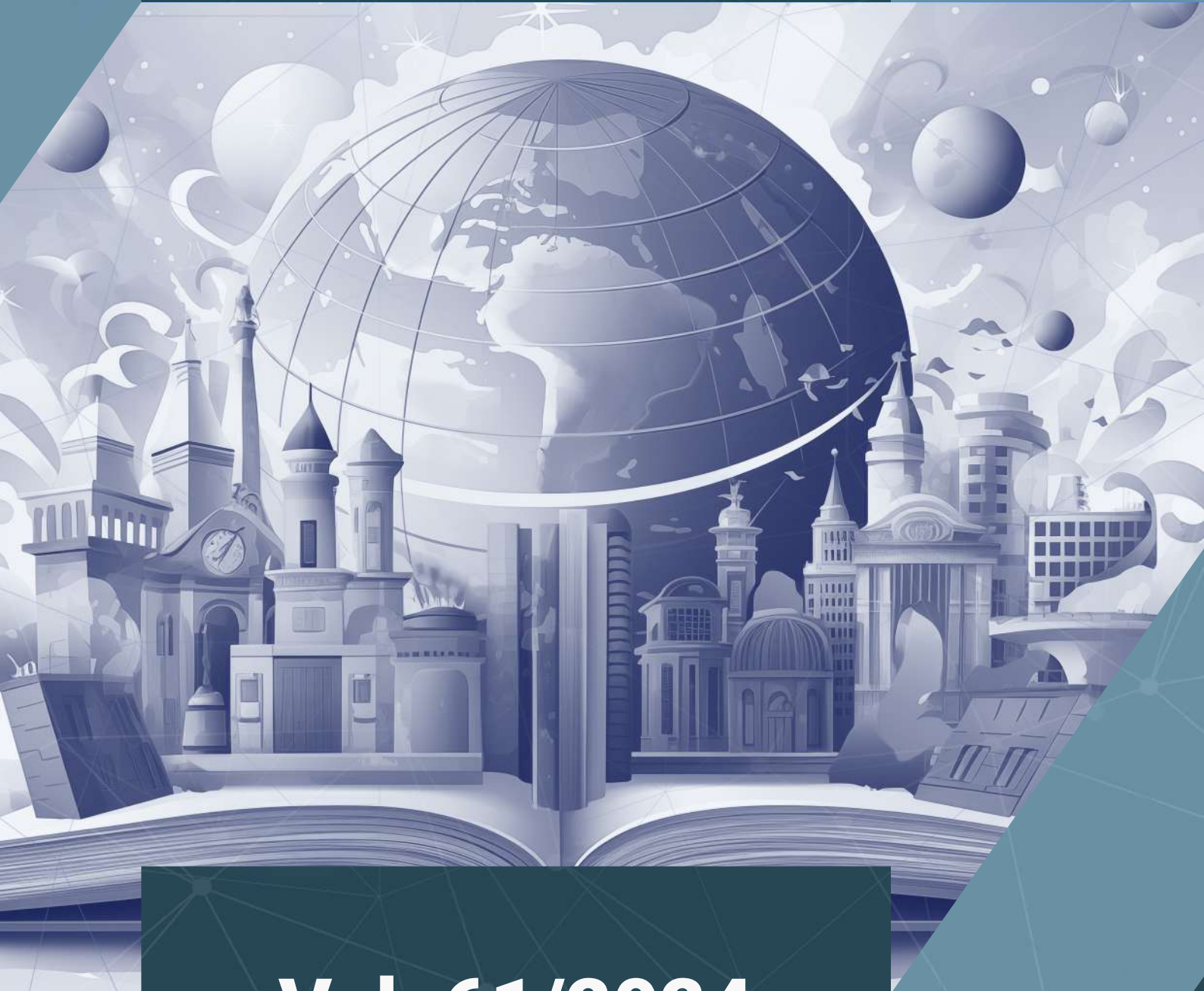




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## **Investigating and evaluating the impact of COVID-19 and post-COVID-19 response measures on construction projects in Iraq**

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**Abstract.** At the end of 2019, the whole world was exposed to a major health crisis, which the Coronavirus, which went out of the control of all countries, including Iraq, The negative impact of the coronavirus pandemic continues to this day on the construction industry sector in Iraq. This research aims to study and find the most common risk factors for the Coronavirus crisis and analyze them using the descriptive analysis method (HEAT MAP), in addition to identifying, analyzing and evaluating response procedures after Covid-19 by finding the relative importance index (RII). The factors of the Covid-19 crisis were extracted and the most common different response procedures were found from the archives of (24) completed construction projects in the projects of the University of Kufa, Karbala and Babylon. The current practice and the possibility of occurrence of risk factors, their severity and the possibility of their occurrence were diagnosed by conducting interviews accompanied by an open questionnaire with (15) Iraqi experts concerned with construction project management and then directing a detailed closed questionnaire to (140) others. All the results obtained were subjected to statistical tests to verify their validity, and the results showed the presence of (37) factors related to the Coronavirus, with the identification of their characteristics and the most affected project objectives, as well as the most affected contracting parties. When using the (HEAT MAP) method, it was found that the group of political risk factors is dominant and that the most harmful factors are the curfew and changes in the current government policies followed to combat the epidemic, curfew decisions and changes in the current government policies followed to combat the epidemic, political division, conflicting decisions, and the absence of plans and preparation for such crises. The delay in state funding for funded projects in the Middle Euphrates due to strict measures in the Middle Euphrates by the government that has existing projects was the most harmful. When applying (RII) to find the most important response measures, it was holding regular working sessions to discuss COVID-19 policies and response mechanisms, imposing a state of emergency due to the Corona virus as a force majeure, and finally cooperating with regulatory bodies to facilitate policy changes as well as enhancing scientific advice. Through this study, the project reached many conclusions and recommendations that would reduce or mitigate the impact of the Corona pandemic or any future events on the objectives of any construction project.

**Keywords.** Covid-19, Post Covid-19 Response, Construction project, Heat Map, Relative Important Index

## 1. Introduction

The concept of crisis refers to a situation or event that goes beyond the normal capacity of a system or organization to deal with it effectively, causing disruption and potentially severe consequences. Crises can be caused by a variety of factors, including but not limited to natural disasters, technological glitches, financial crises, political instability, or public health emergencies [1]. Crisis characteristics can include urgency, uncertainty, complexity, ambiguity, and significant risk. Crises often require immediate and coordinated action, as well as effective communication and decision-making under pressure. In addition, crises can have many dimensions and cascading effects, affecting different aspects of society and requiring systematic responses [2].

Most definitions of a crisis include four elements [3]: 1. A threat to the organization. 2. An element of surprise. 3. A short time to make a choice. 4. The inability to maintain the prior order. Construction company crises can occur regularly or at any time. Businesses must be prepared to deal with any crisis to implement an innovative crisis management plan. Because construction companies have such high investment costs, crises can have a substantial adverse influence on them. [4]. Due to the long-term nature of the projects, both are prevalent features of construction organizations. As a result, good management is required to prevent and resolve crises [5]. As a result, a crisis management procedure is necessary for construction projects to limit or eliminate the adverse effects of difficulties. The response to an emergency or disaster is frequently referred to as "crisis management." Crisis management aims to minimize or eliminate possible hazards, provide prompt and appropriate support to disaster victims, and achieve rapid and effective recovery [6].

When traditional management abilities are no longer sufficient, crisis management approaches, measures, and methods are applied. The goal is simple: lessen the crises' impact or avoid a possible crisis [7]. Depending on the type and extent of crisis, as well as the context and the actors involved, there are different approaches to crisis analysis and management. Some crisis management frameworks emphasize risk assessment, contingency planning, and rapid response, while others focus on crisis communication, stakeholder engagement, and disaster recovery [8]. The long-term. In addition, crisis management can include cooperation between various actors such as government agencies, companies, civil society organizations, and the media [9]. The CORONAVIRUS pandemic has led to significant social and economic disruption, including lockdowns, travel restrictions, and widespread business closures. The pandemic has also highlighted existing inequalities in society, as certain groups have been disproportionately affected by the virus and its impact [10]. According to a report by the International Monetary Fund [11], the global economy is expected to contract by 4.4% in 2020, a contraction that is considered significant despite high growth expectations before the pandemic. It also includes impacts on exports, imports, supply chains, investments, prices and currencies.

The crisis response also needs to include policies that address the risks posed by high levels of government debt in order to ensure that governments maintain their ability to support the recovery effectively [12]. Many construction companies have seen a significant drop in revenue due to disruptions or cancellations of projects that have caused cash flow problems [13]. This has delayed payments to suppliers and subcontractors, and has caused financial hardship for the industry. This research seeks to achieve several objectives, which are:

1. Identify the most important effects of the Covid-19 crisis on construction projects in Iraq.

2. Know the degree of probability and impact of each factor of the crisis and identify the most severe factors on projects by conducting a qualitative analysis using HEAT MAP technology.

3. Study, identify and analyze the most important factors of response to the post-Covid-19 by finding the importance of each response factor.

4. Provide an in-depth look at the risk factors of the crisis as a result of the Corona pandemic, in order to support decision-makers in the process of managing the crisis more efficiently.

As well as, This research answers the following questions:

1. To what extent is the Corona virus affecting construction projects in Iraq?, 2. What are the main groups most affected by the Corona virus?, 3. To what extent is there an impact of post-Covid 19 response factors on projects?.

## **2. Theoretical Study**

### **2.1 Covide-19 Impact**

Over time, the majority of industries and significant businesses encounter a variety of difficulties that result in significant losses on all fronts. both the public and private sectors, with a focus on big businesses [14]. The building sector has been significantly impacted by the CORONAVIRUS outbreak. Because it can generate jobs, the construction industry has a great deal of potential to boost the recovery, according to a research by the International Labor Organization (ILO) [15]. As a result, recovery measures can help the industry adapt toward sustainability and digitization. Based on various state and local responses, the pandemic's effects on stakeholders in the construction sector, such as owners, developers, contractors, subcontractors, and supply chain suppliers, were examined [16].

Due to travel constraints, the majority of investment activity was disrupted by the socioeconomic crisis, which had a substantial impact on the energy sector. In the upcoming years, uncertainty is predicted to arise due to energy project delays [17]. the municipal and state levels [16]. The spread of the (Coronavirus) epidemic in the world has led to increased attention to the importance of crisis management in all institutions, companies and government departments in general and in the construction sector in particular, which is the supporting pillar [18].

State economy regardless of the situation reached by institutions, companies and government departments, the proposed framework helps to define a set of steps necessary to address the crisis, which is represented first in mitigating the severity of the crisis and limiting it in an appropriate manner that facilitates access. The process of adjusting and taking the lessons learned to confront other crises and considering them as a reference that contributes to solving many problems that occur urgently or suddenly in the future [19]. In light of these challenges, the construction industries in Iraq need a set of policies and programs that contribute to mitigating the effects of the pandemic and stimulating economic recovery. Among these policies: providing adequate financing to companies and contractors to cover operating and production costs; Postponing the payment of taxes, fees and debts to the sector; Facilitating the movement of materials, equipment and labor within construction areas; supporting the use of technology and innovation to improve the quality and efficiency of projects; Encouraging cooperation and partnership between the public and private sectors to implement priority projects with a positive impact on development [20, 21].

### **2.2 Post-Covid-19 Response**

Policymakers are in the process of formulating reaction plans to deal with the COVID-19 pandemic's effects. To mitigate the effects of COVID-19, policymakers in Australia [22] and Sri Lanka [23] have created a variety of significant reaction plans. Diverse reaction tactics can guarantee the upkeep of enhanced and standard operating procedures, as well as effective supplier partnerships, at the organizational and operational levels. Additionally, Reference [24] offered several advice and guidelines for response tactics, including forming committees with the necessary training to assess the COVID-19 epidemic and make recommendations and guidelines, as well as utilizing government initiatives designed specifically for this purpose. The research conducted by reference [25] included publications about response plans put forth for building projects that will take place after the epidemic.

Ten response strategies—including portfolio diversification, alternative contracting approaches, a diverse circular economy, remote project work, integrated design management using Building Information Modeling (BIM), executive skill development and employee training, reversible building design, automation, 3D printing, and lean construction—can be employed by construction contractors to build resilience to the COVID-19 pandemic. According to reference [26], stakeholders need to be made aware that the COVID-19 is a result of a force majeure situation because it presents a significant risk to the building sector. According to the study in Reference [27], in order to mitigate the effects of the pandemic, construction initiatives need information and financial support. Additionally, some earlier research has developed response plans to mitigate the pandemic's effects. According to reference [28], utilizing contemporary technologies, putting up signs to redefine site safety, offering disinfectants and washing stations on building sites, and guaranteeing a safe distance between workers can all increase worker productivity and safety.

### **3. Scientific Research Method**

The research procedures consist of the following:

1. Conducting an open questionnaire with stakeholders to collect the most influential factors on construction projects as a result of the Corona virus crisis, in addition to collecting data on post-Covid-19 response procedures.
2. Conducting a closed questionnaire to obtain detailed information on the most common Covid-19 crisis factors in Iraqi construction projects and procedures as well as a closed questionnaire for response procedures.
3. Classifying the Corona crisis factors and response procedures into specific groups based on their sources.
4. Studying the impact of each factor on the project's ultimate goals (Time, Cost, and Quality) and finding the party most responsible for addressing the impact.
5. Conducting qualitative factor analyses using heat map techniques to find the severity of crisis factors.
6. Sorting the risks resulting from the Corona virus crisis according to priorities based on the results of the heat map and analysis of the impact of the failure mode (HEAT MAP).
7. Conducting an analysis of post-Covid-19 response factors to find the relative importance using (Likert) technique.

#### **3.1 Gather Information**

In order to obtain sufficient information about the effects of Coronavirus prevailing in construction projects, the documents of completed construction projects were carefully studied, and personal interviews were conducted with senior engineers at the University of Kufa, Karbala, Babel, and Diwaniyah, accompanied by open questionnaires and followed by well-structured closed questionnaires.

### 3.1.1 Identifying the Factors of the Corona-19 Crisis and Post-Covid-19

#### Response Measures

The archived documents of (24) completed construction projects in (6 projects for each of the University of Kufa, Karbala and Babylon) were carefully studied, and as a result, (19) of the most common factors of the Corona-19 pandemic crisis were extracted, in addition to identifying 9 of the main response measures through direct interviews and brainstorming.

### 3.1.2 Various References, Personal Interviews, and Brainstorming

Direct interviews were conducted first with (15) experts in construction projects: project managers, consultants, and contractors working at the University of Kufa, in addition to experts in in the Department of Construction and Projects in Najaf. Note: The experts are senior engineers with no less than (20) years of experience in contracting companies and consulting centers. 15 forms were submitted directly and discussed face to face. Table (1): shows the results of all information related to crisis factors from the theoretical study, direct interviews and brainstorming, and then they were classified according to their sources. These groups are administrative and organizational, economic and financial, social and cultural, health and environmental factors, and finally political factors. Table (2) shows the main response procedures followed after Covid-19 in Iraq and other countries.

**Table 1.** Factors of the Corona-19 Crisis, its References and Classifications

Code	Influence factors (Sub-Factor)	References	Main Group
RC1	Commitment to health protection strategies such non-convergence, mask use, refraining from touching, protecting work, and on-site worker infection prevention training.	(Tayeh et al, 2018 a) [29]	Administrative and organizational
RC2	Presentation of the table with the important path events that the epidemic has an impact.	(El-Hallaq et al, 2016) [30]	
RC3	Periodically and continually examining the organization's or company's financial situation and budget in general, and the project in question in particular.	Brainstorming	
RC4	Everyone's knowledge and experience, as well as the advantages of expertise, can reduce risks. participation of all stakeholders in the company in the acquisition and facilitation of decision-making	(Tayeh et al, 2018 a) [29]	
RC5	company entrepreneurs who gave up their skills and knowledge during the pandemic.	(Coombs et al, 2013) [31]	
RC6	Prioritizing the execution of projects based on their significance, scale, and execution necessity.	Brainstorming	
RC7	Reliance on communication processes and meetings between the concerned authorities or video Zoom using remote communication technologies	(Coombs et al, 2013) [31]	
RC8	dividing up the labor throughout project implementation to prevent mixing, and authorizing the method of submitting reports to the higher authorities.	Direct interviews	
RC9	Set up a permanent, ongoing Crisis Management Department within the organization or institution to create quick fixes for emergency crisis management and refer.	(Tayeh et al, 2020 c) [32]	
RC10	Selecting technical and administrative staff from the same area will discourage migration, encourage them to carry out the building, and highlight how important it.	(Tayeh et al, 2018 a) [29]	

<b>RC11</b>	Change the cost and risk management process and implementation for daily management at the project level, and create an emergency team to mitigate hazards.	(Albhaisi et al, 2020) [33]	<b>Economic and financial</b>
<b>RC12</b>	utilizing a centralized input system for all personnel inside the business or organization and a web server to collect information in order to minimize mixing.	(Enshassi et al, 2019) [34]	
<b>RC13</b>	examining potential solutions for adoption in communities, organizations, and businesses to minimize damage, such as lowering material imports and relying more on locally accessible materials.	(Albhaisi et al, 2020) [33]	
<b>RC14</b>	To lessen the workload on the general manager of the organization or corporation, form teams and small groups for project management.	(El-Hallaq et al, 2016) [30]	
<b>RC15</b>	Create strategies to mimic the outcomes of project implementation in light of the epidemic's spread using risk simulation software, and assess the associated risks.	(Tayeh et al, 2020 c) [32]	
<b>RC16</b>	Instability of foreign exchange rates, especially in projects funded by donor countries and projects that depend on foreign currencies during the pandemic.	<b>Brainstorming</b>	
<b>RC17</b>	Costs of additional measures and preventive methods conditional on the implementation of the project	<b>Direct interviews</b>	
<b>RC18</b>	increased unemployment and wage exploitation by some business owners in the construction industry during the outbreak	(Tayeh et al, 2019 c) [32]	
<b>RC19</b>	Because to the partial and complete closure of designated regions, the sector's economy is stagnating, resulting in low purchasing power.	<b>Direct interviews</b>	
<b>RC20</b>	Reducing project hours while the pandemic is ongoing	<b>Direct interviews</b>	
<b>RC21</b>	Low pay for engineers, employees, technicians, and project managers in the construction industry as a result of the lack of projects completed during the epidemic.	(Tayeh et al, 2019 d) [35]	
<b>RC22</b>	Fluctuation in the price of raw materials during the epidemic.	<b>Direct interview</b>	
<b>RC23</b>	Interrupting land and sea transportation networks as well as production processes in nations where building materials are imported.	(Shen et al., 2007) [36]	
<b>RC24</b>	The project's process will determine how much the preventative measures and equipment will cost.	(Tayeh et al, 2018 a) [29]	
<b>RC25</b>	Activating the bid pricing item's setting to increase the risk ratio	<b>Direct interviews</b>	
<b>RC26</b>	Overcrowding at the site of project implementation where people are moving around and doing business	(Harold, 2009) [30] [37]	
<b>RC27</b>	Education level, adherence to preventative strategies, household income, and general wellbeing in the areas where the programs are being carried out.	(Tayeh et al, 2018 b) [38]	
<b>RC28</b>	Due to the manager's social and cultural connections, initiatives were able to continue moving forward despite the crisis, and the project implementation team was encouraged and supported.	<b>Direct interviews</b>	
<b>RC29</b>	Social relationships, customs, and traditions in the regions where the programs	<b>Direct interviews</b>	
<b>RC30</b>	citizen and employee adherence to environmental laws to reduce injury	<b>Direct interviews</b>	
<b>RC31</b>	Knowledge and expertise of the team's leader and members regarding environmental and health measures that reduce the anticipated dangers from the Coronavirus pandemic	<b>Direct interviews</b>	<b>Health and environmental</b>
<b>RC32</b>	The company's tolerance for potential pandemic risks	<b>Direct interviews</b>	

<b>RC33</b>	Within the organization or institution, environmental databases are available to support the project implementation process and the preventive measures.	<b>(Tayeh et al, 2020 e) [32]</b>	<b>Political</b>
<b>RC34</b>	Due to stringent regulations in the Middle Euphrates, the donor state's funding of financed projects there was delayed.	<b>Direct interviews</b>	
<b>RC35</b>	Political discord, opposing judgments, a lack of crisis planning and preparation	<b>Brainstorming</b>	
<b>RC36</b>	During the epidemic period, opening borders and starting import and export movement.	<b>Direct interviews</b>	
<b>RC37</b>	To counteract the pandemic, new government regulations and curfews have been implemented.	<b>Brainstorming</b>	

**Table 2. Post-COVID-19 Response Strategies and Approaches**

<b>Code</b>	<b>Recovery Response Post-COVID-19 Strategies</b>	<b>References</b>	<b>Direct Interview</b>	<b>Brainstorming</b>	<b>Main Group</b>
<b>Re1</b>	Stakeholders should get closer to customers and clients.	[39]	√		<b>Implement health and safety measures</b>
<b>Re2</b>	The creation of a special task team to offer assistance in addressing the COVID-19 pandemic.	[40], [41], [42]			
<b>Re3</b>	Make a webpage with the policies and procedures for COVID-19 response.	[40], [43], [44]		√	
<b>Re4</b>	Organize frequent meetings at work to talk about COVID-19 response protocols and policies.		√		
<b>Re5</b>	Imposing a state of emergency due to the Corona virus as a force majeure	[45]			
<b>Re6</b>	Providing additional financial assistance (e.g., funding, grants, tax relief).	[46], [43], [47], [48]	√		<b>Government restrictions and instructions</b>
<b>Re7</b>	Obligating donors to provide assistance for construction loans (e.g. deferring loan repayments, reducing interest rates, maintaining access to liquidity/credit provisions)	[46], [43], [49]		√	
<b>Re8</b>	Comparing COVID-19 measures and procedures in other countries	[43], [41], [48], [49]			
<b>Re9</b>	Speeding up approval procedures for resuming construction work	[43]	√	√	
<b>Re10</b>	The government should support the most affected sectors such as the construction industry.		√		
<b>Re11</b>	The government must make mitigation a priority (delay is costly).		√	√	
<b>Re12</b>	The government should increase the budget allocated to basic facilities.		√		
<b>Re13</b>	Create employee support initiatives that are appropriate for various kinds of work teams.	[46]		√	
<b>Re14</b>	Providing practical assistance in implementing policies and standard operating procedures at project sites.	[48]			
<b>Re15</b>	Building skills and developing good competencies	[39]			

<b>Re16</b>	Collaborate with regulators to facilitate policy changes as well as enhance scientific advice.		√
<b>Re17</b>	Study of operating models for labor and its redistribution		√
<b>Re18</b>	Rebuilding supply chains towards flexibility with re-diversification of supply chains	[39]	√
<b>Re19</b>	Providing financial and moral incentives to motivate individuals working on construction sites	[50], [41]	√
<b>Re20</b>	Accelerate the introduction and adoption of digital technologies such as BIM programs.		√
<b>Re21</b>	Improving policies that will encourage industrial revolution technology.		√
<b>Re22</b>	Adapting project schedules, contracts and agreements		√
<b>Re23</b>	Modifying financing mechanisms and redeploying capital and resources		√

### 3.2 Closed Questionnaire

The primary goal of the closed questionnaire is gathering data regarding the Corona epidemic and how it has affected ongoing building projects in Iraq. It also aims to gather data regarding the response protocols that were implemented. The well-structured closed questionnaire form that may be seen in Appendices **A1**, **A2** was created. The public and private sectors involved in Najaf construction projects, representing various engineering specialties, comprise the study sample.

### 3.3 Sample Size

The engineers who operate as executive managers (contractor), residents, supervising engineers, executive engineers, etc. constitute the research's target group. to get a homogeneous, statistically sound sample. Engineering experts and specialists who develop and supervise building projects in Iraq were given (140) questionnaires to complete. Given that some of the received forms had erroneous and incomplete answers, (130) questionnaires were the results that were used in the analysis and evaluation. Four phases of distribution models are shown in Table 3. starting with the Ministry of Housing, Construction, and Municipalities. The Ministry of Scientific Research and Higher Education is the second. The Najaf reconstruction department comes in third, followed by a few private businesses. The overall percentage of outcomes is 93%.

**Table 3.** Distribution of questionnaire

Distribution places	Distribution	Received	Response rate %
<b>University of Kufa</b>	65	60	92%
<b>Municipality of Najaf</b>	45	42	93%
<b>Private sector</b>	30	28	93%
<b>The total</b>	<b>140</b>	<b>130</b>	<b>93%</b>

#### 4. Result of the Statistical Analysis

The questionnaire was divided into three sections. As described below, this stage aims to streamline and simplify the results of the survey:

##### 4.1 Part One (General Information)

The first part of the main question in the sample questionnaire is about the committees that determine the study sample.

1. Academic certificate and engineering majors.

Table (4) shows the matrix of numbers from the results, which were divided into two dimensions: engineering majors and academic degrees of the respondent, as well as percentages for each category.

**Table 4.** Work field and Academic, certificates matrix

		Engineering disciplines.				Total	Percentage
		Civil	Archie	Mechanic	Electric		
Academic Certificate	B. Sc.	62	10	5	8	85	65.38%
	Hi. Diplo.	9	1	0	0	10	7.69%
	M. Sc.	9	4	0	0	13	10.0%
	Ph. D.	14	8	0	0	22	16.92%
	<b>Total</b>	<b>94</b>	<b>23</b>	<b>5</b>	<b>8</b>	<b>130</b>	<b>100%</b>
	<b>Percentage</b>	<b>72.31%</b>	<b>18%</b>	<b>3.85%</b>	<b>6.15%</b>	<b>100%</b>	

2. Work sector and field of work

The percentage chosen for the public sector is at 100% only because the current field of study is devoted to government projects only, that is, the public sector as well, due to the existence of a problem with the Crisis Management Committee in some of them. Government ministries. Furthermore, it shows the occupational field of the engineers who filled out the questionnaire, stating that department heads (20%), project managers (30%), resident engineers (25%), and implementation engineers (25%) are the most prevalent.

##### 4.2 Part Two (Analysis and Assessment of the Factors of the Corona Pandemic)

This part includes evaluating and classifying the factors of the Corona crisis that negatively affect construction projects in Iraq by finding the likelihood and impact of each of the crisis factors on the project's objectives through statistical analysis. Where heat map techniques were used to analyze and identify the factors of the Corona crisis in the objectives of the project, where the crisis factors obtained were subjected to qualitative analysis using an appropriately designed heat map as shown in Figure (3). It is a grid heat map (5 by 5) in four colors. They include green (low risk, L), yellow (medium risk, M), orange (high risk, V), and red (very high risk, VH). Table (4) represents crisis severity measures. In addition to identifying the party most affected by the contract (contractor or owner or both). Also, identifying the final objective of the project most affected (time, cost and quality).

Table (4) shows the allocation of crisis factors in the heat map according to their likelihood and impact on the final project time. They are also listed numerically in Table (4). This part includes the assessment and classification of the factors of the Coronavirus crisis on the objectives of construction projects in terms of time, cost and quality in Iraq, specifically in the Middle Euphrates region, through statistical analysis and will be presented as follows:

**Figure 1.** A 5\*5 matrix representing the Likelihood and effect Heat map [51]

Likelihood	Very High, 5	5 Low	10 Medium	15 High	20 Extreme	25 Extreme
	High, 4	4 Low	8 Medium	12 High	16 High	20 Extreme
	Moderate, 3	3 Low	6 Medium	9 Medium	12 High	15 High
	Low, 2	2 Low	4 Low	6 Medium	8 Medium	10 Medium
	Very Low, 1	1 Low	2 Low	3 Low	4 Low	5 Low
		Very Low, 1	Low, 2	Moderate, 3	High, 4	Very High, 5
		Impact → (Impact of Crisis Factor on Project Tim)				

**Table 5.** Measures of the severity of the Corona pandemic crisis [51]

Find: Index of Severity = (Probability) X (Impact)		
Value	Degree of severity	Zone (Importance)
20-----25	Extreme	
12-----16	High	
5-----10	Medium	

A measure of stability, the Cronbach's alpha scale, is used to assess the questionnaire's consistency and reliability. When the scale is applied to the same sample again over a specific length of time, the results stay the same, which is known as the absence of contradiction in the scale. According to reference [51], the stability value on the questionnaire must be between zero and one. The validity and stability of each group in the questionnaire are ensured by the high (excellent) Cronbach's alpha value of 0.86. Table (6) shows the validity and stability of each factor.

**Table 6.** Factor validity and reliability have an impact on groups.

Factors Affect Group	No. of Factors	Reliability*
Administrative and organizational	15	88%
Economic and financial	10	80%
Social and cultural	4	89%
Health and environmental	4	91%
Political	4	82%
<b>Total Factors Affect Group</b>	<b>37</b>	<b>86%</b>

\*. (Cronbachs Alpha)

#### 4.2.1 A group of Administrative and Organizational Factors

The data analysis indicates that the lack of "activating the crisis management department permanently and continuously within the institution or company to develop immediate solutions for emergency crisis management and reference" (12.91) is the most significant factor in the workforce group Table (6). But "Everyone's knowledge and experience, as well as the advantages of expertise, can reduce risks." (6.5) is one of the factors that has the least negative effects on labor productivity in this group.

**Table 6.** A group of administrative and organizational factors

Code	Likelihood and Effect	Likelihood and Effect					No of Res...	Mean	Severity on Time	Severity on Cost	Severity on Productivity	Overall severity	Rank	Most influential	Most influential
		Very Low	Low	Moderate	High	Very High									
		1	2	3	4	5									
RC1	Likelihood	0	11	39	35	45	130	3.63	11.36	11.57	13.36	12.10	2	Quality	Owner
	Effect on : Time	13	30	40	47	0	130	2.93							
	Cost	4	32	60	30	4	130	2.98							
	Quality	0	15	61	35	19	130	3.45							
RC2	Likelihood	5	24	55	29	17	130	3.22	11.21	9.89	7.02	9.37	9	Time	Owner
	Effect on : Time	0	12	62	38	18	130	3.48							
	Cost	7	32	49	29	13	130	3.07							
	Quality	39	29	62	0	0	130	2.18							
RC3	Likelihood	11	28	56	30	5	130	2.92	10.03	6.77	6.77	7.85	12	Time	Owner
	Effect on : Time	0	7	72	39	12	130	3.43							
	Cost	26	37	67	0	0	130	2.32							
	Quality	25	39	66	0	0	130	2.32							
RC4	Likelihood	18	32	71	9	0	130	2.55	6.33	6.05	7.13	6.50	15	Quality	Owner
	Effect on : Time	21	29	76	4	0	130	2.48							
	Cost	26	37	59	8	0	130	2.38							
	Quality	6	33	72	19	0	130	2.80							
RC5	Likelihood	17	26	65	12	10	130	2.78	6.64	6.04	9.32	7.33	14	Quality	both of them
	Effect on : Time	28	33	60	9	0	130	2.38							
	Cost	34	40	56	0	0	130	2.17							
	Quality	6	12	61	33	18	130	3.35							
RC6	Likelihood	5	13	77	35	0	130	3.09	9.80	8.68	9.02	9.17	10	Time	Owner
	Effect on : Time	5	9	75	41	0	130	3.17							
	Cost	4	39	65	22	0	130	2.81							
	Quality	5	29	73	18	5	130	2.92							
RC7	Likelihood	0	13	75	30	12	130	3.32	10.30	7.50	8.65	8.82	11	Time	Owner
	Effect on : Time	4	17	80	19	10	130	3.11							
	Cost	29	38	63	0	0	130	2.26							
	Quality	24	24	61	21	0	130	2.61							
RC8	Likelihood	7	15	36	47	25	130	3.52	12.25	10.14	10.19	10.86	3	Time	Owner
	Effect on : Time	0	8	73	28	21	130	3.48							
	Cost	19	30	42	26	13	130	2.88							
	Quality	0	17	110	3	0	130	2.89							
RC9	Likelihood	0	0	68	36	26	130	3.68	14.44	12.03	12.25	12.91	1	Time	Owner
	Time	0	5	59	39	27	130	3.68							

RC10	Effect on:	Effect	Cost	0	17	79	34	0	130	3.13	10.20	11.39	10.51	10.70	4	Cost	both of them
		Quality	0	7	100	23	0	130	3.12								
		Likelihood	10	21	59	28	12	130	3.08								
RC11	Effect on:	Time	11	11	58	27	23	130	3.31	10.69	10.35	9.44	10.16	6	Time	Owner	
		Cost	0	0	67	36	27	130	3.69								
		Quality	0	23	53	32	22	130	3.41								
RC12	Effect on:	Likelihood	9	27	52	25	17	130	3.11	8.43	7.38	7.64	7.82	13	Time	Owner	
		Time	4	9	104	11	2	130	2.98								
		Cost	14	31	76	9	0	130	2.62								
RC13	Effect on:	Quality	14	24	78	14	0	130	2.71	9.95	9.12	8.81	9.29	8	Time	Owner	
		Likelihood	7	22	70	22	9	130	3.03								
		Time	0	11	81	28	10	130	3.28								
RC14	Effect on:	Cost	7	23	69	24	7	130	3.01	10.91	11.33	9.82	10.69	5	Cost	Owner	
		Quality	5	33	64	25	3	130	2.91								
		Likelihood	9	19	57	24	21	130	3.22								
RC15	Effect on:	Time	0	10	79	22	19	130	3.38	11.29	9.71	8.00	9.67	7	Time	both of them	
		Cost	0	16	55	35	24	130	3.52								
		Quality	6	17	80	19	8	130	3.05								
Mean Group										Medium		Rank					
9.50												3					

#### 4.2.2 A group of economic and financial factors

As Table (7) demonstrates, two significant factors that affect the goals of building projects are the government's "instability of foreign exchange rates, especially in projects funded by donor countries and projects that depend on foreign currencies during the pandemic." (12.05) and "Interrupting land and sea transportation networks as well as production processes in nations where building materials are imported." (11.89). On the other hand, the analysis of the data showed that the objectives of construction schemes are less affected by "Because to the partial and complete closure of designated regions, the sector's economy is stagnating, resulting in low purchasing power. (7.82)," to investigate the problems at hand.

**Table 7.** Ranking of economic and financial factors

Code	Likelihood and effect	Likelihood and effect					No of Res...	Mean	Severity on Time	Severity on Cost	Severity on Quality	Overall severity	Rank	Most influential	Most influential	
		V.L	L	M	H	V.H										
		1	2	3	4	5										
RC16	Likelihood	0	10	76	25	19	130	3.41	12.22	12.11	11.82	12.05	1	Time	Owner	
	Effect on:	Time	0	0	75	34	21	130								3.58
	Cost	0	5	71	31	23	130	3.55								
	Quality	0	9	69	34	18	130	3.47								
RC17	Likelihood	0	9	68	43	10	130	3.42	9.43	8.99	8.38	8.93	7	Time	Owner	
	Effect on:	Time	17	22	66	25	0	130								2.76
	Cost	14	30	76	10	0	130	2.63								

RC18	Effect on :	Quality	23	31	70	6	0	130	2.45	8.24	8.54	8.70	8.49	8	Quality	Both them
		Likelihood	10	21	65	29	5	130	2.98							
		Time	16	29	55	30	0	130	2.76							
		Cost	0	28	92	10	0	130	2.86							
		Quality	0	33	75	22	0	130	2.92							
RC19	Effect on :	Likelihood	12	36	56	26	0	130	2.74	8.55	7.46	7.46	7.82	10	Time	Both them
		Time	13	12	60	36	9	130	3.12							
		Cost	19	19	71	21	0	130	2.72							
		Quality	18	18	76	18	0	130	2.72							
		Likelihood	12	22	62	22	12	130	3.00							
RC20	Effect on :	Time	0	11	82	27	10	130	3.28	9.83	9.02	8.70	9.18	6	Cost	Owner
		Cost	7	23	69	24	7	130	3.01							
		Quality	5	34	63	25	3	130	2.90							
		Likelihood	14	22	61	29	4	130	2.90							
		Time	17	29	57	27	0	130	2.72							
RC21	Effect on :	Cost	0	30	94	6	0	130	2.82	7.90	8.16	8.45	8.17	9	Time	Contractor
		Quality	0	33	75	22	0	130	2.92							
		Likelihood	0	14	65	33	18	130	3.42							
		Time	0	18	62	32	18	130	3.38							
		Cost	0	15	60	35	20	130	3.46							
RC22	Effect on :	Quality	18	22	90	0	0	130	2.55	11.59	11.85	8.74	10.73	3	Time	Contractor
		Likelihood	0	0	67	39	24	130	3.67							
		Time	0	4	71	40	13	128	3.43							
		Cost	0	5	77	29	19	130	3.48							
		Quality	10	23	78	19	0	130	2.82							
RC23	Effect on :	Likelihood	0	18	97	15	0	130	2.98	12.59	12.76	10.33	11.89	2	Time	Contractor
		Time	0	23	77	30	0	130	3.05							
		Cost	0	18	81	31	0	130	3.10							
		Quality	0	21	66	30	13	130	3.27							
		Likelihood	0	14	106	10	0	130	2.97							
RC24	Effect on :	Time	0	23	77	30	0	130	3.05	9.09	9.23	9.73	9.35	5	Time	Owner
		Cost	0	18	81	31	0	130	3.10							
		Quality	0	21	66	30	13	130	3.27							
		Likelihood	0	14	106	10	0	130	2.97							
		Time	0	23	77	30	0	130	3.05							
RC25	Effect on :	Cost	0	18	80	32	0	130	3.11	9.07	9.23	10.14	9.48	4	Time	Contractor
		Quality	0	15	64	33	18	130	3.42							

#### 4.2.3 A group of Social and Cultural Factors

Table (8) indicates that the factor most influencing construction projects in this category is "Social relationships, customs, and traditions in the regions where the programs are executed," with an influence rate of (10.23). On the other hand, the least important component, which accounts for (7.28) and ranks this group fourth, is "Due to the manager's social and cultural connections, initiatives were able to continue moving forward despite the crisis, and the project implementation team was encouraged and supported."

**Table 8.** Ranking of social and cultural factors

Code	Likelihood and effect	Likelihood and effect					No of Res...	Mean	Severity on	Severity on	Severity on	Overall	Rank	Most	Most	
		V.L	L	M	H	V.H										
		1	2	3	4	5										
RC26	Likelihood	0	28	78	24	0	130	2.97	9.18	9.59	8.72	9.17	2	Time	Contr	
	Effect on	Time	0	16	86	28	0	130								3.09
	Cost	0	0	100	30	0	130	3.23								

RC27	Effect on :	Likelihood	8	18	78	26	0	130	2.94	8.68	8.85	6.77	8.10	3	Quality	Owner
		Time	10	28	59	33	0	130	2.88							
		Cost	7	17	74	32	0	130	3.01							
		Quality	9	18	68	25	10	130	3.07							
RC28	Effect on :	Likelihood	25	35	70	0	0	130	2.35	7.25	7.04	7.56	7.28	4	Time	Owner
		Time	16	28	67	19	0	130	2.68							
		Cost	18	20	75	17	0	130	2.70							
		Quality	20	20	79	11	0	130	2.62							
RC29	Effect on:	Likelihood	10	23	78	19	0	130	2.82	10.70	10.14	9.85	10.23	1	Time	Owner
		Time	0	5	77	30	18	130	3.47							
		Cost	0	18	83	29	0	130	3.08							
		Quality	0	24	92	14	0	130	2.92							
Mean Group									8.7		Medium		Rank		4	

#### 4.2.4 A group of Health and Environmental Factors

With an impact rate of 10.41, Table 9 demonstrates that the most significant element is "Within the organization or institution, environmental databases are available to support the project implementation process and the preventive measures." The company's tolerance for potential pandemic risks is "the degree to which the organization or company bears the risk of the epidemic," with a (7.19) coefficient. This team came in fourth place.

**Table 9.** Ranking of health and environmental factors

Code	Likelihood and effect	Likelihood and effect					No of Res...	Mean	Severity on Time	Severity on Cost	Severity on Quality	Overall severity	Rank	Most influential factor	Most influential partner
		V. L	L	M	H	V. H									
		1	2	3	4	5									
RC30	Likelihood	0	28	78	24	0	130	2.97	9.27	9.59	8.61	9.16	2	Time	Owner
	Time	0	20	74	36	0	130	3.12							
	Cost	0	0	100	30	0	130	3.23							
	Quality	8	17	85	20	0	130	2.90							
RC31	Likelihood	12	27	67	24	0	130	2.79	8.14	8.38	7.35	7.95	3	Cost	Both of them
	Time	8	19	79	24	0	130	2.92							
	Cost	7	22	70	26	5	130	3.00							
	Quality	12	31	80	7	0	130	2.63							
RC32	Likelihood	17	27	67	19	0	130	2.68	7.12	7.02	7.43	7.19	4	Time	Contractor
	Time	19	21	75	15	0	130	2.66							
	Cost	20	20	79	11	0	130	2.62							
	Quality	12	23	77	18	0	130	2.78							

<b>RC33</b>	Likelihood	0	5	77	30	18	<b>130</b>	3.47	10.70	10.14	10.38	10.41	<b>1</b>	<b>Quality</b>	<b>Contractor</b>
	Time	0	18	83	29	0	<b>130</b>	3.08							
	Effect on : Cost	0	24	92	14	0	<b>130</b>	2.92							
	Quality	0	23	85	22	0	<b>130</b>	2.99							
							Mean Group		<b>Medium</b>		Rank				
							8.67				5				

#### 4.2.5 A group of Political Factors

As shown in Table (10), "To counteract the pandemic, new government regulations and curfews have been implemented." significantly impact construction projects. While "opening border crossings and activating import and export movement during the pandemic period" has a weak impact on construction projects. In fact, "Due to stringent regulations in the Middle Euphrates, the donor state's funding of financed projects there was delayed." have a medium impact on projects.

**Table 10.** Ranking of Political factors

Code	Likelihood and effect	Likelihood and effect					No of Res...	Mean	Severity on	Severity on Cost	Severity on	Overall severity	Rank	Most influential factor	Most influential party
		V. L	L	M	H	V. H									
		1	2	3	4	5									
<b>RC34</b>	Likelihood	0	0	5	4	29	<b>130</b>	3.80	15.05	14.82	12.74	14.21	<b>4</b>	<b>Time</b>	<b>Owner</b>
	Effect on: Time	0	0	4	5	35	<b>130</b>	3.96							
	Cost	0	0	5	3	39	<b>130</b>	3.90							
	Quality	0	1	6	2	20	<b>130</b>	3.35							
<b>RC35</b>	Likelihood	0	0	1	3	82	<b>130</b>	4.55	19.34	19.65	18.81	19.27	<b>2</b>	<b>Cost</b>	<b>Owner</b>
	Effect on: Time	0	0	1	7	45	<b>130</b>	4.25							
	Cost	0	0	3	2	74	<b>130</b>	4.32							
	Quality	0	0	2	7	38	<b>130</b>	4.13							
<b>RC36</b>	Likelihood	8	2	7	2	0	<b>130</b>	2.90	9.73	8.45	8.48	8.89	<b>3</b>	<b>Time</b>	<b>Owner</b>
	Effect on: Time	5	8	7	2	18	<b>130</b>	3.35							
	Cost	8	2	6	3	0	<b>130</b>	2.92							
	Quality	7	2	6	2	0	<b>130</b>	2.92							
<b>RC37</b>	Likelihood	0	0	1	3	72	<b>130</b>	4.41	19.80	19.94	18.27	19.34	<b>1</b>	<b>Cost</b>	<b>Owner</b>
	Effect on: Time	0	0	6	5	70	<b>130</b>	4.49							

Cost	0	0	7	4	75	<b>13</b>	4.5
				8		<b>0</b>	2
Quality	0	0	1	7	37	<b>13</b>	4.1
			8	5		<b>0</b>	5
Mean Group						<b>High</b>	Rank
15.424							1

#### 4.2.6 Factors most Affecting the Objectives of Construction Projects

Table (11) below lists the factors that the study determined had the most effects on project. With an overall Severity Index value of 19.34, "Curfews and changes in current government policies being adopted in order to combat the pandemic. The "The project's process will determine how much the preventative measures and equipment will cost." ranks tenth with a relative significant index value of 12. Where was the political group the most influence on projects objectives.

**Table 11.** The seven factors most affecting the objectives of construction projects

Rank	Influencing factors	D.E	Severity Index	Effect group
1	Curfews and changes in current government policies being adopted in order to combat the pandemic	HE	19.34	Political
2	Political division, conflicting decisions, absence of plans and preparation for such crises	HE	19.27	Political
3	State funding for funded projects in the Middle Euphrates was delayed due to strict measures in the Middle Euphrates	HE	14.21	Political
4	Set up a permanent, ongoing Crisis Management Department within the organization or institution to create quick fixes for emergency crisis management and refer.	HE	12.17	Administrative and organizational
5	Commitment to health protection strategies such non-convergence, mask use, refraining from touching, protecting work, and on-site worker infection prevention.	HE	12.10	Administrative and organizational
6	Instability of foreign exchange rates, especially in projects funded by donor countries and projects that depend on foreign currencies during the pandemic period	HE	12.05	Economic and financial
7	The project's process will determine how much the preventative measures and equipment will cost.	HE	12	Economic & finance.

#### 4.2 Part Three (Analysis and Assessment of Post-Covid-19 Response Measures)

This section includes the analysis and evaluation of the response strategies that were collected and classified through various sources, direct interviews and brainstorming techniques. The analysis is done through statistical analysis to find the relative importance index by applying the five-point Likert law. To analyze the data, the relative importance index was

used according to the following equation (1), [52,53]:

$$RII \% = \frac{5 * (n5) + 4 * (n4) + 3 * (n3) + 2 * (n2) + 1 * (n1)}{5 * (n1 + n2 + n3 + n4 + n5)} \dots\dots\dots(1)$$

Where: n1 = modest impact, n2 = some impact, n3 = medium impact, n4 = strong impact, and n5 = extremely high impact are the number of respondents that selected each option. When using the five-dimensional Likert scale [53], Table (12) illustrates the significance of the steps used to obtain the response using the scale displayed in Table (12). The examination of the relative relevance index for post-COVID-19 response options is shown in Table (13).

**Table 12.** Evaluation scale for affecting factors

$\leq 20$ SE < 40	$40 \leq$ AE < 60	$60 \leq$ HE < 80	$80 \leq$ VHE $\leq 100$
Some Effect.. (SE)	Average Effect.. (AE)	High Effect.. (HE)	Very High Effect. (VHE)

**Table 13.** Evaluation of Main and Sub Response Strategies for Construction Projects.

Key response strategies	Sub-response Strategies Arrangement						Ranking of Main response strategies			
	Cod e	RII %	Degree of Effect	S.D *	Ranking	Overall Ranking	RII%	Degree of Effect	Rankin g	C.A **
<b>Implement health and safety measures</b>	Re1	75.60	HE	0.78	5	9	<b>83.12</b>	<b>VHE</b>	<b>1</b>	<b>0.88</b>
	Re2	85.90	VHE	0.77	3	7				
	Re3	78.90	HE	0.82	4	8				
	Re4	86.78	VHE	0.75	2	2				
	Re5	88.50	VHE	0.71	1	1				
<b>Government restrictions and instructions</b>	Re6	79.40	HE	0.7	4	14	<b>75.73</b>	<b>HE</b>	<b>3</b>	<b>0.91</b>
	Re7	80.50	VHE	0.79	3	11				
	Re8	83.50	VHE	0.8	1	4				
	Re9	64.70	HE	0.72	9	29				
	Re10	82.90	VHE	0.72	2	10				
	Re11	66.50	HE	0.85	8	22				
	Re12	78.00	HE	0.9	5	15				
	Re13	69.00	HE	0.77	6	18				
	Re14	77.10	HE	0.85	7	19				
<b>Improving management skills and using digital technology</b>	Re15	82.90	VHE	0.89	2	5	<b>80.59</b>	<b>VHE</b>	<b>2</b>	<b>0.89</b>
	Re16	83.50	VHE	0.69	1	3				
	Re17	78.00	HE	0.7	9	21				
	Re18	78.90	HE	0.78	8	20				
	Re19	80.00	VHE	0.77	6	16				
	Re20	79.32	HE	0.72	7	17				
	Re21	80.94	VHE	0.79	4	12				
	Re22	80.55	VHE	0.69	5	13				

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Re2	81.24	VHE	0.7	3	6
3			7		

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\*\*. C.A: Cronbach Alpha, \* S.D Standard Deviation

Eight of the twenty-three response strategies that had a relative importance index greater than 80% were taken out. These included arranging frequent meetings to discuss COVID-19 response policies and mechanisms in the workplace, declaring a state of emergency in the event of a COVID-19 outbreak, and working with regulatory bodies to support scientific advice and facilitate policy changes. These strategies ranked first, second, and third, respectively, with an overall standard deviation of 74%, as Table 13 also demonstrates. Cronbach's alpha coefficients, which range from 0.88 to 0.91 in Table 1 and are higher than the minimum necessary of 0.60 [52], suggest that each construct exhibited strong internal consistency.

### 5. Conclusion

The results of the investigation have a wide range of theoretical implications. This study contributes to the body of knowledge on construction engineering and management by examining the effects of COVID-19 on the construction industry and response strategies to lessen these effects. A full understanding of the ramifications can help in creating efficient response plans. This study adds to the body of knowledge about appropriate response methods to address the effects of COVID-19 on the construction industry by experimentally modeling the relationship between the pandemic's effects and response measures.

In order to formulate the questions that were highlighted in the analysis and evaluation of the factors affecting labor productivity in the final goals of construction projects in Iraq in terms of time, cost, and quality, the initial visit, meetings, and experimental study were designed to make use of and apply these experiences. Finding out how the virus has affected building projects—especially in Iraq—was the aim of the study.

The results of the questionnaire and the interviews indicate that the coronavirus has had a major effect on building projects. It has raised the cost of labor and supplies, caused some to be abandoned, and caused the deadlines of others to be extended. Despite all of the difficulties, the epidemic has created a lot of fresh chances for the construction industry. Among these were the openings brought forth by reduced interest rates. rising demand in the housing, transportation, and medical industries; the capacity to recruit competent personnel. The investigation also uncovered particular strategies used to address the coronavirus pandemic problem at building sites. This includes safety precautions like mandating face coverings for employees, enforcing social distance policies, offering coronavirus safety training, and supporting work-from-home programs. Last but not least, this analysis corroborates other studies that claim COVID-19 has hurt the construction sector by raising material costs, delaying projects, and creating a labor scarcity. It also offers a more thorough comprehension of the effects that call for reaction plans. Ultimately, this research provides empirical evidence supporting the impact of COVID-19 on the construction sector.

Finally, the results of this study help stakeholders, management managers and implementing engineers to understand the impact of Covid-19 on the final outputs of a project, in addition to formulating better strategies for employment and work environment and reconsidering how to increase productivity in construction sites and offices, thus creating a suitable work environment for implementation.

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**Annex A1:** Questionnaire form provided to respondents regarding the evaluation of Covid-19 crisis factors

Code	Items	Crisis Classification					The most influential party			Likelihood and effect	Likelihood and effect Measure				
		Administrated	Economic & Financial	Social & Cultural	Environmental	Political	Owner	Contractor	Both		Very Low	Low	Moderate	High	Very High
											1	2	3	4	5
1---37										Likelihood					
										:Effect on	Time				
											Cost				
											Quality				

**Annex A2:** Questionnaire form provided to respondents to evaluate post-Covid-19 response measures

Code	Recovery Response Strategies Post-COVID-19	Number of Respondents Scoring Impact				
		LE	SE	AE	HE	VHE
		1	2	3	4	5
Re1	Stakeholders should get closer to customers and clients.					
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Re23	Modifying financing mechanisms and redeploying capital and resources					