

## Research Paper

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# An impact overview of COVID-19 on the construction industry in Pakistan

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**Abstract:** The construction and development sector is considered as the backbone of any growing economy. Globally, the construction industry (CI) has experienced significant growth alongside increasingly complex projects that involve multi-disciplinary stakeholders such as clients, consultants and contractors, known as the 3Cs. Despite modern efforts towards digitalisation and the introduction of technology, this industry was among the most impacted by COVID-19 in many countries. The 3Cs have faced impediments in practicing their respective roles. This research utilises a mixed methodology approach by utilising an extensive literature review combined with statistical analysis to study the impacts on working practices of the 3Cs of the CI in Pakistan. The six major impact factors were related to planning and overhead cost, manufacturing and shipping, permit issuance, liquidated damages, cash flows, material availability and delivery. Among the six factors, delays in permit issuance and materials availability were the two global factors investigated in the study. The significance of the impact factors was further justified by comparative analysis with existing literature. The study further revealed that contractors were the most affected party within the 3Cs of the CI in Pakistan. The findings of this study are significant to tackle such a pandemic in the future, by suggesting effective emerging practices which may also be made and enforced as regulations by the government.

**Keywords:** construction, construction management, cost, safety, safety, hazards

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## 1 Introduction

The construction industry (CI) plays a pivotal role in the growth of the economy in many developing countries. Infrastructure projects including roads, highways, urban rail transit and flyovers indirectly facilitate communication and also enhance agricultural and industrial production (Frazier and Kyle 2011). The importance and role of the CI can be fathomed by its global scale, which indicates that this industry contributes to one-tenth of the world's Gross Development Product (GDP) and provides jobs to almost around 7%–10% of the workforce globally (EconomyWatch 2021). The projects in the modern CI have three main engaged stakeholders having different roles and responsibilities: the client who is the owner of the project, the consultant who is the appointee of the client acting as the engineer and the contractor who undertakes and executes the contract works, all together referred to as the 3Cs of the CI. A successful project is a product of the integrated efforts and contribution of these 3Cs (Egemen et al. 2005).

Pakistan is recognised as a developing country (Qasim et al. 2021). It is the fifth most populous country in the world with 220 million citizens and more than a 60 million strong labour force. The CI in Pakistan is growing rapidly day by day and has become of social and economic importance. Around 30%–35% of employment is directly or indirectly related to this industry (Farooqui et al. 2018). The construction sector in Pakistan provides up to Rs. 380 billion in GDP, which accounts for 2.53% of GDP. Moreover, the construction sector has been declared as an industry that has brought tax relief and attraction for new investors, builders and developers (Board-of-Investment 2020). The value projections, as shown in Figure 1, reflect that despite the current situation where the country's GDP is not performing at its best, there is a rising trend in value projections of the construction sector.

This study intends to explore the impact of COVID-19 through in-depth analysis of three sub-sectors: the Client, the Consultant and the Contractor of the CI. The expected outcome of the study will help to establish a knowledgebase for the concerned authorities regarding the

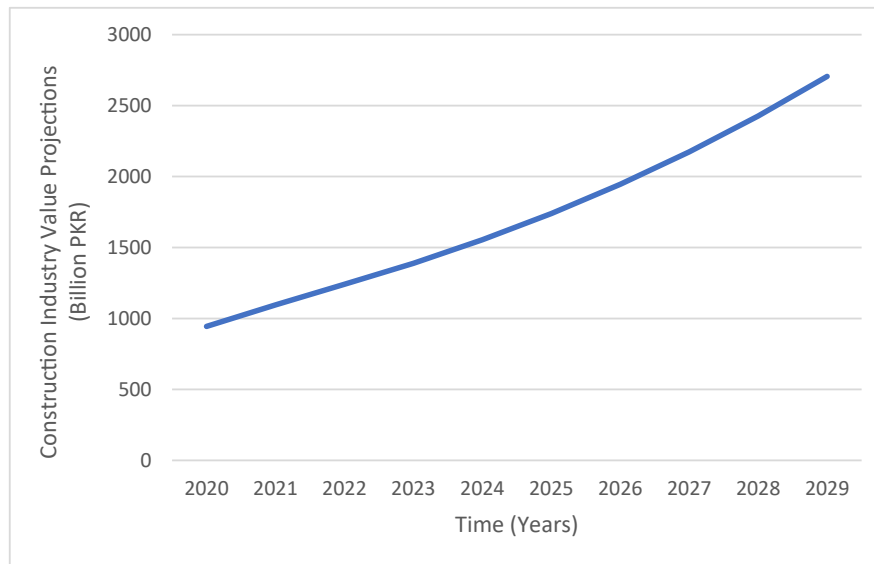


Fig. 1: CI value projections (Board-of-Investment 2020). CI, construction industry.

individuals from the most affected sub-sector among the 3Cs of the CI in Pakistan.

Since the beginning of 2019, the COVID-19 pandemic has adversely affected economies globally. The construction sector was among the most affected sectors in several countries. In the first few months during the days of partial lockdown and then even in complete lockdown, there were disparities while deciding whether the CI is essential or not (Hao et al. 2020). In the United States, a developing country, although stay-at-home or shelter-in-place orders were being enforced across several states to prevent the spread of the novel coronavirus, a few states did not require any such restrictions (Alsharif et al. 2021), leading to a lot of confusion and greatly affecting in calculating the actual days as a 'Force Majeure' situation (Hansen and Seng 2020; Ogunnusi et al. 2020; Assaad and El-Adaway 2021). Most of the Consultants and Clients agree to the fact that this situation will result in more claims leading to disputes, eventually into litigation. Moreover, once the industry was reopened there were extreme material shortages (Ogunnusi et al. 2020; Alsharif et al. 2021) reported due to stoppage in the production line and the supply chains, and there was a delay in securing permits; at the same time, there had been a delay in the execution and inspection of work at the sites (Azeem et al. 2020).

In developing countries, there had been a complete loss of productivity which was primarily due to the newly imposed safety laws and reduced operational timings. Financial issues such as non-payment to contractors and sub-contractors due to lack of funds with the client departments in both the public and private sectors also contributed to the loss of productivity. Due to the prevailing

situation, certain contractors refrained from working due to non-payment issues, as most of their revenue had been lost while paying salaries to idle employees (Ramesh et al. 2020). Most of the projects in the private sector were suspended entirely, crucial projects in the public sector had slowed down (Azeem et al. 2020) and the international CI growth rate decreased from 3.1% to 0.5% (Iqbal et al. 2021). Moreover, the start dates of new projects had been shifted all along, which immediately vanished upcoming construction jobs out of the market and reportedly created a risk of losing existing jobs (Zheng et al. 2020). Many projects failed to meet the initial deadlines and faced unique challenges such as time urgency, overburdened resources and mobilization of contractors (Azeem et al. 2020).

## 1.1 The efforts to manage COVID-19 challenges

The pandemic generated the need wherein companies had to adopt interactive continuous contingency planning. This crisis forced the organisations involved in the CI to adopt long-term strategic goals and develop the best health and safety practices to continue the work and activities on the ongoing projects (Afkhamiaghda et al. 2020). Later on, the representatives of organisations involved in construction projects started interaction online through Zoom and other applications to avoid the risk of COVID-19 (Iqbal et al. 2021). The findings of an analytical study on the CI regarding preventive COVID-19 measures suggested that ensuring workplace safety policies and providing paid sick leave could protect essential workers in high-contact industries and prevent further

widening of disparities in COVID-19 morbidity and mortality (Pasco et al. 2020). A study, carried out by Iqbal et al. (2021) proposed a crisis management framework for the CI, which is required to be adopted in similar scenarios as of COVID-19.

Conclusively, it can be drawn from the literature review that the CI is diversified, and it includes both services and product construction components with the involvement of diverse organisations with competing interests on projects. Thus, there is a need to assess the impact of COVID-19 on the CI while taking into account the individuals belonging to these different organisations.

## 2 Methodology

The methodology is divided into two phases. Phase-01 of the methodology constitutes the compilation of factors from the existing literature and thereby forming a data bank and list of factors arising in the form of impact points on the practices of the 3Cs as a result of COVID-19. The studies of Alsharef et al. (2021) were set as a benchmark in this regard, which even segregated the impact points into sub-groups of similarities, as shown in Figure 2.

After combining the factors from the literature review, 43 impact factors or impact points along with

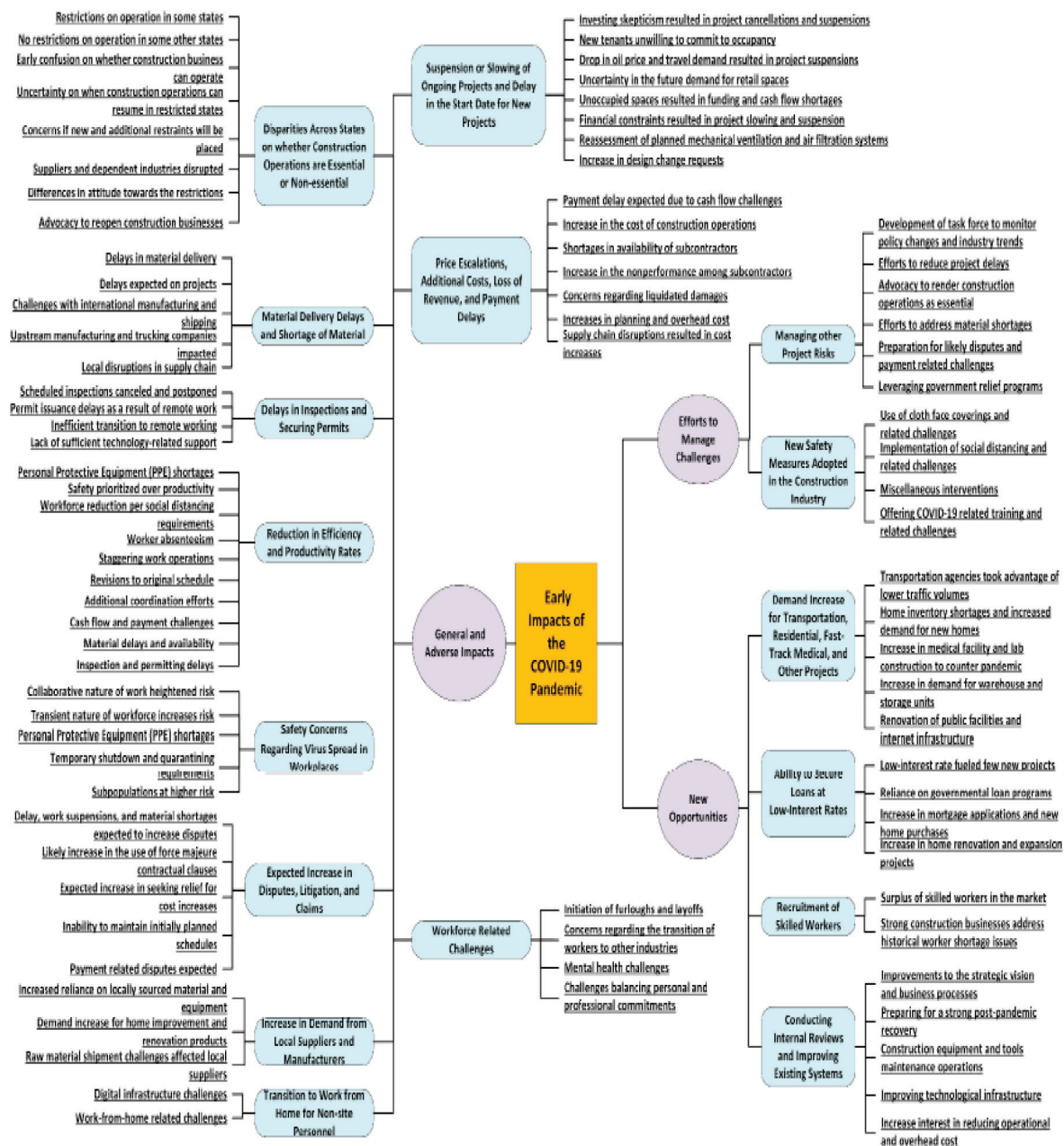


Fig. 2: Themes, sub-themes and codes as established from an early impact study (Alsharef et al. 2021).

14 factors of emerging practices or the exit strategy for COVID-19 as gathered from the literature review were initially characterised into eight sub-classes and two sub-classes, respectively, depending on conceptualising exercise. These two groups combined formed an initial questionnaire which was to be subjected to a pilot study with the subject matter experts (SMEs) for the validity of these factors for the final questionnaire. Face-to-face deliberations were done with the Construction Professional SMEs (five consultants, five contractors and three

owners) to determine the factors most suitable to be a part of the final survey. These interviews lasted around 0.5 h to 1 h in which after taking an insight into the experience of the SME, the initial questionnaire was proposed after discussion.

The Pilot Study resulted in fruitful outcomes, thereby resulting in shortlisting of the most important factors and practices that were impacted by COVID-19. As a result of the Pilot Studies, 31 factors were shortlisted as impact factors of COVID-19 on the CI as shown in Table 1.

**Tab. 1:** Revised impact factors on projects (after pilot studies).

| Categories  | No. | Factors  |
|---|-----|--|
| Suspension or slowing of ongoing projects or delay in the start of new projects | F1  | Investing scepticism resulted in project cancellations and suspensions |
|   | F2  | Financial constraints resulted in projects slowing and suspension      |
| Price escalation, additional cost, loss of revenue and payment delay            | F3  | Payment delay expected due to cash flow challenges                     |
|   | F4  | Increase in the cost of construction operations                        |
|   | F5  | Shortages in the availability of sub-contractors                       |
|   | F6  | Increase in the non-performance among sub-contractors                  |
|   | F7  | Concerns regarding liquidated damages                                  |
|   | F8  | Increase in planning and overhead cost                                 |
|   | F9  | Supply chain disruptions in cost increases                             |
| Material delivery delays and shortages of material                              | F10 | Delays in material availability and delivery                           |
|   | F11 | Challenges with international manufacturing and shipping               |
|   | F12 | Upstream manufacturing and trucking companies Impacted                 |
|   | F13 | Local disruptions in the supply chain                                  |
| Delays in inspection and securing permits                                       | F14 | The scheduled inspection was cancelled and postponed                   |
|   | F15 | Permit issuance delayed as a result of remote work                     |
|   | F16 | Inefficient transition to remote working                               |
|   | F17 | Lack of sufficient technology-related support                          |
| Reduction in efficiency and productivity rates                                  | F18 | PPE shortages  |
|   | F19 | Workforce reduction/social distancing requirements                     |
|   | F20 | Worker absenteeism   |
|   | F21 | Revisions to the original schedule                                     |
|   | F22 | Cash flow and payment challenges                                       |
| Transition to work from home for on-site personnel                              | F23 | Work from home related challenges                                      |
|   | F24 | Digital infrastructure challenges                                      |
| Increase in demand from local suppliers and manufacturers                       | F25 | Increased reliance on locally sourced material and equipment           |
|   | F26 | Raw material shipment challenges affected local suppliers              |

(Continued)

Tab. 1: (Continued)

| Categories  | No. | Factors   |
|---|-----|---|
| Expected Increase in Claims, Disputes, Arbitrations and Litigations | F27 | Delays, work suspensions and material shortages are expected to increase disputes |
|   | F28 | Likely increase in the use of 'Force Majeure' contractual clauses                 |
|   | F29 | The expected increase in seeking relief for cost increases                        |
|   | F30 | Inability to maintain initially planned schedules                                 |
|   | F31 | Payment-related disputes expected   |

PPE, personal protective equipment.

A completely new category under the name of 'Relief Sought (for ongoing and future projects)' was additionally added to the already defined two categories in the exit strategy for COVID-19. This category constitutes the relief factors that were provided or to be provided by the government or

regulating body. After the addition of this category on the recommendation of the SMEs, the framework for tackling COVID-19 at the 3Cs level, that is, the organisation-wise exit strategy had a list of 22 practices which were sub-divided into three classes, as shown in Table 2.

Tab. 2: Factors for exit strategy for COVID-19 (ongoing and future).

| Categories                                      | No. | Factors  |
|---|-----|--|
| Future practices                                | F1  | Advocacy to render construction operations essential   |
|   | F2  | Efforts to reduce and overcome project delays  |
|   | F3  | Preparation of likely disputes and payment challenges  |
|   | F4  | Limiting shifts to 8 h and increasing to three shifts for projects to engage surplus employees                           |
|   | F5  | Digitising the construction site monitoring and inspection system  |
|   | F6  | Increasing communication technology awareness and reliance   |
|   | F7  | Efforts to address material shortages  |
| Relief Sought (For Ongoing and Future Projects) | F8  | Future government relief programmes for your organisation  |
|   | F9  | Future government relief programmes at the employee level  |
|   | F10 | Reducing tax on services for the next 5 Fiscal years   |
|   | F11 | Reducing Tax on Goods for the next 5 Fiscal years  |
|   | F12 | Current relief policy of the government for your sector (2019–2021)  |
|   | F13 | Ban towards COVID-19 firing for private sector   |
|   | F14 | Policy plan for increasing the development of infrastructure with equal opportunities and support to the private sector. |
|   | F15 | Limiting shifts to 8 h and Increasing to three shifts for projects to engage surplus employees                           |
| New Safety measures adopted in the CI           | F16 | Use of face covering   |
|   | F17 | Use of gloves of any sort is mandatory for all site personnel  |
|   | F18 | Efficacy of social distancing  |
|   | F19 | Offering COVID-19 training to employees  |
|   | F20 | Paperless operations   |
|   | F21 | Predefined decision-making sops  |
|   | F22 | Implementation of social distancing  |

CI, construction industry.



### 3 Statistical analysis of COVID-19 factors and effective emerging practices

The next step in the systematic approach adopted to study the impacts of COVID-19 on the CI, while taking into consideration the representatives of the 3Cs, was to adopt a statistical approach to carry out analysis on a larger population size to determine the significant impact factors.

This research utilises the Importance Index ‘IMPI’, which is a statistical technique that is used to statistically rank the factors based on the degree of frequency and the degree of severity (Susmitha et al. 2018). In this technique, the IMPI is calculated as a function of frequency and severity indices. In this technique, both frequencies of occurrence and severity are spread on a 5-point scale with values of ‘1 to 5’. Both the Frequency Index (FI) and Severity Index (SI) are described hereunder.

a. FI

FI used to rank causes or factors based on the frequency of occurrence based on the identification by the participants of the survey.

$$\text{Frequency Index (F.I) (\%)} = \frac{\sum a ((n/N) \times 100)}{5} \dots$$

(Wilfred and Sharafudeen 2015)

Where:

- a* – Weightage given to each response (ranges from 1 to 5);
- n* – Frequency of the response;
- N* – Total no. of responses.

b. SI

SI is used to rank causes or factors based on the severity of occurrence based on the identification by the participants of the survey.

$$\text{Severity Index (S.I) (\%)} = \frac{\sum a ((n/N) \times 100)}{5}.$$

(Wilfred and Sharafudeen 2015)

Where:

- a* – Weightage given to each response (ranges from 1 to 5);
- n* – Frequency of the response;
- N* – Total no. of responses.

Subsequently, the IMPI of each factor is calculated as a function of both frequency and severity indices.

c. IMPI

$$\text{Importance Index (IMP.I) (\%)} = \frac{[\text{F.I. (\%)} \times \text{S.I. (\%)}]}{100}.$$

(Wilfred and Sharafudeen 2015)

### 3.1 Questionnaire survey

A 5-point Likert scale-based questionnaire was employed in the survey to gather the results from respondents. The respondents indicated their level of agreement using an ordinal scale (Bertram 2007). The respondents were requested to rate the factors from ‘1 to 5’ where ‘1’ indicates no impact or no chance of happening while ‘5’ depicts very high influence/impact or a very high chance of happening, as shown in Tables 5 and 6, respectively. The questionnaire survey based on the Likert scale from ‘1 to 5’ is used twice: once to assess the frequency of occurrence and second, to assess the severity of impact, as shown in Table 3.

Moreover, the questionnaire was designed in such a way that it collected the basic demographic data, like information on the participant, like the participant’s name and experience and current position in the company, and other requisite information like the participant’s organisation type, the scale of project based on several personnel, and COVID identified personnel within the firm and on the project, which were related to the research.

### 3.2 Sample population procedure and data collection

Considering the availability and ease of access, the post-COVID-19 restrictions period, and primarily the availability

Tab. 3: Likert scale frequency and SI.

| FI scale | F.I No.  | Strongly disagree<br>( <i>a</i> = 1) | Disagree<br>( <i>a</i> = 2)          | Neutral<br>( <i>a</i> = 3)         | Agree<br>( <i>a</i> = 4)           | Strongly agree<br>( <i>a</i> = 5) |
|----------|----------|--------------------------------------|--------------------------------------|------------------------------------|------------------------------------|-----------------------------------|
|          | Question |                                      | Frequency ( <i>n</i> )               | Frequency ( <i>n</i> )             | Frequency ( <i>n</i> )             | Frequency ( <i>n</i> )            |
| SI scale | S.I No.  | No impact<br>( <i>a</i> = 1)         | Negligible impact<br>( <i>a</i> = 2) | Marginal impact<br>( <i>a</i> = 3) | Moderate impact<br>( <i>a</i> = 4) | Major impact<br>( <i>a</i> = 5)   |
|          | Question |                                      | Frequency ( <i>n</i> )               | Frequency ( <i>n</i> )             | Frequency ( <i>n</i> )             | Frequency ( <i>n</i> )            |

SI, severity index.

of funds, the data were collected through a snowball sampling technique considering the respective SMEs (Shafi et al. 2020). Snowball sampling is a type of non-probability sampling technique that is used for the sample population size, that is, the probability that every unit or respondent included in the sample cannot be determined. It is a widely used technique for its time and cost-related benefits (Bo Liu et al. 2014).

An exhaustive list of CI stakeholders, that is, owners, consultants and contractors, was prepared as a first step using mainly the Pakistan Engineering Council's (PEC) comprehensive list of consultants and contractors. An initial screening was done to identify stakeholders working mainly in the major cities of Pakistan, primarily with public sector buildings and infrastructure-related projects. Certain dominant firms in the industry were particularly included in the sample. The clients selected were mainly decision-makers belonging to executing agencies and ministries that were responsible for delivering large infrastructure projects in road, water, power and railways. There are 41,025 registered companies of consultants, clients and contractors registered with the PEC. Out of these many registered consultants and contractors, some were out of business and some were out of the project domains.

Therefore, to adopt the most accurate sample size for this non-probabilistic approach, a finite population sample check was applied using the equations of well-known researchers (Wiegand 1968; Arain and Pheng 2005):

$$n = n' \quad \text{Eq. 1}$$

$$(1 + n'/N)$$

Where:

$n'$  = Sample size from infinite population =  $S^2/V^2$ ;

$n$  = Sample size from a finite population;

$N$  = Total population (41,025);

$V$  = Standard error of sample population equal to 0.05 for confidence interval 95%;

$S^2$  = Standard error variance of population,  $S^2 = P(1 - P)$ ; Maximum  $P = 0.5$ .

The sample size for the target population was calculated as follows:

$$n' = S^2/V^2 \quad \text{Eq. 2}$$

$$n' = (0.5)^2 / (0.05)^2 = 100$$

$$n = 100 / (1 + 100/41,025) = 100$$

Thus, the sample population considering the margin for the client bodies was selected as 125. Therefore, 125 participants from the 3Cs of the CI were selected, and to

achieve this desired number, the number of participants per organisation was increased to three.

### 3.3 Data collection

The designed questionnaires were distributed in the local CI of Pakistan for a detailed survey. Responses to these questionnaires were collected via emails, Facebook, WhatsApp, LinkedIn and hard copies. The complete data collection period took over 02 months in which initially the data were collected electronically, whereas in the later phase the participants were approached for the interviews.

### 3.4 Statistical analysis and simulations

The software analysis and simulations for this research were majorly carried out by importing the data collected from the questionnaires into the Predictive Analysis Software PASW-18.0 version formerly known as statistical package for the social sciences (SPSS-18). It is a statistical software developed by IBM for data management, multivariate analysis and advanced analysis.

### 3.5 Validity and reliability tests

The validity and reliability of the research instrument are essential in research data collection. Here in this study, the research instrument was questionnaires. Thus, an application of a validity test was carried out on the data collected from the participants and all the questionnaires were valid for the reliability of the data test. Afterwards, the test regarding the reliability of data was carried out in which 31 items of the FI questionnaire were considered. In the scale of reliability test, the value of Alpha was computed as 0.879, which is considered to be very reliable. It is also important to mention here that only 31 cause factors as established from the pilot studies were included in this FI questionnaire, and not the emerging practices, as it intended to first collect the frequency of occurrence among these points.

### 3.6 Importance Index (IMP.I) analysis of factors

To obtain the IMP.I, the data from the first questionnaire, which involved 31 COVID-19 impact factors, were analysed for the authentic values. The  $N$  value of valid responses for

this survey was 101, which is 80% and considered appropriate. Although the desired number of responses was increased to 125, however, owing to the delayed response and time factor of the research the number of responses

was settled at 101 responses for each survey. The result of the FI text is the percentage of FI developed from the score awarded by the participants to each cause factor for assigning ranking, as shown in Table 4.

**Tab. 4:** IMP.I for COVID-19 impact factors.

| No. | No. of responses 'N' | Total score of frequency | Total score of index | FI (%) | SI (%) | Imp. index (%) | Rank |
|-----|----------------------|--------------------------|----------------------|--------|--------|----------------|------|
| F1  | 101                  | 201                      | 235                  | 39.8   | 36.68  | 14.60          | 29   |
| F2  | 101                  | 144                      | 210                  | 28.5   | 35.21  | 10.03          | 18   |
| F3  | 101                  | 145                      | 199                  | 28.7   | 23.60  | 6.77           | 11   |
| F4  | 101                  | 247                      | 271                  | 48.9   | 22.66  | 11.08          | 22   |
| F5  | 101                  | 126                      | 181                  | 25.0   | 48.94  | 12.24          | 24   |
| F6  | 101                  | 98                       | 188                  | 19.4   | 32.81  | 6.37           | 9    |
| F7  | 101                  | 78                       | 161                  | 15.4   | 31.50  | 4.85           | 4    |
| F8  | 101                  | 75                       | 148                  | 14.9   | 18.50  | 2.76           | 1    |
| F9  | 101                  | 245                      | 292                  | 48.5   | 17.60  | 8.54           | 14   |
| F10 | 101                  | 244                      | 269                  | 48.3   | 11.80  | 5.70           | 6    |
| F11 | 101                  | 175                      | 237                  | 34.7   | 11.33  | 3.93           | 2    |
| F12 | 101                  | 245                      | 242                  | 48.5   | 21.65  | 10.50          | 19   |
| F13 | 101                  | 194                      | 259                  | 38.4   | 36.00  | 13.82          | 27   |
| F14 | 101                  | 137                      | 204                  | 27.1   | 27.46  | 7.44           | 13   |
| F15 | 101                  | 128                      | 191                  | 25.3   | 18.41  | 4.66           | 3    |
| F16 | 101                  | 190                      | 225                  | 37.6   | 17.67  | 6.64           | 10   |
| F17 | 101                  | 148                      | 205                  | 29.3   | 33.78  | 9.90           | 17   |
| F18 | 101                  | 142                      | 206                  | 28.1   | 42.90  | 12.05          | 23   |
| F19 | 101                  | 197                      | 250                  | 39.0   | 27.24  | 10.62          | 20   |
| F20 | 101                  | 180                      | 253                  | 35.6   | 34.60  | 12.32          | 25   |
| F21 | 101                  | 149                      | 224                  | 29.5   | 48.82  | 14.40          | 28   |
| F22 | 101                  | 146                      | 199                  | 28.9   | 17.01  | 4.92           | 5    |
| F23 | 101                  | 128                      | 214                  | 25.3   | 27.29  | 6.90           | 12   |
| F24 | 101                  | 108                      | 183                  | 21.4   | 29.34  | 6.28           | 8    |
| F25 | 101                  | 81                       | 209                  | 16.0   | 36.07  | 5.77           | 7    |
| F26 | 101                  | 152                      | 223                  | 30.1   | 31.21  | 9.39           | 15   |
| F27 | 101                  | 190                      | 241                  | 37.6   | 45.22  | 17.00          | 31   |
| F28 | 101                  | 141                      | 219                  | 27.9   | 48.20  | 13.45          | 26   |
| F29 | 101                  | 152                      | 203                  | 30.1   | 36.50  | 10.99          | 21   |
| F30 | 101                  | 176                      | 251                  | 34.9   | 28.23  | 9.85           | 16   |
| F31 | 101                  | 166                      | 265                  | 32.9   | 45.30  | 14.90          | 30   |

FI, frequency index; IMP.I, importance index; SI, severity index.



### 3.7 Severity Index (SI) analysis of emerging practices and requirements

The 22 factors under the emerging practices and requirements as established from the pilot studies were put under the severity test and made part of the SI questionnaire as a separate section aside from the 31 cause factors of COVID-19, as shown in Table 5.

## 4 Results and discussion

This section discusses the important results and findings alongside drawing the comparative analysis of the major impact factors with that found in the literature review to establish a sense of the key impact factors globally impacting the 3Cs. First, the key statistical facts representative of the sample population as gathered from the questionnaire

Tab. 5: S.I.% values for the emerging practices.

| No. | No. of responses 'N' | S.I. (%) | Rank |
|-----|----------------------|----------|------|
| F1  | 101                  | 37.5     | 8    |
| F2  | 101                  | 38.75    | 15   |
| F3  | 101                  | 43       | 18   |
| F4  | 101                  | 35.5     | 4    |
| F5  | 101                  | 36.25    | 5    |
| F6  | 101                  | 37.25    | 7    |
| F7  | 101                  | 37.75    | 10   |
| F8  | 101                  | 38       | 11   |
| F9  | 101                  | 37.5     | 9    |
| F10 | 101                  | 36.75    | 6    |
| F11 | 101                  | 38.25    | 12   |
| F12 | 101                  | 38.5     | 13   |
| F13 | 101                  | 32.75    | 1    |
| F14 | 101                  | 34.75    | 2    |
| F15 | 101                  | 47.25    | 21   |
| F16 | 101                  | 46.25    | 20   |
| F17 | 101                  | 38.5     | 14   |
| F18 | 101                  | 39.5     | 17   |
| F19 | 101                  | 39       | 16   |
| F20 | 101                  | 45       | 19   |
| F21 | 101                  | 48       | 22   |
| F22 | 101                  | 35       | 3    |

S.I. severity index.

survey like participation stats, percentage of participants with years of experience, province-wise participation stats and participation stats of the public and private sectors are shown in Figures 3–6.

### 4.1 COVID-19 affected personnel statistics from 3Cs

A major question in the questionnaires was included in the opening section, regarding the number of identified and recognised COVID-19-affected personnel within the participant’s organisation. This question provided the potential numbers as options for the number of participants as >10 but <20, >20 but <50, >50 and <100 and lastly >100. The comprehensive results from a study comparing the percentage of the number of affected persons within the representative organisations, as shown in Figure 8, clearly establish the point of view that 63% of Contractors had the greatest number of COVID-19-affected personnel above the number of 100. This resulted from taking into account the total number of participants with 101 from each survey counting to 202 participants in total. However, as the number of participants from each organisation increased, therefore, only the shortlisted participants from unique organisations accounting for 84 participants from the 3Cs representative of different organisations were taken to present the results in Figures 7 and 8.

It is also pertinent to mention here that data obtained from survey participants did not account for any mortalities which rendered the mortality figure among the workforce as an insignificant figure. This was primarily because organisations and participants were found to be hesitant to share such data, which was rather a limitation to obtaining direct mortality statistics among the workforce. However, during the interviews, two mortalities during the period were pointed out by the participants and the causes of mortality were associated with COVID-19. Furthermore, during the same period, there was a restriction on the full-strength presence of the workforce owing to which the statistics about absentees were also rendered insignificant and inaccurate as marking attendance like bio-metric and other means were not practiced as a precautionary measure.

### 4.2 Key impact factors and disruptions caused by COVID-19 for 3Cs

This study carried out a comprehensive statistical analysis while taking into account all three stakeholders of the CI of Pakistan. It was found that among all impact factors

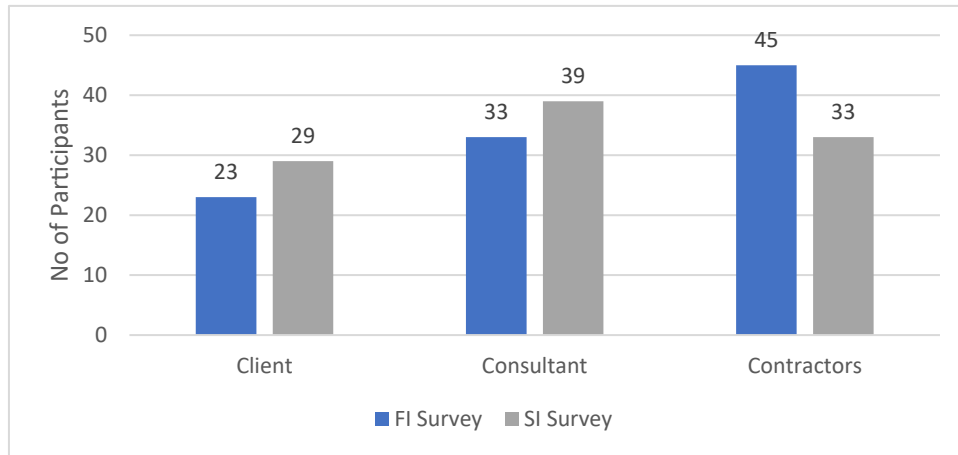


Fig. 3: Participants statistics for FI and SI survey. FI, frequency index; SI, severity index.

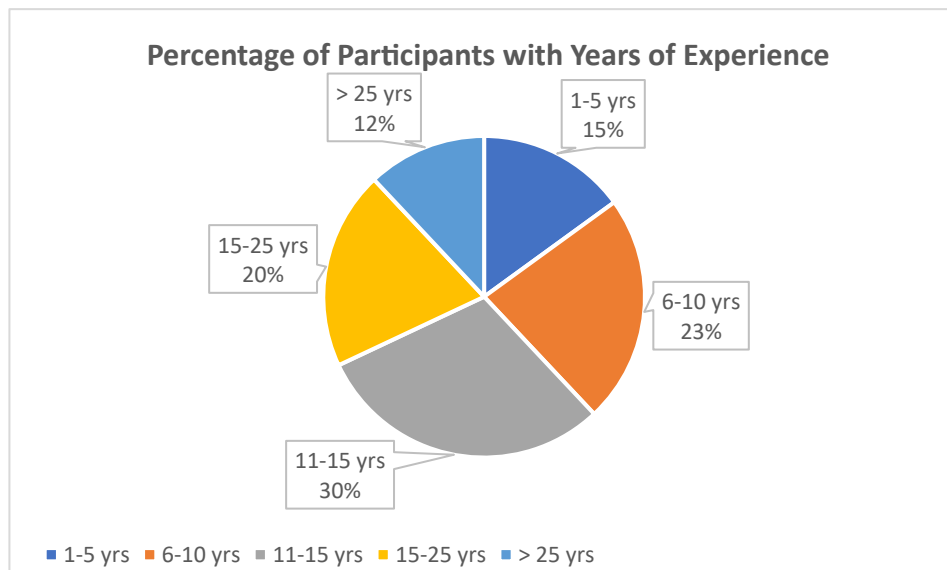


Fig. 4: Survey participant experience statistics.

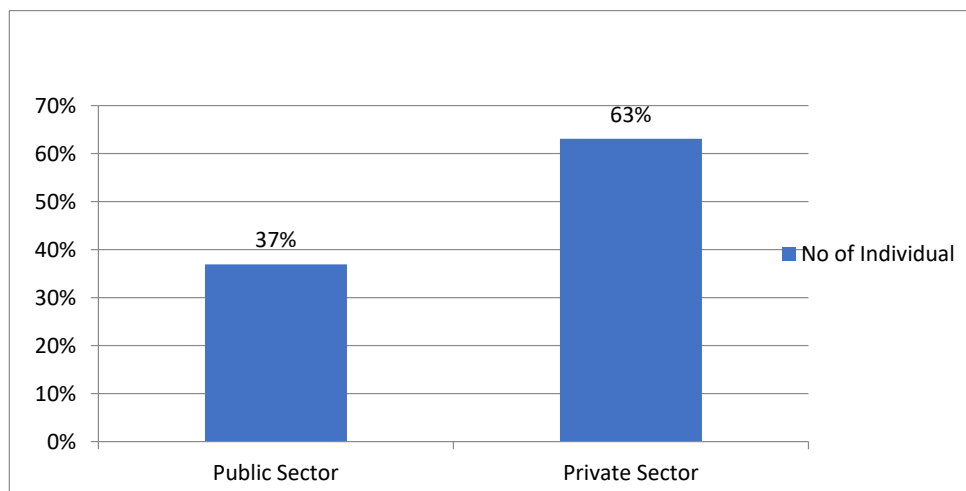


Fig. 5: Province wise participation statistics (Azad Jammu Kashmir & Gilgit Baltistan, Baluchistan, Sindh, Khyber Pakhtunkhwa, Punjab).

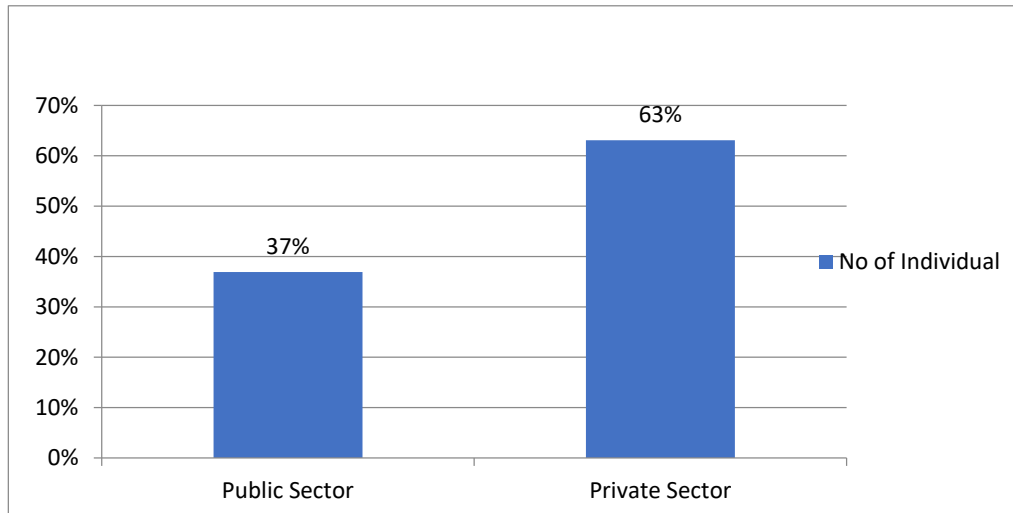


Fig. 6: Public sector vs private sector participation statistics.

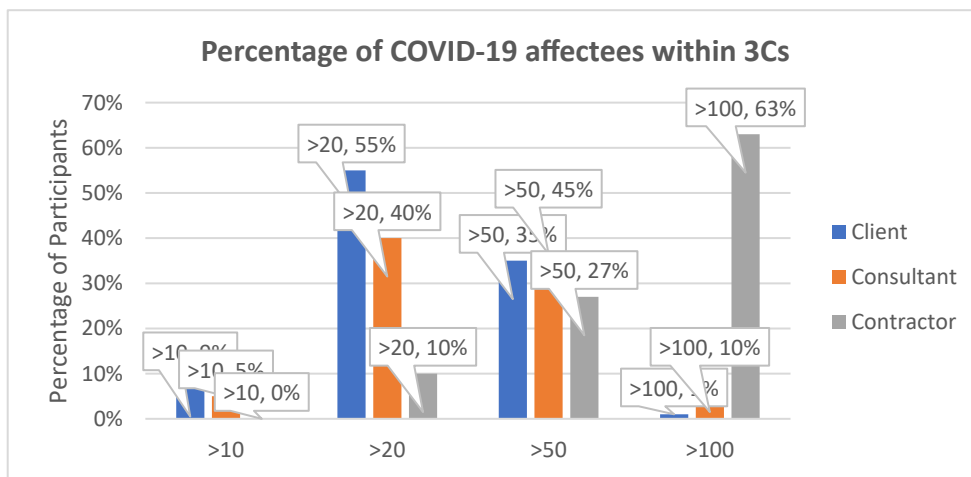


Fig. 7: Organisational percentage corresponding to the number of COVID-19 patients.

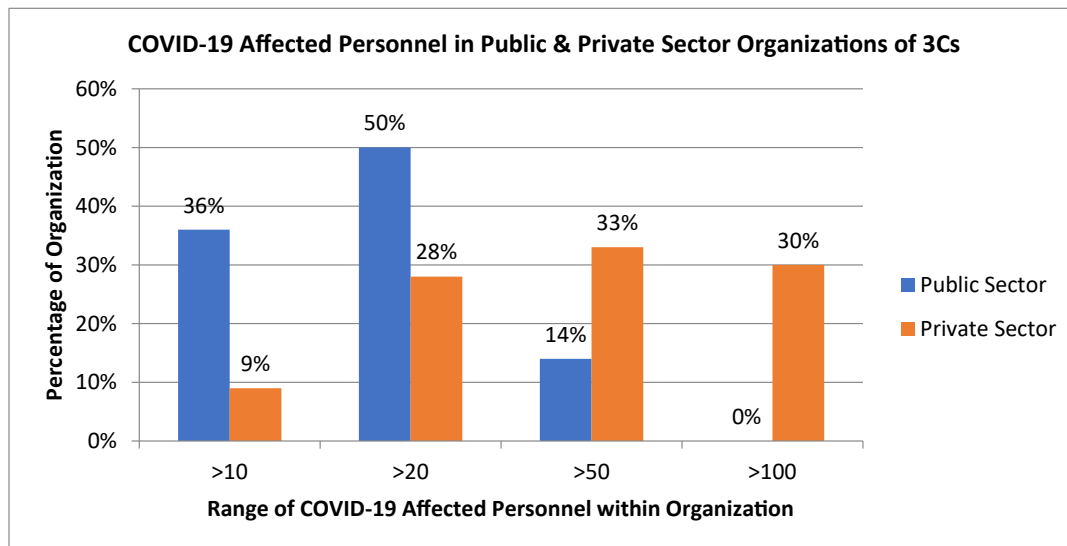


Fig. 8: COVID-19 affected personnel within the organisation (public vs private sector).

some factors majorly impacted the operational practices of 3Cs. The ranking of such impact factors was developed based on the IMP.I and the six leading major impact factors are presented for further discussion and relevance concerning the 3Cs, as shown in Table 6.

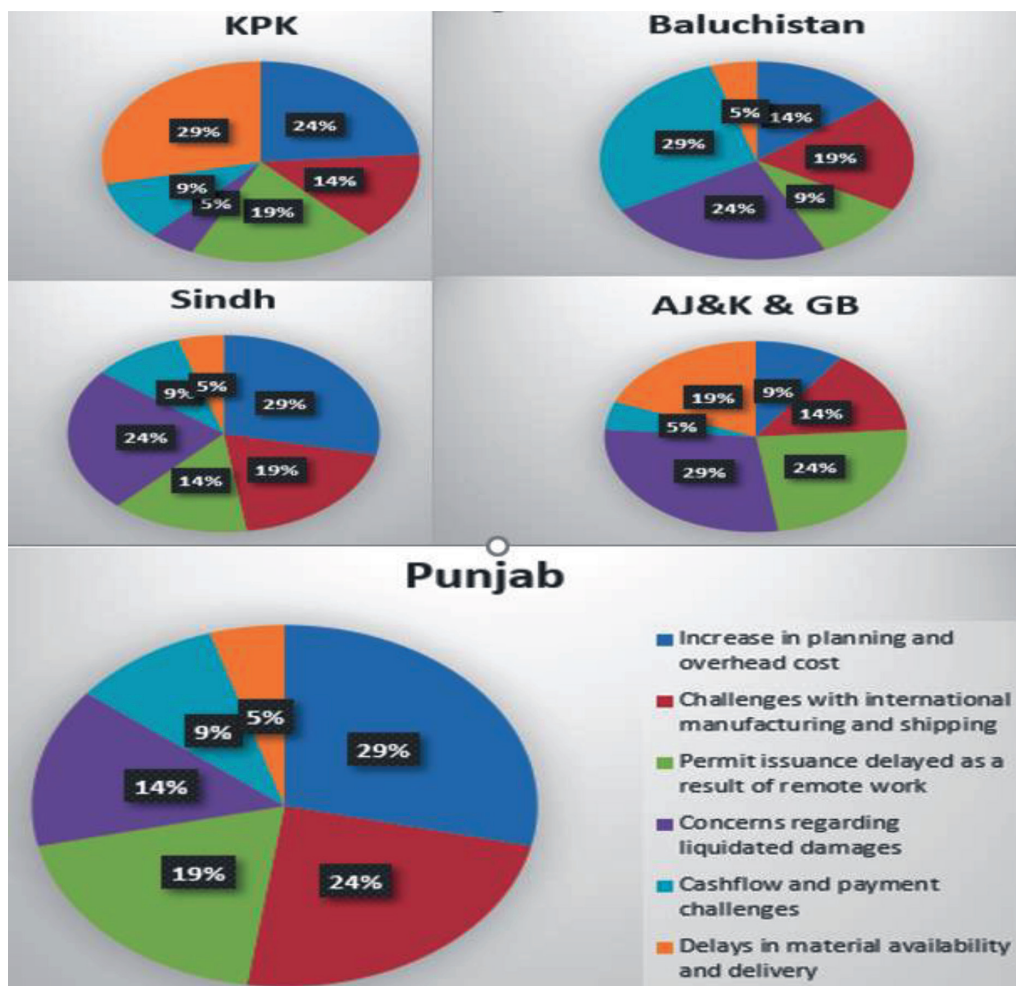
The increase in planning and overhead costs had been ranked as the most important impact factor by the 3Cs of

the CI (Ogunnusi et al. 2021). This is primarily because even during the work suspension, the employees were to be retained and paid, which substantially increased the overhead charges of all the organisations. This resulted in increased overheads of the contractor and reduced the contractor’s profit (Thapa and Priyanka 2020).

Challenges with international manufacturing and shipping were ranked second and the delays in material availability and delivery were ranked sixth. It was assessed that both these factors being related to the supply chain had overlay. The global supply chain had been broken and managing the projects in such cases had been challenging for even global contractors during the pandemic period (Thapa and Priyanka 2020). During the early months of the pandemic, many contractors were unable to source basic materials, such as sand, cement and bricks, while they also suffered from labour shortages. For example, in the United Kingdom, a national shortage of plaster led to significantly increased costs (Marsh 2021). The supply chain crisis had another negative impact on the project

**Tab. 6:** Key impact factors or disruptions caused by COVID-19 for 3Cs.

| No. | Description  | Rank |
|-----|--|------|
| F8  | Increase in planning and overhead cost                   | 1    |
| F11 | Challenges with international manufacturing and shipping | 2    |
| F15 | Permit issuance delayed as a result of remote work       | 3    |
| F7  | Concerns regarding liquidated damages                    | 4    |
| F22 | Cash flow and payment challenges                         | 5    |
| F10 | Delays in material availability and delivery             | 6    |



**Fig. 9:** Province-wise impact contribution of key impact factors.

costs in the form of abnormal increase in rates and prices of the materials on which the escalation of price adjustment had not been paid. Moreover, the rates quoted by the Contractor before the pandemic were left inappropriate (Hanif and Usman 2021). Other than the permit issuance delays, concerns regarding liquidated damages, cash flow and payment challenges were ranked among the top 6 by the participants as key impact factors of the COVID-19 pandemic. The statistics of each key impact factor in the provinces of Pakistan are shown in Figure 9.

It is critical to understand that the increase in planning and overhead cost was the first and foremost factor that impacted all three stakeholders of the construction project industry, irrespective of the province. This factor contributed to a maximum of 29% in both Punjab and Sindh Provinces, whereas it was 24% for KPK and the least in AJ&K & GB, at 9%. These statistics are compatible with studies abroad where an average 27% increase in the overall cost of the project was reported due to extended overheads owing to the COVID-19 pandemic (Thapa and Priyanka 2020; Ogunnusi et al. 2021).

### 4.3 Key emerging practices as pointed out by 3Cs

Aside from the prime objective of this study, which was to study the COVID-19 pandemic impact across the 3Cs, the secondary objective was to establish a list of emerging practices and the requirements or reliefs sought by the 3Cs to tackle the post-pandemic and future risks and to develop a readiness at the government level. This study ranked the six leading practices among numerous practices, as shown in Table 7. These six leading practices were carried forward to establish the relevance with the 3Cs.

According to AGC, 40% of the contractor firms had to lay off half of their staff due to the COVID-19 outbreak.

Tab. 7: Key emerging practices as pointed out by 3Cs.

| No. | Description  | Rank |
|-----|--|------|
| F13 | Ban towards COVID-19 firing for private sector   | 1    |
| F14 | Policy plan for increasing the development of infrastructure with equal opportunities and support to the private sector. | 2    |
| F22 | Implementation of social distancing  | 3    |
| F4  | Limiting shifts to 8 h and Increasing to three shifts for projects to engage surplus employees                           | 4    |
| F5  | Digitising the construction site monitoring and inspection system  | 5    |
| F10 | Reducing tax on services for the next 5 Fiscal years   | 6    |

Moreover, as a result of the slowing down of construction projects, 27% of the construction companies globally had either furloughed or laid off their project-based employees (Ward and Emily 2020). During this study, the participants greatly favoured and even solicited legislation and regulations regarding the ban on firing or laying off employees during the work suspension period. This was especially required for the private sector in Pakistan as most of the government clients and authorities offer permanent employment, whereas the consultants and contractors are mostly private bodies. According to labour unions, around 75% of Pakistan’s total 65 million labour force is unregistered (Latif and Aamir 2020).

### 4.4 Implementation of social distancing

The implementation of social distancing and other safety policies and their enforcement by the client departments was key to continuing safe operation of the construction. It required the development and updating of plans and procedures for both office and job site operations compliant with the most updated standards, regulations and orders, including advice and counsel regarding Occupational Safety and Health Administration (OSHA) standards (Chivilo et al. 2020).

Digitalising construction site monitoring was a major factor and was imperative for economic restart after the shutdown. It was obvious that without the use of advanced technology, the performance gap could not be filled (ECEC 2021). The use of latest engineering communication techniques like 4D and 5D BIM could be used to bridge the gap developed as a result of the pandemic.

Another aspect that may be brought to reduce the exposure of individuals to the site was by limiting the working shift of the construction site workers to 8 h. The average work shift on fast-track mega projects in Pakistan was around 10–12 h, which greatly increased the risk of contracting the pandemic. This limitation in shifts with no overtime can create more jobs with increased productivity, which was otherwise limited due to on-site permit issues and regulations.

### 4.5 Comparative analysis of key impact factors and emerging practices with pilot studies

There was a dearth of studies providing key impact factors or otherwise nominating specific factors that were to be dealt with by the public and private sectors while tackling



**Tab. 8:** Comparison of significance of key impact factors (of current study) with factors analysed in similar studies around the world.

| Sr. No. | Impact factors (this study)                              | Similar literature reviewed issue identified | Study origin                       | Significance of impact factor from literature review |                 |
|---------|--|--|------------------------------------|--|-----------------|
|         |  |  |                                    | Significant  | Non-significant |
| 1       | Increase in planning and overhead cost                   | Assaad and El-Adaway (2021)                  | Iran                               | ✓  | –               |
|         |  | Alsharef et al. (2021)                       | United States of America           | ✓  | –               |
|         |  | Tariq and Umar (2021)                        | Gulf Cooperation Council Countries | –  | ✓               |
|         |  | Thapa and Priyanka (2020)                    | Nepal                              | ✓  | –               |
| 2       | Challenges with international manufacturing and shipping | Assaad and El-Adaway (2021)                  | Iran                               | ✓  | –               |
|         |  | Alsharef et al. (2021)                       | United States of America           | –  | ✓               |
|         |  | Thapa and Priyanka (2020)                    | Nepal                              | –  | ✓               |
| 3       | Permit issuance delayed as a result of remote work       | Assaad and El-Adaway (2021)                  | Iran                               | ✓  | –               |
|         |  | Alsharef et al. (2021)                       | United States of America           | ✓  | –               |
|         |  | Tariq and Umar (2021)                        | Gulf Cooperation Council Countries | ✓  | –               |
| 4       | Concerns regarding liquidated damages                    | Assaad and El-Adaway (2021)                  | Iran                               | ✓  | –               |
|         |  | Alsharef et al. (2021)                       | United States of America           | –  | ✓               |
|         |  | Hansen and Seng (2020)                       | Indonesia                          | ✓  | –               |
|         |  | Tariq and Umar (2021)                        | Gulf Cooperation Council Countries | ✓  | –               |
| 5       | Cash flow and payment challenges                         | Assaad and El-Adaway (2021)                  | Iran                               | ✓  | –               |
|         |  | Alsharef et al. (2021)                       | United States of America           | ✓  | –               |
|         |  | Iqbal et al. (2021)                          | China                              | –  | ✓               |
|         |  | Thapa and Priyanka (2020)                    | Nepal                              | –  | ✓               |
| 6       | Delays in material availability and delivery             | Assaad and El-Adaway (2021)                  | Iran                               | ✓  | –               |
|         |  | Alsharef et al. (2021)                       | United States of America           | ✓  | –               |
|         |  | Iqbal et al. (2021)                          | China                              | ✓  | –               |
|         |  | Wang et al. (2020)                           | Global                             | ✓  | –               |
|         |  | Tariq and Umar (2021)                        | Gulf Cooperation Council Countries | ✓  | –               |

the pandemic. In this section, a comparative analysis of the six major impact factors as found out in this study with other studies of the region and the world is shown in Table 8, to highlight the most significant and globally impacting factors.

The critical analysis also considered similar studies carried out globally to find out the most critical factors as (i) permit issuance delayed as a result of remote work and (ii) delays in material availability and delivery. Whereas, other factors had also been found significant from the literature review except for the developed countries like the United States of America and the Gulf Cooperation Council where the CI was much more advanced. However, the study in Pakistan's neighbouring country Iran being a developing country possessing similar construction traits had similar significant impact factors as a result of COVID-19.

The permit issuance delay as a result of remote work had been highlighted as an important and key factor by many studies, because public sector employees were much more relaxed outside their jobs as compared with the private sector. Moreover, the major number of client departments were public sector organisations from all over the world (Francis et al. 2013). So this was a global issue being faced by the contractors, which should be dealt with by a quick communication and decision-making process. The simplest way to accelerate was that the client and the consultant should avoid delays in approving documents and decision-making by setting out clear rules and regulations while working from home using digitalisation techniques (Eik-Andresen et al. 2016).

The 'delays in material availability and delivery' were a key factor primarily because of discontinuation of national and international supply chains due to the pandemic,

and even the most efficient contractors were not able to meet the planned progress (Alsharaf et al. 2021). A study carried out on 12 tunnel construction projects globally identified a shortage of materials as the third most significant risk impact factor in project delay and failure (Wang et al. 2020). The mitigation plan involved multiple measures that were already being implemented around the globe at both national and provincial levels. These measures included timely communication and planning with suppliers, seeking assistance from the local government and coordinating with the transport department. However, the success of the aforesaid measures would depend on the active interest and radical steps of the concerned departments (Wang et al. 2020).

## 5 Conclusions and recommendations

- The six major impacts of the COVID-19 pandemic on the 3Cs of the CI in Pakistan with the order of their ranking or impact are (i) increase in planning and overhead cost, (ii) challenges with international manufacturing and shipping, (iii) permit issuance delayed as a result of remote work, (iv) concerns regarding liquidated damages, (v) cash flow and payment challenges and (vi) delays in material availability and delivery.
- The critical analysis of the six key impact factors deduced two factors: (i) permit issuance delayed as a result of remote work and (ii) delays in material availability and delivery as the most significant globally. It clearly elaborates the relevance and importance of the findings of this study for the CI stakeholders in both developing and developed countries.
- The significant affected party chalked out during the study was the contractor, the greatest number of impacted personnel, that is, 63% of representative organisations of the contractors having more than 100 COVID-19 affected personnel, as compared with the other stakeholders. Whereas, the consultant being dependent on the running project had been found struggling with managing the finances. This impact could be reduced by implementing pertinent legislation and directing the relief for the most affected parties.
- The six emerging practices and exit strategies for COVID-19 were found as key to tackling such situations in the future for the 3Cs.
- It is recommended that advanced statistical analysis techniques may be applied to the research to closely evaluate the long-term impacts of such a pandemic and the emerging practices on the productivity of the construction projects.

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