

ASSESSING THE EFFECTS OF GLOBAL PANDEMIC ON THE CONSTRUCTION INDUSTRY: IMPACT FACTORS AND MITIGATION STRATEGIES

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DOI: <https://doi.org/10.5281/zenodo.21790104>

Keywords

Covid-19, Impact factors, Construction Industry, Post-Pandemic

Article History

Received: 18 February 2026

Accepted: 14 April 2026

Published: 30 April 2026

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Abstract

Following the global pandemic outbreak, construction industry has faced considerable disruptions and challenges. For creating efficient plans and policies to reduce the negative consequences, it is essential to understand the causes that have affected this industry. The objective of this research was to find and assess the variables that have affected construction industry during and post-pandemic era of Covid-19 and determine their mitigation strategies. Fifteen (15) impact factors were identified and prioritized created on Relative Importance Index (RII), and 25 mitigation strategies were found. This was done after conducting an extensive literature review and gathering expert judgment. Quantitative assessment of these factors was formulated in this study, offering valuable insights into the relative importance of these factors, which contributed to shape the construction industry's landscape during and after the pandemic. In last, the relationships were made to assign the relative mitigation strategies to each impact factor. Policymakers, industry professionals, and stakeholders are direct beneficiaries of this study include who can utilize the findings to develop effective strategies, policies, and mitigation strategies to successfully overcome the challenges posed by the identified impact factors during and post-pandemic era of Covid-19 on construction sector.

1. Introduction

Global pandemic (Covid-19) that changed the world economic perspective [1]. COVID-19 has significantly disrupted the human life and its impact is far more devastating. The COVID-19 eruption has been announced as a public health emergency of international anxiety by the World Health Organization. COVID-19 originated from China and thus the most affected one latter it spread across the world affecting countries in Europe and North America. Remedial actions were taken to limit the spread of virus. Regions in which Standard

Operating Procedure (SOP) were followed was least affect one. From previous studies, the closure of transport services and school terminations were resulted to decrease virus transmission, but these would derive at an economic charge [2, 3]. Primarily Parada [4], investigated that impact of COVID-19 – on engineering and construction. The outcomes described that, in first two months of 2020, China's industrial manufacture decrease by 13.5%, compared to the similar era in 2019. Investment in the permanent resources released by 24.5%, with industrial and land

communication the firmest hit. Overall retail consumption also decreased by 20.5%. According to Goswami [5] By February and March 2020, the COVID-19 eruption was spread in whole world, further distracting economic actions.

According to Mohsen, et al. [6] and the construction sector, in particular, faced numerous challenges such as delays, revenue losses, licensing issues, travel bans, health and safety concerns, labour and equipment shortages, and infrastructure project delays. These challenges have hindered the timely completion of construction projects. Study of Nadeem, et al. [7] also identified the pandemic as critical delay factor in construction industry of Pakistan. According to Shaw, et al. [8] almost 95% people lost their jobs in construction industry. Whereas more than 90% projects were delayed due to the material supply, labour availability, lockdown, and other sources. The challenging situation may lead to insufficient revenues generation from some states to meet their immediate spending [1].

According to Majumder and Biswas [9] the construction industry is one of the prominent industry, it drives a large number of people in order to deliver their work but due to the pandemic of COVID-19 most of the construction sites were being frozen due to fear due to the contagion of Coronavirus. The WHO [10] measured the influence of the eruption of COVID-19 on construction developments as well as the Government's approach after the lockdown is lifted. The minister enquired administrators to make the greatest utilization of the lockdown, and complete incomplete work name as payment to contractors, granting scheme sanctions, so that construction effort can restart in full swipe as soon as possible. As the international comeback continues to improve, as it is known that construction project stakeholders are commencement to face possibly important challenges which they need to oppose with speedily. Corporations, which were already feeling the heat on project execution and scheme ends, may face more reservations correlated to scheme completion, new scheme sponsoring, and future command flows. The communication, difficulty and worldwide environment of the construction sectors supply

chains and staff influence the cost and delay of construction developments. Any slowdown crossways construction funds could have an influence on scheme start dates, with possible longer-term financial effects. This research aims to find the substantial factors that impact the construction works due to COVID-19 in terms of cost and delay. Therefore, this study highlighted the factors which have impacted the construction industry during after the COVID-19 pandemic.

2. Literature review

The Covid-19 epidemic had a substantial affect on construction industry. The implementation of strict lockdown measures and social distancing protocols disrupted construction activities to a great extent. This resulted in project delays, disruptions in the supply chain, and a shortage of labour and machinery, causing financial losses and increased costs for companies involved [11]. The closure of construction sites and restrictions on mobility further compounded these challenges. The COVID-19 pandemic conveyed crises world preceded to additional measures concerning social distancing, self-seclusion, and restraints on traveling. Due to these measures there were lack of the workforce [12]. Several studies have been conducted to analyse the during and post pandemic effects of COVID-19 on construction sector, also the measures to mitigate those impacts during and after pandemic. The study of Gamil and Alhagar [13] conducted to determine the effect of COVID-19 pandemic on the persistence of the construction industry, both private and public sector. This study determined about 14 impacts of COVID-19 on the construction industry and divided those all influences into two groups i.e., economic, and human resources. The data were collected through the detailed questionnaires and remote interviews. Findings concluded that the most influential impacts on the constructions industry were Project suspension, workforce shortage, delays in construction, cost overrun, and financial impact. Pamidimukkala and Kermanshachi [14] conducted study to identify the health and safety issues in the construction industry and their measures. Through literature and other previous studies, they identified 17

disputes and categorized them into five groupings. Their outcomes shown that lack of a safe environment, heavy amount of work, home situations, and concerns about job stability are main challenges. They also identified the 11 approaches to defeat health and safety disputes occurring during COVID -19 pandemic and categorized them into three categories. This study also demonstrated that by placing signs of safety on work sites, confirming a safe distance between workers, providing sanitizers, and washing stations in the fields, and employing efficient tools can be used to overcome the challenges. Gumusburun Ayalp and Çivici [15] conducted study on the influential factors and their effects on the performance of construction industry of Turkey during COVID-19. This study used quantitative and comprehensive method of research for identifying factors. They considered the 10 influential factors and 59 impacts of those factors on the construction industry. Data was collected via e-mail by sending questionnaires to the experts. To identify the critical factors, they analysed collected data using SPSS 22 and LISREL 8.7. After data analysis, they concluded that most influential or critical factors effecting the performance of construction industry of Turkey during COVID-19 were “inflation due to shortage of materials, challenges with payment and cash flows.” The study of [16] was conducted to find and assess the factors that has important effect on the construction industry of Riyadh, Saudi Arabia. Total of 43 factors were identified through literature. Data were calculated through the questionnaire having five-point Likert scale. To analyse data reliability analysis and RII methods were used. This study identified four main factors contributing to the disruptions: (1) Managerial factors, which involved business owners neglecting talent and expertise during the pandemic; (2) Economic factors, where contractors faced conflicts in bidding prices due to the limited projects available; (3) Social and cultural factors, encompassing customs, traditions, and social relations in project implementation areas; and (4) Environmental factors, including the procurement process for raw materials, whether locally sourced or imported, and its impact. [17] conducted study to establish the implications of the COVID-19

pandemic on project delivery and determine negative implications of COVID-19 for the construction industry in the UAE. Purposive and simple random sampling was used in the selection of the experts. Data was collected through online questionnaires and analysed by using SPSS software. This study revealed that significant effects of COVID-19 was time overrun and lack of access to raw materials and labour which also causes delay in construction. [18] conducted study in India identify, analyse, and compare the impacts on projects in construction industry of India. Firstly, interviews were taken to identify the impacts and 12 impacts were identified. Then a survey of those impacts was developed to collect data. After the analysis of data by using reliability analysis, mean score ranking, overlap analysis, agreement analysis, and correlation analysis, this study revealed that most impactful factors are labour shortage, supply chain disturbance, declined productivity of construction, improved project funding refusal rate, and diminish foreign funding. Azeem, et al. [19] performed research to determine the effect of COVID-19 on the construction industry of Pakistan by using concept of rework projects. Rework projects are those projects which are completed in 2nd turn. The data taken through interviews was analysed. This study revealed that time constraints, limited resources, contractor mobilization, incomplete documentation, and technological advancements were key risks in rework projects. Another study was conducted by [20] to determine the risks occurred due to COVID-19 pandemic in the construction industry of Sri Lanka. This research used a questionnaire survey to gather data and find the risk factors. Initially this study considered the 07 risk factors and after survey 09 other factors were also added which had impact on construction industry during COVID-19 pandemic. They used a simple method of percentage to analyse the data and find the critical risk factors. This study founded that supply chain disruptions, prophylactic absenteeism due to phobia, regional lockdowns, fear of 2nd wave, and decrement in investment are the critical factors which have critical impact on the construction industry of Sri Lanka. Ebekozi, et al. [21] conducted study to investigate the challenges faced during the

pandemic and propose their solutions to overcome them post-COVID-19 era to achieve Sustainable Development Goals (SDGs) connected to the construction sector. They identified 27 challenges faced during the COVID-19 and 27 solutions to those challenges. They used qualitative research methodology to identify the challenges. Firstly, they conducted face-to-face interviews and results from those were analysed through a questionnaire in Nigeria. This study revealed that improvement of management efficiency, use of digital technologies, building of new skills on new tools, and increment of infrastructure budget by government are the part of the feasible solutions to achieve SDGs in post pandemic era. Chourasia, et al. [22] conducted study to highlight the challenges faced by construction industry after lockdown and their measures to mitigate them. With the implementation of lockdown and closure worldwide, the construction has faced many challenges and disruptions caused halt of the work. Due to this halt of construction activities, the construction and real estate industry to face the challenges like risk of global collapse, lack of building materials, lack of skilled labour, financial catastrophe, and delay in construction projects. The government, construction industry and academicians or researchers can play an important role to mitigate the effects of these challenges through integrated approach by adopting economic, social, managerial policies and technological solutions. Bisiu [23] conducted study to find perception of Jordanian engineers that faced lockdown and their views regarding future of construction sector. To attain these goals online questionnaires were circulated among the experts. The results of this research demonstrated that only design engineers can work from home with competence, while many site engineers have concerns regarding the post-lockdown period, as they doubt whether construction workers will follow social distancing measures and wear necessary personal protective equipment. The study of [24] was performed to determine the impacts of COVID-19 on the construction

industry of Pakistan and their measures to overcome. The data was gathered through semi structured discussions and that data was examined using thematic investigation. This study revealed the four dimensions of the COVID-19 impact on construction industry. Those four dimensions were working style and behavioural changes, challenges and risks, stakeholders, and new directions. This study makes significant contributions by examining the impacts of COVID-19 on the construction industry, proposing innovative approaches for its future direction, and implementing a range of mitigation measures to minimize project disruptions and ensure successful achievement of objectives. Majumder and Biswas [9] conducted qualitative research to emphasize the need of risk assessment and implementation of safety measures in construction industry of India during and after COVID-19 pandemic. In post pandemic period construction industry or employer should prioritize the health and safety of the workers. This study discussed the different policies of World Health Organization (WHO) and Indian control agencies for the pandemic period.

COVID-19 has impacted construction industry in efficiency, economy, schedule etc. There is need of identifying those impacts and measures to overcome those impacts in post pandemic era of COVID-19. This need motivated to conduct study to identify those impacts and their measures.

3. Methodology

This research aims to highlight the factors in terms of delay and cost which have great impact on the construction sector of Pakistan due to Covid 19. The overall approach of this research depends on a survey conducted by pursuing the stakeholders of construction. Figure 1 exhibits the flowchart of methodology. One of the chief study objectives is to know which factor greatly impacted the construction industry by most experts. A designed questionnaire was developed for this study as stated in the subsequent divisions.

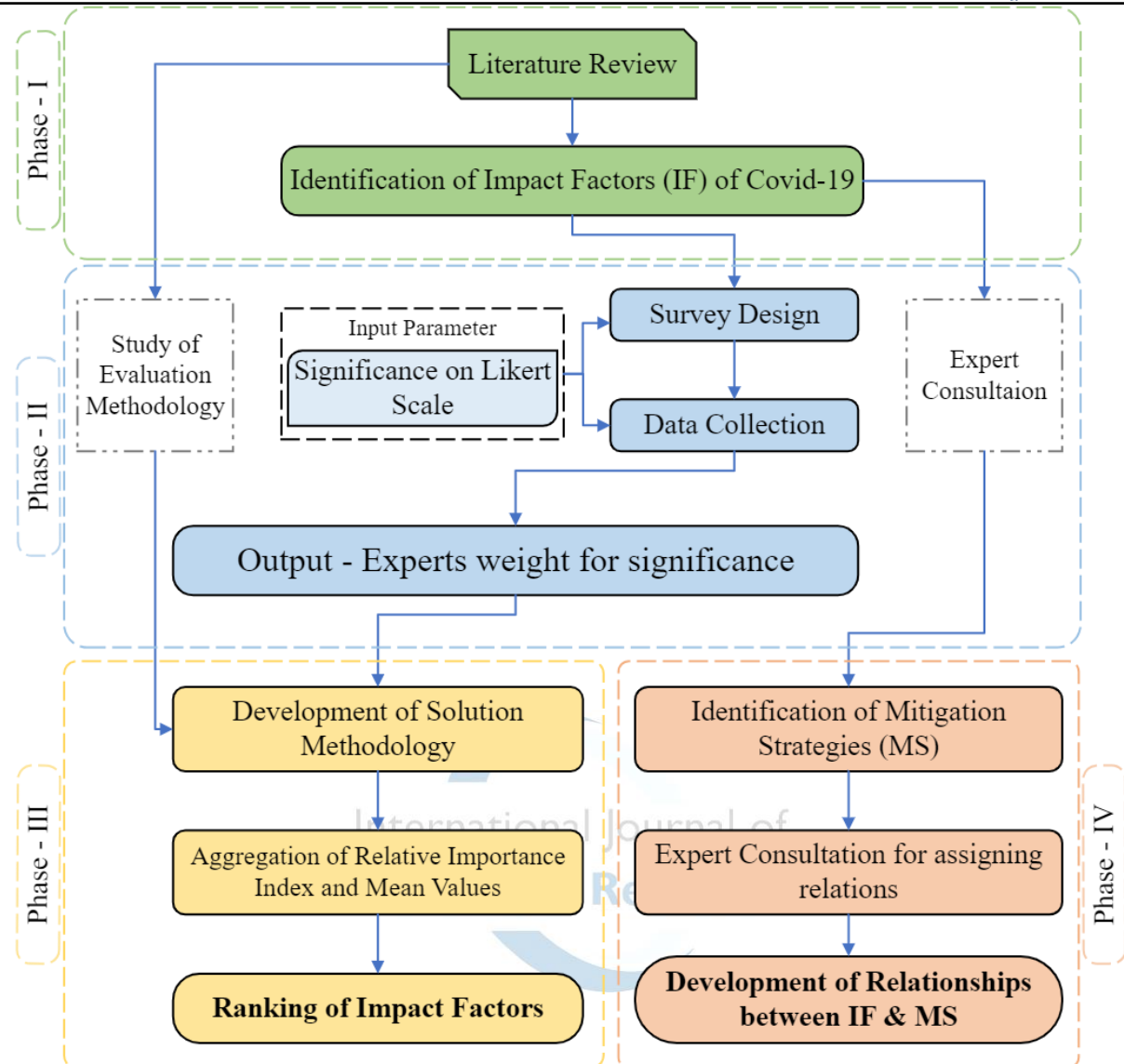


Figure 1. Methodological approach for elucidation of research study

a. Identification of impact factors

To identify the impact factors of Covid-19 during and post-pandemic era, the detailed literature review and expert consultation were done. After doing this all fifteen impact factors were identified listed in Table 2.

b. Development of Questionnaire

The developed questionnaire was separated into three parts: Part 1: Overview, Part 2: Factors impacted on construction industry due to Covid 19, and Part 3: Application package. Participants were recruited using a formal invitation letter describing the objectives and scope of the study. The questionnaire was developed to be clear, concise, and manageable to complete. Participation in Section 1 was voluntary, and

demographic information was requested only at the end of the survey. This approach was adopted to maintain respondent anonymity and encourage greater participation by minimizing concerns about personal identification. Part 2 focussed on gathering of contestant data concerning the factors impacted on construction industry due to Covid 19. In this section, a valuation of the significant factors impacted on the construction industry was conducted. Part 3 of the form concentrating on experts that gave their responses through online data base. For instance, the participants were obligatory to answer following Likert scale of 1 to 5 as shown in Table 1. The evaluation was in English, to be returned on-line through a 24-hour reachable internet site deprived of time restrictions for

answering. It was expected that stakeholders might practise numerous options and highlight the significant factor, participants were permissible to choose numerous answers, inducing the total percentages over 100%. As the assessment attentive on the customers,

consultant and contactors of construction industry, guidelines given by the online data gathering instrument did the contestants to suitable questions created on their earlier answer.

Table 1. Scale used in questionnaire

Rating	Likert Scale
1	Not Significant
2	Slightly Significant
3	Moderately Significant
4	Very Significant
5	Extremely Significant

c. Sample Size Selection

The important feature for the study to be reliable is the adoption of a suitable and satisfactory sample size of survey participants. The sample size in this study is created on the procedures for categorical variables using Cochran's equation, which produces a least sample size of 120 respondents. As a total of 150 participants contributed to this survey, it can be concluded that the sample is expressively demonstrative.

d. Survey Group

The identifying an appropriate survey population was a critical step. The objective of this research was to obtain responses from experienced professionals representing the global construction industry. Given the absence of a clearly defined sampling frame and the large number of construction practitioners worldwide, selecting suitable participants presented a considerable challenge. To address this issue, professional networking platforms were used to identify and reach potential respondents. Among these platforms, LinkedIn was selected because it provides access to an extensive international network of professionals from a wide range of industries and geographic regions. Its industry-specific groups enabled the researchers to target individuals with relevant expertise. Accordingly, members of the "Impact of COVID-19 Group Construction Industry" were invited to participate in the survey. This group included professionals from diverse

sectors of the construction industry, including contractors, consultants, architects, engineers, material suppliers, and project owners, thereby ensuring broad representation of industry perspectives.

e. Respondents details

The questionnaire was emailed to two hundred thirty (230) experts employed in construction schemes, as result of one hundred fifty-five (155) feedbacks were received, yielding feedback rate of 67.39 %. The feedback rate for the questionnaire survey was satisfactory as in construction study the usual feedback rate for the questionnaire survey is about 30% [25]. Figure. 2 displays the three main clusters of stakeholders that contributed to this survey. From Figure 2 almost half of the respondents were from consultant. Whereas 35% were contractors and remaining were owners. Subsequently Figure 3 elaborates the experience of the survey respondents. Figure 3 describes that 32 out of 155 (20.64%) participants had experience more than 20 years in construction industry. Consequently 18 (11%) respondents of the survey had less than 10 years' experience. Lastly the respondents in this survey were highly qualified as represent in Figure 4. From Figure 4 it can be seen that the educational level of the survey respondents was diploma, bachelor's and master's degree with different percentage of 22%, 64% and 14% respectively.

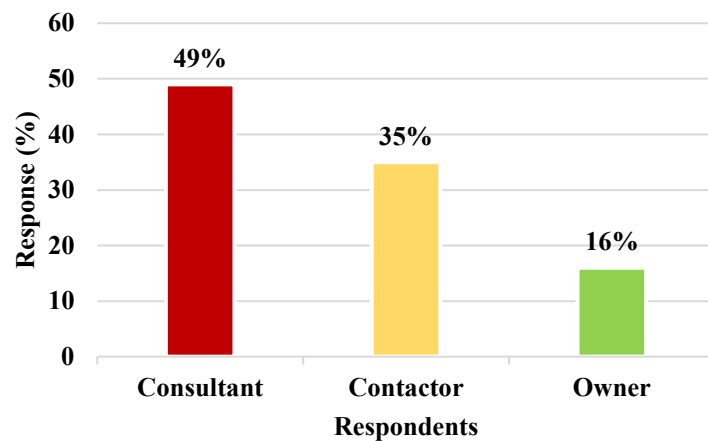


Figure 2. Respondents' classification based on categories

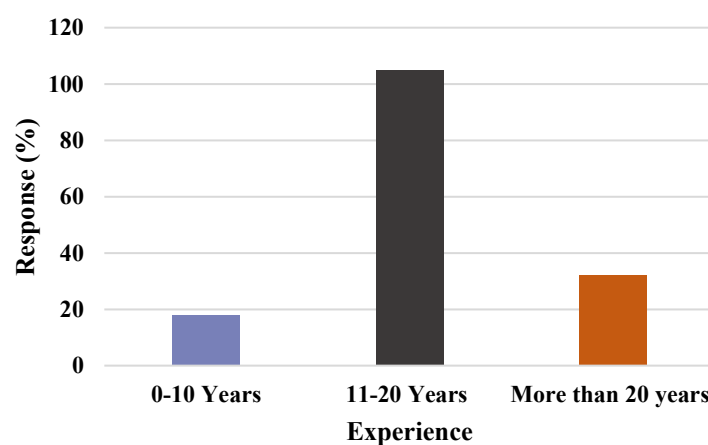


Figure 3. Respondents' classification based on experience of respondents.

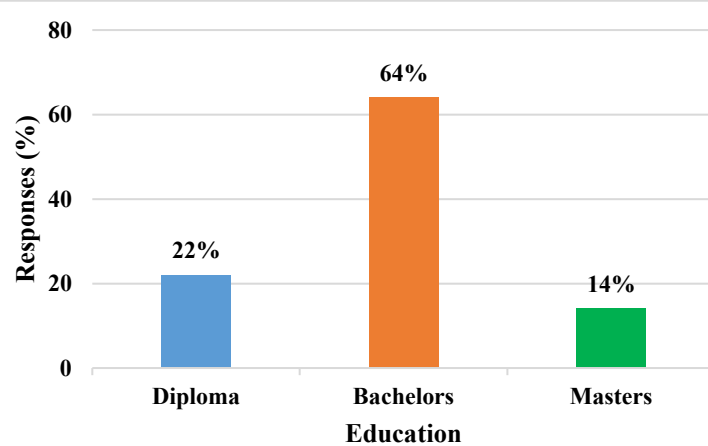


Figure 4. Respondents' classification based on level of education.

4. Data Analysis

Dixit, et al. [26] and Kassem, et al. [27] used the Relative Importance Index (RII) method to determine the relative importance in their research. Gündüz, et al. [28] used RII to quantification of delay factors using the relative

importance index method for construction projects in Turkey. The same method was adopted in this stud to quantify factors that impacted the construction industry of Pakistan due to COVID-19. Eq. (1) indicates the

equation for RIIs, based on which each factor was calculated:

$$\text{Relative Importance Index} = \frac{\sum W}{(A \times N)} \quad (1)$$

Whereas in the Eq. (a), (W) is the weight given to each factor by respondents which ranges from 1 to 5; A is the highest weight (i.e., 5 in this case), and N represent the total number of respondents involved in this study. The Relative Importance Index (RII) value had a range of 0 to 1, the higher the value of RII, the more important was the factor. The RIIs were then ranked, and the results are shown in Table 2.

5. Results

To analyse the significant factors that have great impact on the construction industry due to Covid 19. The survey data was invested by using SPSS software. Cronbach's alpha coefficient is adopted to validate the internal reliability of questionnaire. In this research 0.875 Cronbach's alpha was obtained which is more than 0.7, hence data collected from questionnaire survey is consistent. The factors that impacted the construction industry due to Covid 19 were ranked according to their Relative Importance Index (RII) as shown in Table 2.

Table 2. Relative Importance Index (RII), Mean and Ranking of Impact Factors (IF)

Code	Impact Factors	RII	Mean	Rank
IF5	Delay in Subcontractor's Work	0.93	4.19	1
IF13	Approval from the Municipality	0.91	4.1	2
IF6	Delay in transportation of Special Manufactured Imported Materials	0.9	4.07	3
IF1	Shortage of Manpower due to risks of health	0.9	4.04	4
IF14	Transportation Permit	0.88	3.96	5
IF8	Lack of Communication and Coordination Between the Parties Involved in Construction	0.85	3.9	6
IF9	Contract Modifications due to delays and inconsistency	0.84	3.85	7
IF3	Non-availability of Materials on Time	0.82	3.81	8
IF15	Delay in Testing of Materials and Site Conditions from Laboratory	0.8	3.74	9
IF2	Shortage of Materials on Site	0.79	3.7	10
IF11	Lack of Data in Estimating the Activity Duration and Resources	0.77	3.65	11
IF12	Late Payment to Subcontractor by the Main Contractor	0.76	3.63	12
IF4	Shortage of Equipment	0.73	3.5	13
IF7	Delay in Preparation of drawings	0.72	3.44	14
IF10	Inadequate Early Planning of the Project	0.7	3.33	15

From Table 2 it is evident that the significant factors that have impacted the construction industry are Delay and cost in construction schemes. Respondents of the survey ranked the "Delay in subcontractor's work" as the main reason of delay in construction due to Covid 19 in construction industry. Contractor is one of the main stakeholders in construction industry as they directly play their role in construction activities at site. Thus, due to restrictions in movement of workforce and adoption of safety precautions causes the delay in construction due to Covid 19. On the other hand, factor name as "Obtaining permit/approval from the municipality/different government authorities" was ranked second. Due to Covid 19, all relevant

authorities were not working in their offices due to which, it was very difficult for the construction stakeholders to run their project accordingly as per planning. Whereas "Delay in special manufactured imported materials" factor was on ranked third on the list. As the international flights and trade was closed during pandemic, construction stakeholders faced problem to procure the special materials. Subsequently other factors have the same impact on the construction industry. Therefore, it is revealed from the results of the above-mentioned factors, have subsequently impacted the construction industry due to Covid 19 and thus requires remedial strategies to run the construction industry smoothly.

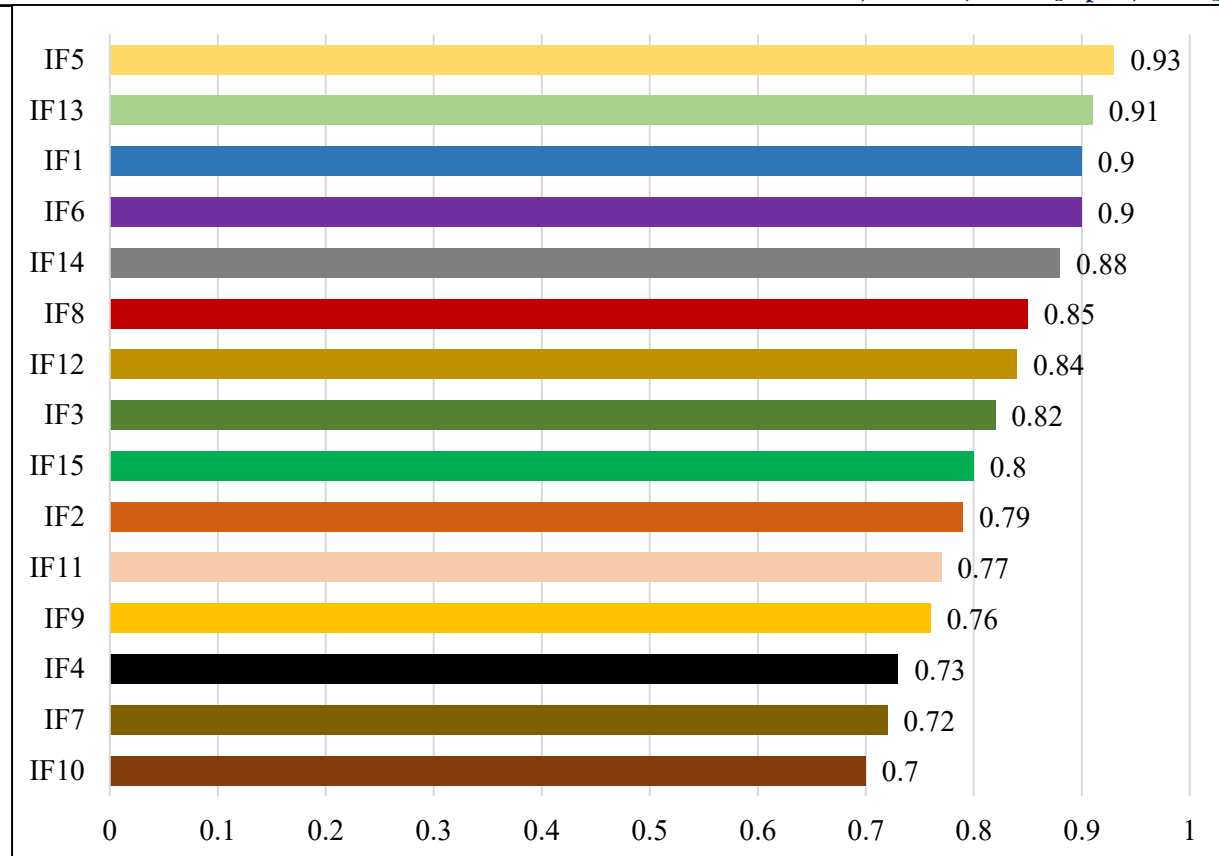


Figure 5: Relative Importance Index (RII) of Impact Factors

Figure 5 represents the factors influenced by COVID-19 pandemic and their adverse impact on the construction industry. The presented data indicates the impact of COVID-19 pandemic on the construction industry in Pakistan. The findings abased on expert judgement highlights various challenges faced by the industry. Key factors were identified that influenced the construction industry. These findings underscore the complex and multi-faceted impact of COVID-19 on the construction industry of Pakistan, providing valuable insights for stakeholders and informing strategies to address these challenges. Based on the study stakeholders can propose remedial strategies to overcome the evident risks impose on the construction projects due to COVID-19. After identifying the impact factors, now discussing the mitigation strategies to overcome those impacts on construction industry. To overcome these impacts of Covid-19 the industry experts were involved to identify the mitigation strategies of each impact factor. After expert consultation, different mitigation strategies were identified and finalized strategies are shown in

Table 3. To identify the relation of each impact factor with different mitigation strategies a graph was created. Figure 5 shows the relationships of impact factors and mitigation strategies. Relationships shows the mitigation strategies of relative impact factors by those we can mitigate that impact. Top ranked impact factor "IF5: Delay in Subcontractor's Work" can be mitigated by negotiating the completion time and budget by changing the contracts and providing flexible project schedules. Mitigation strategies for "IF13: Approval from the Municipality" which is 2nd ranked can be risk assessment and contingency planning, early application, and planning. Similarly , the 3rd ranked factor "IF1: Shortage of Manpower due to risks of health" can be mitigated by the strategies like: Reduce worker per shift, add more shifts, refrain workers to stay home if they have COVID-19 symptoms, regularly check if people are following COVID-19 rules, provide hand sanitizers, temperature checking, enforcing mask use, Establish and follow safety standards, and Plan for social distancing among

workforces. All the related mitigation strategies for reach impact factor are shown in Figure 6.

Table 3. Mitigation strategies for impact factors of Covid-19 pandemic

Code	Mitigation strategies
MS1	Reduce worker per shift, add more shifts
MS2	Refrain workers to stay home if they have COVID-19 symptoms
MS3	Regularly check if people are following COVID-19 rules
MS4	Provide hand sanitizers, temperature checking, enforcing mask use
MS5	Negotiate completion time and budget by changing them
MS6	Use prefabricated materials
MS7	Ensure project teams communicate and coordinate regularly
MS8	Conduct project meetings via remote meetings
MS9	Establish and follow safety standards
MS10	Contract amendments
MS11	Improve supply chain
MS12	Digital Data Sharing and Reporting
MS13	Contract Review and Analysis
MS14	Proactive Planning
MS15	Testing Schedule Adjustments
MS16	Risk Assessment and Contingency Planning
MS17	Scenario-Specific Estimates
MS18	Digital Payment System
MS19	Remote Work and Collaboration Tools
MS20	Digital Submission and Review
MS21	Early Application and Planning
MS22	Historical Data Analysis
MS23	Flexible Project Schedules
MS24	Prioritization of Critical Tests
MS25	Digital Collaboration Tools

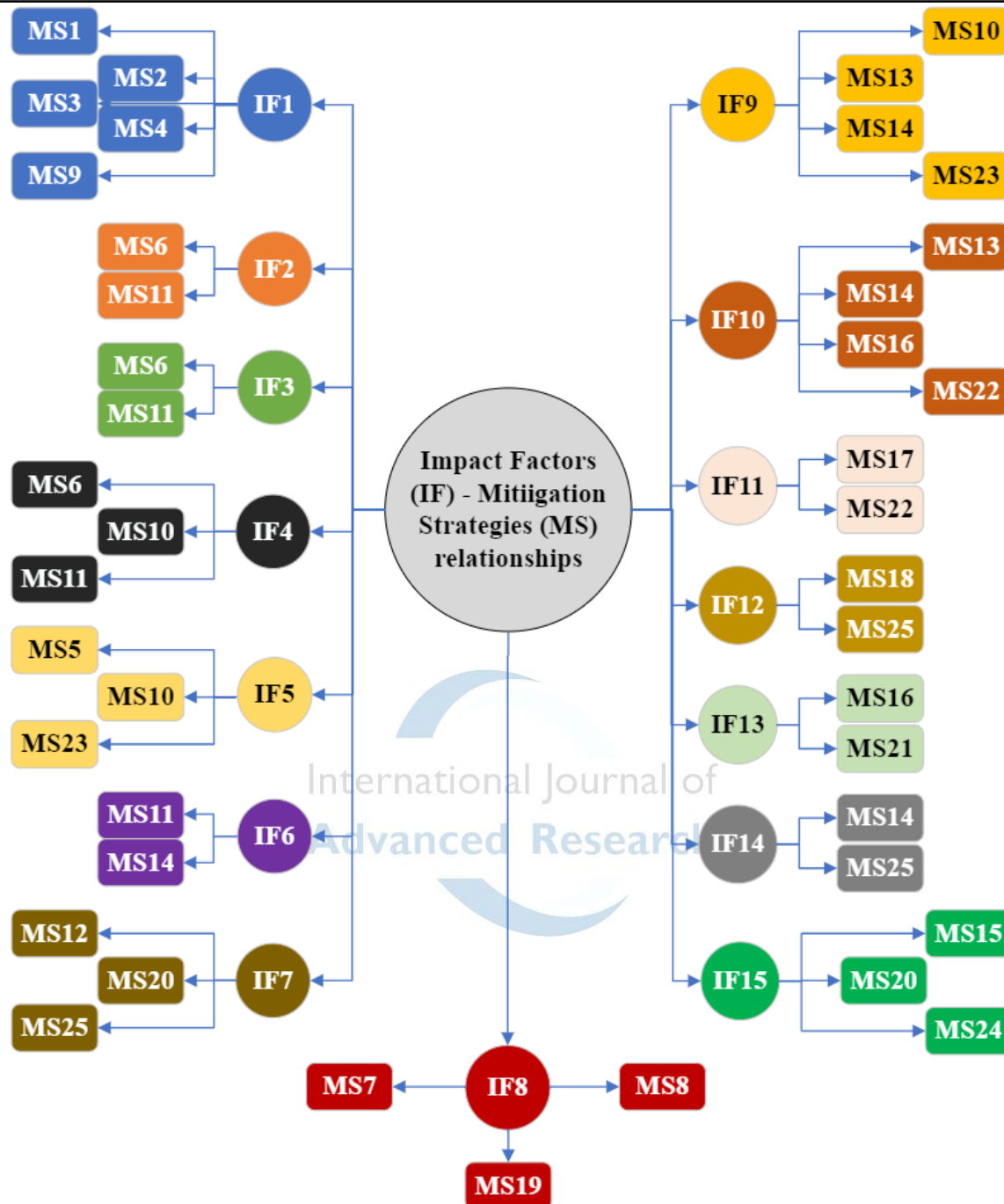


Figure 6: Relationships between impact factors (IF) and mitigation strategies (MS)

6. Conclusion

The findings based the conducted study underscore that the construction industry in Pakistan has experienced significant challenges and disruptions due to the COVID-19 pandemic. Construction industry itself is facing the problems bestowed by COVID-19 and is facing problems to overcome them. This research highlights the factors that have great impact on the construction industry due to

Covid 19. The results described that delay in sub contractor works due to restriction on movement of work force and adoption of safety precautions, problem to get approval from authorities and procurement of imported materials are the most significant factors which have great capabilities to impact on the construction industry due to Covid 19. These results indicate the need for remedial measures and strategic planning to mitigate the impact of

the pandemic on the construction industry of Pakistan. Stakeholders should prioritize enhancing coordination and communication mechanisms, improving supply chain resilience, and incorporating digital solutions to make project delivery efficient. Furthermore, collaboration between the industry stakeholders, government, and relevant authorities are crucial for addressing these challenges effectively thus ensuring the long-term sustainability and recovery goal of the industry. The scope of this research was limited to investigate the factors that have impact on the construction industry, future studies can be carried out to mitigate these factors. The outcomes of this research can help construction stakeholders to overcome the present problems in the construction industry.

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