quantitative risk analysis, risk responding, and risk controlling and responding. **(Guide, 2008, as cited in Kadum, 2021)**
6. Seven phases
    - Project, process, Risk identification, Risk evaluation, Risk analysis, Risk re-evaluation, and Urgent planning and actions. (Alfredo del Cano and pilar,1998, as cited in Kadum, 2021)
7. Nine phases
    - Define project sections, Pay attention to the strategic approach of risk management, recognition of risks sources, Define information about relationships and risk assumption, Assign responsibility for risks and responses, Uncertainty assessment, Estimation of the relative weight of risks,

response strategy, and Ensure control and monitoring of the implementation phase **(Chapman and Ward, 1997)**

According to researchers' perception, the main phases of the risk management process can be outlined in six steps:

- Planning
- Data collection and risk identification
- Evaluation of risks quantitatively and qualitatively
- Developing a risk responses plan
- Evaluation and implementation
- Monitoring and control

4. RISK RESPONSE DEFINITION

In the risk management process, after risks are identified, quantified, and qualified, the next step should be determining actions to address the evaluated risks. The risk response phase includes planning, monitoring, and controlling the determined actions to reach the required result.

Many researchers attempt to clarify the risk response phase according to their point of view by developing a suitable and understandable definition for it, such as:

- Risk response is developing actions to improve opportunities and minimize threats to project objectives. **(Nieto-Morote and Ruz-Vila, 2011)**
- Risk response can be defined as recognizing response actions (steps) for threats and opportunities related to risks. **(Ehsan et al., 2010; Singh et al., 2017)**
- Risk Responses is the procedure (process) for developing options, choosing methods (strategies), and approving actions to handle overall project risk exposure and address individual project risks. **(PMBOK, 2017)**
- Risk response is one of the risk management phases associated with identifying, evaluating, choosing, and executing necessary actions to reduce the likelihood of risks and their adverse impacts. **(Soofifard et al., 2018)**
- Risk response is a planning process that reduces the probability of risk events and the negative effects to achieve project success. **(Fateminia et al., 2019)**

From the researchers' point of view, risk response is a critical and vital stage in project risk management, and it involves developing appropriate responses to reduce or eliminate threats and increase opportunities from the identified and evaluated risks in the early stages of the risk management process.

5. STRATEGIES OF RISK RESPONSES

To deal with risks in construction projects, **(Ehsan et al., 2010; Kadum, 2021; Singh et al., 2017; Rasheed, 2015; Bransah, 2020)** have reviewed the following strategies for risk responses that would be helpful to use one or more of them:

- Avoiding means removing the threats of risks by not doing part of the actions that include risks or changing the project plan.
- Accepting means accepting the risk and not taking any action unless the risk occurs. This method can be useful in situations when the consequences of the risk are cheaper than the cure.

- Mitigating and reducing: it is about reducing the negative impact of risks on the project by educating and training project team members and enhancing the working environment.
- Transferring: This strategy refers to passaging the responsibility of doing the work and resolving risks to third parties.
- Sharing: the concept of this method is to share the risk responsibility with other partners across different teams or projects, so the risks would be handled by the partners who think these risks are within their capabilities.
- Removing: it refers to eliminating the risks by removing their causes.

6. LITERATURE REVIEW RELATED TO RISK RESPONSE

For the first time, risk response to the project was presented by **(Chapman, 1979),** who introduced a systematic work breakdown structure WBS-based approach to analyze, assess, and respond to risks. **(Fateminia et al., 2019; Cheraghi et al., 2017)**
This section reviews several previous studies about risk response in construction projects where the researchers have tried to understand and solve the problems related to risk responses using different approaches and tools.

6.1. Literatures from 1997 to 2002

(Chapman and Ward, 1997) used the trade–off approach and focused on the expected costs of the strategies of risk responses and uncertainties of the expected costs, while **(Pipattanapiwong and Watanabe, 2000)** proposed a multi-party risk management process to help in the decision-making process efficiently and systematically risk Management within the multi-part environment by using trade–off approach.
(Ben-David and Raz, 2001) presented an optimization model that integrated project work breakdown structure (WBS), risks, risk reduction actions, and their impacts into a framework. The model represents the overlapping impacts of risk reduction actions, and the effects of secondary risks, as well as the model supports the assessment of the risk exposure of the project under different risk reduction actions. **(Kujawski, 2002)** used Trade, Decision trees, Monte Carlo simulation, and Cumulative risk profiles to propose a mathematical approach that: links the risk response action to contingency planning and the success probability and supports decision-makers toward risk mathematically and practically.

6.2. Literatures from 2003 to 2008

(Haimes, 2005) focused on two factors: 1) the cost of the risk response method, 2) the work losses percentage related to the risk response strategy. **(Kayis et al., 2007)** used five heuristic algorithms to find feasible solutions for risk mitigation. The developed approach aims to support project managers in selecting the best mitigation strategy within the budget constraints and project objectives.
(Fan et al., 2008) made a conceptual framework that explains the quantitative relationships between project characteristics and risk–handling strategy. The analysis is performed to find the minimum cost of risk responses for each risk event using optimization and mathematical modeling. **(Kılıç et al., 2008)** proposed a mixed integer programming model to address the

problem of the impact of risks on project scheduling. The main objectives of the optimization model were to minimize both: 1) expected makespan and 2) total cost. A genetic algorithm (GA) was used to solve small problems, and that experiment showed that GA was a fast and efficient approach. To minimize the losses due to risks, **(Sherali et al., 2008)** presented an optimization model to assign obtainable resources for risk mitigation actions.

6.3. Literatures from 2009 to 2014

An article by **(Seyedhosein et al., 2009)** provides a methodology incorporating modeling and WBS approaches. The proposed model helps risk analysts select risk response actions that reduce the undesirable deviation from achieving the scope of projects. **(Nik et al., 2011**) provided an optimization model to minimize the expected time, cost, and quality loss. The proposed model integrates 1) project WBS: 2) risks: 3) risk responses, and: 4) their impacts into one framework. The Fuzzy analytic hierarchy process (FAHP) calculated the coefficients of the objective function.

To help decision-makers and experts to make judgments traditionally, **(Mousavi et al., 2011)** presented a methodology in a fuzzy environment by using Fuzzy Decision Tree and Fuzzy Technique for order preference by similarity to the ideal solution (TOPSIS) to assess and choose the appropriate response for risks. Using Integer linear programming (ILP) and simulation, **(Gonen, 2012)** proposed a cost-based approach to allocating a budget for risk management between the transference or mitigation strategies regarding response feasibility. A Multiple criteria decision-making approach that allows decision-makers and experts to evaluate risk response actions for risks of mega projects was developed by **(Mousavi et al., 2012)**.

(Fang et al., 2013) used genetic algorithm, Design Structure Matrix (DSM), and greedy algorithm to provide a five-step framework to support project managers in risk response decision-making. The framework comprises a risk network, objective function, budget constraints, response action, and an optimized risk response plan. **(Zhang and Fan, 2014)** had put together Integer programming, WBS, and Trade-offs tools to propose analyzing method which combines qualitative analysis and quantitative model to select the optimal risk response strategies. A network-structured framework that confronts the multi-dimensional nature of project risks and responds to highly prioritized risks was presented by (Samadi et al., 2014) using tools such as Information Technology Outsourcing (ITO), fuzzy ANP, and fuzzy TOPSIS.

To understand the optimization of risk reduction, **(Bai et al., 2014)** proposed a multi-phase approach. The risk response process in their method was divided into two phases:1) analyzing and determining the actions to reduce the initial risks;2) identifying and analyzing the secondary risks to ensure that secondary risk losses are less than initial risks. **(Motaleb and Kishk, 2014)** used questionnaire and d statistical analysis to evaluate the relationship between risk response mitigation (reduction, absorption, and transfer) and project management maturity (PMM). The result of the study was a framework to enhance the practical functioning of risk response.

6.4. Literatures from 2015 to 2020

(Fan et al., 2015) provided a practical method using case-based reasoning for generating appropriate risk response actions. The proposed approach consists of five steps: (1) target case and historical cases representation; (2) similar historical cases retrieval; (3) create the solution and revise it using related knowledge; (4)solution validation; (5) updating the case

base by adding the validated solution. The proposed method helps decision-makers solve the project risk response problem.

Optimization modeling is one of the main approaches to analyze, assess, and determine actions to respond to risks, so **(Zhang, 2016)** proposed the ILP model to calculate the risk interdependencies quantitatively. The optimization model to select risk response strategies considers the anticipated risk loss, risk interdependence, and its two directions. **(Qazi et al., 2016)** put together trade-off and modeling approaches**,** Bayesian belief networks, and Expected utility theory to present a model for choosing a set of optimal risk responses at the commencement stage of a project by measuring the effect of the combination of responses on the objective function of a project. The proposed modeling approach assists in recognizing the interdependency among project complexity, risks caused by complexity, and project objectives.

An optimization method was proposed by **(Wu et al., 2016)** to find the ideal risk response and support decision-making for allocating resources to risk response action. The researchers used in their work Shaply value and cooperative game. The Shaply value-based method helps measure the actual effects of risks. **(Soofifard and Bafruei, 2016)** presented a mathematical model to assess and select risk responses. The model clearly shows the relation among work structure breakdown, risk events, measures of risk reduction, and their effects.

(Prakash and Jokhan, 2017) developed a model using a Monte Carlo simulation approach that integrates aspects of projects with the costs and benefits of risk response strategies. The model aims to facilitate the decision-making process and help project managers choose the preferred approaches to be implemented. **(Cheraghi et al., 2017)** combined ISO 31000 and Failure Mode and Effects Analysis (FMEA) to develop a mathematical model for selecting risk response strategies for construction projects. The risk response has been identified, and a mathematical model was presented based on project tringle; cost, quality, and time. **(Fukuda and Kuwano, 2017)** built a mathematical model to calculate the effectiveness of risk responses and to decide which risk response should be implemented quantitatively.

An integer linear programming model has been proposed by **(Soofifard and Gharib, 2017)** to choose appropriate responses for risks. This suggested model has considered the relationships between risk responses, relationships between risks, as well as time and quality constraints. **(Naji and Ali, 2017)** their study aims to explain and control the uncertainties, identify the reasons for risk response failure, and use optimization methods to choose the strategy to respond to risk successfully. The questionnaire, Gravitational Search Algorithm (GSA), and particle swarm (PSO) were the tools that the researchers used.

A quantitative multi-objective risk response method was provided by **(Wu et al., 2018),** considering the risk correlation among different project sub-processes. The decision-making model was proposed to assist the project managers in selecting the optimal risk responses that minimize the total expected losses, delays, and quality reduction by using Non-dominated Sorting in the Genetic Algorithm (NSGA) technique. **(Ghassemi and Darvishpour, 2018)** proposed a comprehensive framework consisting of three phases using techniques such as ANP, DEMATEL, Fuzzy theory, and zero-one programming. The first phase was detecting all the risks, responses, and their relations. The second phase weighed the risk and responses; the third phase reflected the budget constraints by programming to enable realistic solutions. The framework was constructed for risk evaluation and risk response planning.

An optimization method was developed by **(Zuo and Zhang, 2018)** to confront the problem of selecting risk response actions with consideration of secondary risk. The optimization

model objective is to minimize the total risk costs with time constraints being placed on the project makespan. **(Soofifard et al., 2018)** developed a mathematical model to evaluate and select project risk responses. The objective function maximizes the expected impacts from responses on project objective criteria. The study has taken into account the relation among risk responses.

To evaluate the effectiveness of strategies for risk responses, **(Fateminia et al., 2019)** used a Fuzzy Rule-Based System (FRBS) that consists of 3 inputs (affordability, achievability of responses, and controllability of risks) and one output, which is the effectiveness of the risk responses. **(Shoar and Nazari, 2019)** proposed an optimization framework consisting of three techniques (Multi-criteria decision-making, Ant colony optimization, and fuzzy TOPSIS) to select the risk response actions. The presented framework considered: the impact of risks on the project objectives, the interactions among risks, and management criteria and preferences.

Expert judgment, questionnaire, and Statistical Package for the Social Sciences (SPSS) are utilized to provide a risk response approach. It is adopted to develop and enhance the risk management process, reduce threats, increase the influence of responses, and advise stakeholders to guarantee project success with the lowest anticipated cost losses and time delays. **(Renault et al., 2020)** used a structured questionnaire and exploratory factor analysis of risk response measures among small and medium enterprises in South Africa. The obtained result from the study was that both mitigation and avoidance were reliable measures of risk response measures RRMs. **(Ahmadi-Javid et al., 2020)** developed eight steps quantitative method for response planning. The optimization model maximizes the overall expected risk reduction subject to budget constraints.

In sum, all the above previous studies have made considerable contributions to the understanding and the execution of project risk management in general and the risk response phase in particular, which will facilitate the decision-making process and lead to achieving the objectives of construction projects.

7. CLASSIFICATION OF REVIEW

The previous studies can be classified into different categories based on the process, approach, and research methodology used by researchers, as illustrated in **Fig. 3**. It is worth noting that there are sub-categories as a result of overlapping between the original classifications. For example: **(Zhang and Fan, 2014)** proposed a study that combined optimization and trade-off approaches for risk response selection, **(Zuo and Zhang, 2018)** developed an optimization model then they testified the effectiveness of the developed model by implementing it on a case study in China, while **(Mousavi et al., 2011)** presents a methodology to evaluate and select project risk responses.

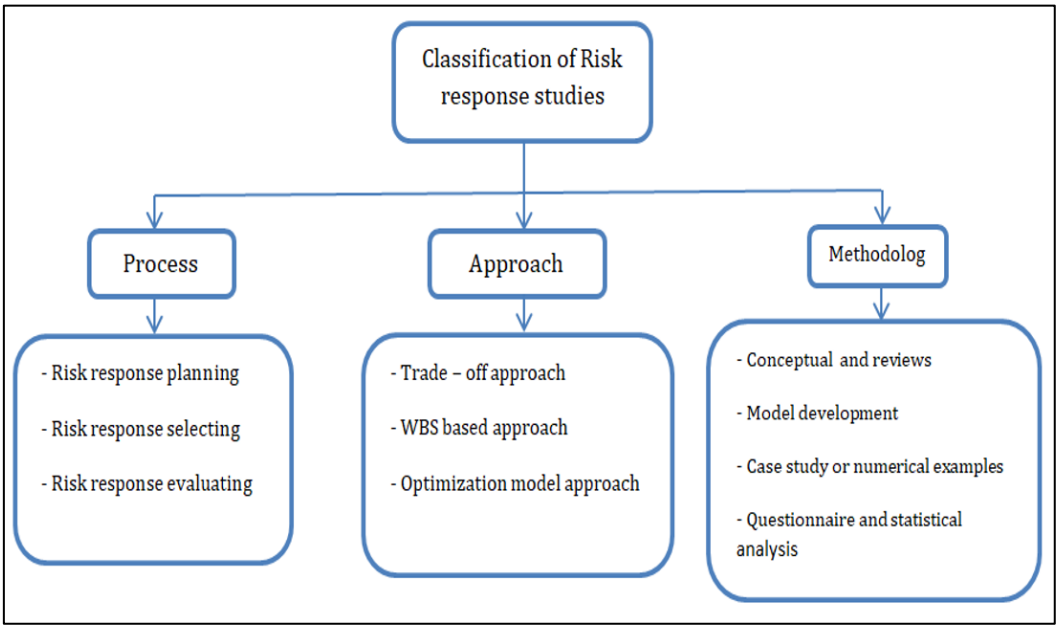

Figure 3. Classification of risk response studies

8. CONCLUSIONS

Although most of the research papers have discussed risk management and focused especially on risk identification and assessment. This study has focused on reviewing works of literature related to the risk response stage with the fulfillment of all objectives of projects. To achieve the aim of this research, the concepts of risk, risk management in general, and risk response in specific were reviewed.

This study suggests that six steps could outline risk management:

1) Planning
2) Data collection and risk identification
3) Evaluation of risks quantitatively and qualitatively
4) Developing a risk response plan
5) Evaluation and implementation
6) Monitoring and control.

The risk response literature showed two important points:

- Risk response is a crucial phase in the risk management process. After the risks have been identified and evaluated, they can be eliminated, reduced, or controlled by choosing the appropriate response to address the risks.
- There is an obvious augmentation in the interest in studying the risk response stage. Therefore, this study concludes and emphasizes that risk response should be considered an essential activity to complete the risk management process to execute project activities successfully, which will lead to achieving the objectives of projects, minimizing the losses due to risks, and maximizing the benefits due to opportunities.

  As indicated in the literature review, a new research direction has opened. This study recommends proposing more detailed research papers to address the problems of planning, selecting, evaluating, implementing, controlling, or monitoring risk response phases during different situations, such as presenting a study about responding to risk:
- According to the perspective of each project party (owner, contractor, engineer, etc.)

- According to the type of project (residential, industrial, etc.)
- by taking into account new criteria and constraints to achieve specific objectives
- by using new tools to collect, analyze data, and helpfully show the result to decision-makers

REFERENCES

Ahmadi-Javid, A., Fateminia, S.H., and Gemu¨nden, H.G., 2020. A method for risk response planning in project portfolio management. *Project Management Journal*, 51(1), pp. 77-95, Doi:10.1177/8756972819866577.

Abu Safayet, M., Islam, M.H., and Ahmed, S., 2018. A case study on risk management in existing construction project in Bangladesh. *Journal of Logistics, Informatics and Service Science*, 5(1), pp. 1-16.

Al-Ajmi, H.F., and Makinde, E., 2018. Risk management in construction Projects. *Journal of Advanced Management Science*, (2), pp. 113-116.

Al-Geelawee, E.K., and Mohammed, A.N., 2016. Application of total quality management (TQM) requirements in risk management in construction project in Iraq. *Journal of Engineering*, 22(6), pp. 1-15, Doi:10.31026/j.eng.2016.06.12.

Al-Mukahal, A.A.M., 2020. Risk management of construction projects. *Engineering Management Research*, 9(1), pp. 15-27, Doi:10.5539/emr.v9n1p15.

Bai, Y., Dai, Z., and Zhu, W., 2014. Multiphase risk-management method and its application in tunnel engineering. *Natural Hazards Review*, 15(2), pp. 140-149, Doi:10.1061/(ASCE)NH.1527-6996.0000124.

Baloi, D., and Price, A. D., 2003. Modelling global risk factors affecting construction cost performance. International Journal of Project Management 21(4), pp. 261-269, Doi:10.1016/S0263-7863(02)00017-0.

Banaitiene, N., and Banaitis, A., 2012. Risk management in construction project. In: Risk Management - Current Issues and Challenges, IntechOpen, pp. 429-448.

Ben-David, I., and Raz, T., 2001. An integrated approach for risk response development in project planning. *Journal of the Operational Research Society*, 52(1), pp. 14-25, Doi:10.1057/palgrave.jors.2601029.

Bransah, W., 2020. Discovering project risk management practices in construction industry of Ghana. *Dama Academic Scholarly Journal of Researchers*, 5(3), pp. 1-14.

Burhan, A.M., 2003. Risk management in construction projects. Iraq, MSc. Thesis, Department of Civil Engineering, University of Baghdad.

Chapman, C.B. and Ward, S. C., 1997. *Project risk management. Processes, techniques and insights*. Chichester, UK: John Wiley.

Chavas, J.P., 2004. *Risk analysis in theory and practice*. United States of America: Academic Press.

Cheraghi, E., Khalilzadwh, M., Shojaei, S., and Zohrehvandi, S., 2017. A mathematical model to select the risk responses strategies of the construction projects: case study of Saba tower. Barcelona, Spain, *Procedia Computer Science*,121, pp. 609-616, Doi:10.1016/j.procs.2017.11.080.

Ehsan , N., Mirza, E., Alam, M., and Ishaque, A., 2010. Risk management in construction industry. *Chengdu, China, International Conference on Computer Science and Information Technology*.

Fang, C., Marle, F., Xie, M., and Zio, E., 2013. An integrated framework for risk response planning under resource constraints in large engineering projects. *IEEE Transactions on Engineering Management*, IEEE, 60(3), pp. 627-639. Doi:10.1109/TEM.2013.2242078

Fan, M., Lin, N P., and Sheu, C., 2008. Choosing a project risk-handling strategy: An analytical model. *International Journal of Production Economics*, 112(1), pp. 700-713, Doi:10.1016/j.ijpe.2007.06.006.

Fan, Z. P., Li, Y.H., and Zhang, Y., 2015. *Generating project risk response strategies based on CBR. Systems Expert with applications*, 42(6), pp. 2870-2883, Doi:10.1016/j.eswa.2014.11.034.

Fateminia, S.H., Seresht, N.G., and Fayek, A.R., 2019. Evaluating risk response strategies on construction projects using a fuzzy rule-based system. 36th International Symposium on Automation and Robotics in Construction (ISARC), pp. 282-288, Doi:10.22260/ISARC2019/0038.

Fukuda, H., and Kuwano, H., 2017. The mathematical model of project risk responses in project management. *Journal of the Operations Research Society of Japan*, 60(2), pp. 192-200. Doi:10.15807/jorsj.60.192

Ghassemi, A., and Darvishpour, A., 2018. A novel approach for risk evaluation and risk response planning in a geothermal drilling project using DEMATEL and fuzzy ANP. *Decision Science Letters*, 7(3), pp. 225-242. Doi:10.5267/j.dsl.2017.10.001

Gonen, A., 2012. *Selecting a response plan under budget constraints in risk management-current issues and challenges*. Third chapter in risk management-current issues and challenges, InTech Press.

Haimes, Y., 2005. A unified framework for risk assessment and management of sanitary and phytosanitary (SPS) situations.Center for Risk Management of Engineering Systems, University of Virginia.

Hertz, D.B. and Thomas, H., 1994. *Risk analysis and its applications. Detroit*. John Wiley and Sons.

Hossny, H.E., Ibrahim, A.H., and Elnady, A., 2021. Assessment of construction project complexity. *The Open Civil Engineering Journal*, 15(1), pp. 414-423. Doi:10.2174/1874149502115010414

Jaafari, A., 2001. Management of risks, uncertainties and opportunities on projects: time for a fundamental shift. *International journal of project management*, 19(2), pp. 89-101, Doi:10.1016/S0263-7863(99)00047-2.

Kadum, N. H., 2021. The integration of Risk management and BIM to Manage the duration of construction projects. Iraq. MSc. Thesis, College of Engineering University of Diyala.

Kayis, B., Arndt, G., Zhou, M., and Amornsawadwatana, S., 2007. A risk mitigation methodology for new product and process design in concurrent engineering projects. *CIRP Annals*, 56(1), pp. 167-170, Doi:10.1016/j.cirp.2007.05.040.

Kılıç, M., Ulusoy, G., and Şerifoğlu, F.S., 2008. A bi-objective genetic algorithm approach to risk mitigation in project scheduling. *International Journal of Production Economics*, 112(1), pp. 202-216. Doi:10.1016/j.ijpe.2006.08.027

Kujawski, E., 2002. Selection of technical risk responses for efficient contingencies. Systems Engineering, 5(3), pp. 194-212, Doi:10.1002/sys.10025.

Larson, E.W., and Gray, C.F., 2011. *Project management: The managerial process*. New York: McGraw-Hill Hills Companies.

Mcnamara, C., 2008. *Field guide to developing, operating and restoring your nonprofit board*. Authenticity Consulting, LLC.

Motaleb, O.H., and Kishk, M., 2014. Assessing risk response maturity A framework for construction projects success in the United Arab Emirates. International Journal of Managing Projects in Business, 7(2), pp. 247-262.

Mousavi, S.M., Raissi, S., Vahdani, B., and Mojtahedi, S.M.H., 2011. A fuzzy decision-making methodology for risk response planning in large-scale projects. *Journal of Optimization in Industrial Engineering*, 7, pp. 57-70.

Mousavi , S.M., Makui, A., Raissi, S., and Mojtahedi, S.M., 2012. A multi-criteria decision-making approach with interval numbers for evaluating project risk responses. *International Journal of Engineering Transactions B: Applications*, 25(2), pp. 121-129.

Naji , H.I., and Ali, R.H., 2017. Risk response selection in construction projects. Civil Engineering Journal, 3(12), pp. 1208-1221, Doi.10.28991/cej-030950.

Nassar, Y.S., 2021. Explore and assess the risks of the project parties involved in the construction projects. *Journal Of Global Scientific Research*, 6(12), pp. 1906-1919.

Nieto-Morote, A., and Ruz-Vila, F., 2011. A fuzzy approach to construction project risk assessment. International *Journal of Project Management*, 29(2), pp. 220-231, Doi:10.1016/j.ijproman.2010.02.002.

Nik, E.R., Zegordi, S.H. and Nazari, A., 2011. A multi-objective optimization and fuzzy prioritization approach for project risk responses selection. Singapore, In Proceedings of the 2011 IEEE international conference on industrial engineering and engineering management, pp. 889-892. Doi:10.1109/IEEM.2011.6118044

Perry, J.G., and Hayes, R.W., 1985. Risk and its management in construction projects. Proceeding of Institution Civil Engineers, 78(3), pp. 499-521.

Pipattanapiwong, J., and Watanabe, T., 2000. Multi-party risk management process (MRMP) for a construction project financed by an international lender. Glasgow, Proceedings of the 16th Association of Researchers in Construction Management (ARCOM) Annual Conference.

PMBOK, 2017. http://faspa.ir/wp-content/uploads/2017/09/PMBOK6-2017.pdf

PMI, 2022. https://www.pmi.org/about/learn-about-pmi/what-is-project-management.

Prakash, S., and Jokhan, A., 2017. *Monte Carlo for selecting risk response strategies*. Auckland, New Zealand, Australasian Transport Research Forum 2017 Proceedings.

Qazi, A., Quigley, J., Dickson, A., and Kirytopoulos, K., 2016. Project complexity and risk management (PROCRIM): towards modelling project complexity driven risk paths in construction projects. International Journal of Project Management, 34(7), pp. 1183-1198.

Rasheed, E.K., 2015a. Development of a blueprint impact system of the risks on construction projects implementation. *Journal of Engineering*, 21(8), pp. 28-49, Doi:10.31026/j.eng.2015.08.12.

Rasheed, E.K., 2015b. Valuation the impact of risks on the goals and safety of construction projects in Iraq. *Journal of Engineering*, 21(4), pp. 1-19, Doi:10.31026/j.eng.2015.04.10.

Renault, B.Y., Agumba, J.N., and Ansary, N., 2020. Underlying structures of risk response measures among small and medium contractors in South Africa. *Construction Economics and Building*, 20(1), pp. 1-16. Doi:10.5130/AJCEB.v20i1.6721

Samadi, H., Nazari-Shirkouhi, S., and Keramati, A., 2014. Identifying and analyzing risks and responses for risk management in information technology outsourcing projects under fuzzy environment. *International Journal of Information Technology & Decision Making*, 13(6), pp. 1283-1323. Doi:10.1142/S021962201450076X

Seyedhoseini, S.M., Noori, S., and Hatef, M.A., 2009. An integrated methodology for assessment and selection of the project risk response actions. *Risk Analysis*, 29(5), pp. 752-763. Doi:10.1111/j.1539-6924.2008.01187.x

Sharma, S., and Swain, N., 2011. Risk management in construction projects. *Asia-Pacific Journal of management research and Innovation*, 7(3), pp. 107-120. Doi:10.1177/097324701100700310

Sherali, H. D., Desai, J., and Gli, T. S., 2008. Optimal allocation of risk-reduction resources in event Trees. Management Science, 54(7), pp. 1313-1321. Doi:10.1287/mnsc.1070.0844.

Shoar, S., and Nazari, A., 2019. An optimization framework for risk response actions selection using hybrid ACO and FTOPSIS. *Scientia Iranica*, 26(3), pp. 1763-1777. Doi:10.24200/sci.2018.20225

Singh, M.K., Deep, S., and Banerjee, R., 2017. Risk management in construction projects as per Indian scenario. *International Journal of Civil Engineering and Technology*, 8(3), pp. 127-136.

Soofifard, R., and Bafruei, M. K., 2016. An optimal model for project risk response portfolio selection (P2RPS) (case study: research institute of petroleum industry). *Iranian Journal of Management Studies*, 9(4), pp. 741-765. Doi:10.22059/IJMS.2017.59374

Soofifard, R., and Gharib, M., 2017. A New approach to project risk responses selection with inter-dependent risks. *International Journal of Engineering*, 30(5), pp. 720-728. Doi:10.5829/idosi.ije.2017.30.05b.12

Soofifard, R., Bafruei, M.K., and Gharib, M., 2018. A mathematical model for selecting the project risk responses in construction projects. *International Journal of Optimization in Civil Engineering*, 8(4), pp. 601-624.

Van Well-Stam, D., Van Kinderen, S., Lindenaar, F., and Van den Bunt, B.P., 2013. *Risk management for projects applied the RISMAN method,* Spectrum.

Wu, D., Dai, Q. and Zhu, X., 2016. Measuring the effect of project risks based on Shapley value for project risk response. *Procedia computer science*, 91, pp. 774-778. Doi:10.1016/j.procs.2016.07.076

Wu, D., Li, J., Xia, T., Bao, C., Zhao, Y., and Dai, Q., 2018. A multiobjective optimization method considering process risk correlation for project risk response planning. *Information sciences*, 467, pp. 282-295. Doi:10.1016/j.ins.2018.07.013.

Zhang, Y., 2016. Selecting risk response strategies considering project risk nterdependence. *International Journal of Project Management*, 34(5), pp. 819-830, Doi:10.1016/j.ijproman.2016.03.001.

Zhang, Y., and Fan, Z.P., 2014. An optimization method for selecting project risk response strategies. *International Journal of Project Management*, 32(3), pp. 412-422, Doi:10.1016/j.ijproman.2013.06.006.

Zuo, F., and Zhang, K., 2018. Selection of risk response actions with consideration of secondary risks. *International Journal of Project Management*, 36(2), pp. 241-254, Doi:10.1016/j.ijproman.2017.11.002.