

CAPITAL UNIVERSITY OF SCIENCE AND
TECHNOLOGY, ISLAMABAD



**Impact of COVID-19 on Activity
Execution and Resource
Management at Local Construction
Sites**

by

Faisal Yaseen

A thesis submitted in partial fulfillment for the
degree of Master of Science

in the

**Faculty of Engineering
Department of Civil Engineering**

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I want to dedicate this achievement my parents, teachers and friends who always encourage and support me in every crucial time.



CERTIFICATE OF APPROVAL

Impact of COVID-19 on Activity Execution and Resource Management at Local Construction Sites

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List of Publications

It is certified that following publication(s) have been made out of the research work that has been carried out for this thesis:-

1. Yaseen, F., Qadeer, A., and Ali, M. (2022). "An overview of Construction projects to deal with COVID-19." *1st International Conference on Engineering and Applied Natural Sciences Konya, Turkey. Paper ID: 740.*

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In the Name of **Allah**, The Most Gracious, The Most Merciful. Praise be to God, the Cherisher and Sustainer of the worlds. All thanks to Almighty **Allah**, The Lord of all that exist, who bestowed me with His greatest blessing i.e. knowledge and Wisdom to accomplish my task successfully. Thousands of salutations and benedictions to the **Holy Prophet Hazrat Muhammad (PBUH)** the chosen-through by whom grace the sacred Quran was descended from the Most High.

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Abstract

The construction industry is the largest industry in the world and it contributes to many socioeconomic indicators. Construction work are considered the biggest source of economic growth, and development, these activities play a significant role in uplifting the economy of the country. In developing countries, the construction sector is more significant because it provides earning sources to the public. The pandemic of COVID-19 hit construction sector very hard and caused significant loss to sector. The pandemic disrupted the on-going operation of construction work at sites. Since the application of work from home was not feasible for the construction activities as practical work must be performed on sites, which resulted in halation and postponing of construction work at projects. During the pandemic it was challenge for managements to manage the resources at projects. Construction projects demand a unique combination of labour and material inputs on-site in order to perform various activities. Unfortunately, construction projects have to face the availability and management problem of both human resources and material resources due to pandemic.

The current research explores the impacts of COVID-19 on activity execution and resource management at local construction sites. The objective of this study was to evaluate the impact of identified factors on activity execution and resource management of local construction sites. After a comprehensive literature review, different impact factors were identified. These factors were then categorized into different impact areas. Based upon these areas, a questionnaire was developed and authenticated by using Delphi technique. The developed questionnaires were distributed among industry professionals of different organizations to assess impact of COVID-19 on activity execution and resource management. The response of industry professionals was analysed using statistical analysis package SPSS. To assess the reliability of sample, data was analysed against the reliability test. Normality test was applied on data to identify the distribution pattern of the data. Corelation analysis was used to describe the type of corelation between the variables. The application of regression analysis defines the impact of COVID-19 pandemic on activity execution and resource management of local construction sites.

While performing the reliability analysis each section of variables resulted Cronbach's Alpha value higher than 0.7 which provided the justification for the reliability of the data. The distribution pattern of the data was assessed, the results of tests showed, p value greater than 0.05 which indicated the normal distribution of the data. There is a strong correlation of the COVID-19 pandemic with activity execution, and moderate correlation with resource management. While analyzing the impact of COVID-19 pandemic on activity execution results revealed that unexpected and unpredicted environment of pandemic caused an increase of 0.52 units of impacts on activity execution at local construction sites for every single unit of its increased impacts on society. While analyzing the impact of COVID-19 pandemic on resource management results revealed that unexpected and unpredicted environment of pandemic caused an increase of 0.49 units of impacts on resource management for every single unit of its increased impacts on society. The overall results of this study helped to develop strategies to continue construction work at sites in case of COVID-19 like future pandemic. This study refers to the analysis of COVID-19 pandemic on local construction sites of Pakistan that has not been still established.

Keywords: COVID-19 Pandemic, Construction Industry, Delphi Technique, Identified Factors, Human Resources, Questionnaire, Material Resources, SPSS

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Abbreviations

ABM	Agent-Based Modelling
CDMS	COVID-19 Decision Making System
COVID-19	Coronavirus Disease 2019
HIV	Human Immunodeficiency Virus
HR	Human Resources
HRM	Human Resource Management
LLCI	Lower Level of Confidence Interval
NHRM	New Human Resource Management Practices
RNA	Ribonucleic Acid
SCM	Supply Chain Management
SCO	Supply Chain Orientation
SPSS	Statistical Package for the Social Sciences
TB	Tuberculosis
ULCI	Upper Level of Confidence Interval
WHO	World Health Organization

Chapter 1

Introduction

1.1 Background

The construction industry is the largest industry in the world and it contributes to many socioeconomic indicators. It has the ability to improve the quality of people lives so its impact on their lives can't be denied [1]. Construction activities are considered the biggest source of economic growth, and development. Construction activities play a significant role in uplifting the economy of the country. In developing countries, the construction sector is more significant because it provides earning sources to the public. The construction sector accounts for the highest share of the economy in these developing countries. It is a very important tool used by governments to manage the economy. For example, when there is a high unemployment government uses the construction sector to increase public expenditure. Construction projects are helpful in providing employment because they required significant labor for operations. The labor is the integral part of construction projects as they carry out the burden of work and contributes significantly in the success of the project.

Construction projects demand a unique combination of labor and material inputs on-site in order to perform various activities [2]. Construction activities requires proper management for the attainment of desired product. The management of the construction projects is more complex and challenging due to the lack of technology usage within construction projects [3]. Unfortunately, the implementation process of technological

reforms in construction industry is too slow. This leads to cost inefficiencies, project delays, poor quality performance, uninformed decision making and poor performance [4]. In order to counter these challenges, construction industry needs innovations to pave the way [5]. The innovations and advancement will improve the organization's performance by making management of planning and monitoring easier, furthermore they enhance productivity [6].

The outbreak of corona virus disease (COVID-19) back in 2019 caused considerable loss to the construction industry. Virus has intense capability to blowout between human, so limits were enforced from the authorities which concentrated the human workforce availability with regions. The construction industry is dependent on many other industries like the manufacturing industry, transportation, trade etc. Hence, closing of these industries and strict environment due to COVID-19 created many challenges to manage the construction work at projects. COVID-19 also impacted the material industry which is the major supporter of the construction industry. This resulted in the unavailability of materials at construction sites. The management team of construction projects with the assistance of Human resources and by applying certain measures and approaches on material builds the project. Human resources are the vital for any project, while materials are the main element of construction projects. During the pandemic of COVID-19 construction projects faced the problem of inaccessibility and management of both human resources and material resources. While these two are the most crucial resources for construction projects.

COVID-19 hit the construction industry gravely its effects were severe that most of the construction projects were halted. During the lockdown, the halation of construction activities on-site caused a decrease in construction output [7]. At the same time, COVID-19 is the opportunity to analyze the challenges of the construction sites and discuss the possible solutions for working in the pandemic environment. Such a working environment is also a test for the management team's capabilities to take the maximum output from restricted input of resources and management. While most of the management teams were unable to tackle such situation properly due to the lack of planning. Such situation demands extra efforts in planning, execution of plans and upgrading on regular bases for continuation of work.

1.2 Research Motivation and Problem Statement

Construction projects involves multiple stakeholders having different responsibilities and preferences which makes it difficult for managers to properly manage the project activities and to address the challenges. In any construction projects one of the important and tough ask for managers is to properly manage and utilize the resources in order to perform the construction operations in efficient way. In most cases, the proper utilization of the resources decides the succes of the projects. Five types of resources are involved in construction projects which are Human resources, Material resources, Equipment resources, Financial resources and Information resources. Human resources are the most valuable resources for any organization, in construction projects they are more significant as they carry out the whole process of construction work. Availability and proper management of human resources is crucial for the success of the project. Materials are the main and basic components for any construction project. Construction projects demands the availability of materials on time, according to requirement and as per quality. With the help of worker management uses material to build a unique unit of construction project according to demands.

Construction sites faced a significant loss with the outbreak of COVID-19. The pandemic of COVID-19 severely affected the sufficient availability of human resources and material resources at construction projects. Since the effects of COVID-19 were worldwide and almost every industry suffered a lot due to spraeding pattern of the virus. There were shutdowns of manufacturing industry which made the unavailability of material like cement, bricks, steel etc on site. Which eventually affected the performance of the projects. Meanwhile the application of work from home was not practical for construction projects as physical activity must be conducted on site. The illness from COVID-19 and unavailability of some proper vaccine and later on work in shifts by following the SOPs decreased the required human resources for construction projects. Electronic methods were available for the circulation of information resources and banking for the transfer of financial resources. But the availability and management of both human resources and material resources was problematic for the management during the COVID-19 pandemic [8]. The research motivation is as follow;

Analyzing the challenges of managing construction work at projects. Construction sites were fully operational until it hit severely by the COVID-19 pandemic. Due to COVID-19 pandemic there were contractual problems material shortage, Labour unavailability and many more. All this forced the suspension of construction work at projects and eventually projects were closed. Construction sector has to face huge loss due to lack of proper planning and guidance during pandemic days. It was challenge for management to keep the project on track with minimum resources and also to plan accordingly while facing the abstraction in supply chain. Moreover, this study provides the strategic guidelines to deal such circumstances in future in case of such pandemic. The problem statement is as follow;

The pandemic of COVID-19 infected the entire world and disrupted the entire system. Due to COVID-19 pandemic, authorities faced serious challenges to manage the normal routine life of public. Pandemic forced the people to stay in homes and industries suspended their operations. The corona virus, along with other industries affected the construction sites severely. It created challenging situation for management to manage the construction work at site. In this situation of pandemic, it was challenge for construction firms to manage the resources properly.

1.2.1 Research Questions

Following are research questions which are explored in this study.

- Is data for current study complete and accurate?
- Is data collected for current research linear i.e., continuous, normally distributed?
- Is the correlation of COVID-19 pandemic with activity execution and resource management modest, moderate or strong?
- How the increase of COVID-19 pandemic impacting completion of project, adoption of new methods, technology use, workplace safety, circulation of information and resource management?
- What were the impacts of COVID-19 on society, managing of construction work and resource management within projects?

1.3 Overall Objective of Research Program and Specific Aim of this MS Research

To develop feasible guidelines for coping various prevailing issues in the construction industry of developing countries, particularly Pakistan, for smooth and safe execution of construction activities.

The specific objective of this MS thesis is to evaluate the impact of COVID-19 pandemic on activity execution and resource management at local construction sites for developing guidelines at different levels in order to counter any pandemic similar to COVID-19 at construction sites in future..

1.4 Scope of Work and Study Limitations

The performance of the construction projects during the pandemic of COVID-19 is examined in terms of challenges to manage the construction work at site. The overall impact of COVID-19 on the construction industry around the globe has been examined by literature review. The issues and challenges faced by management while managing the resources at construction projects during COVID-19 have been investigated by a questionnaires survey. At the end the steps and measures are provided to manage the construction work in case of any such pandemic in future.

This study is limited to construction projects being carried out in Islamabad only. Questionnaires survey is conducted from the construction firms situated only within of Islamabad. The literature review is an integral part of this research to review the impact of COVID-19 around the globe, while articles on COVID-19 are available from 2019 onward. In resource management only human resources and material resources are considered.

1.4.1 Rationale Behind Variable Selection

Resource management selected on the superiority of most crucial part of construction projects. Due to the absence or the lack of technology in construction sector puts enormous pressure on manager while managing the resources in normal days. During the

COVID-19 management has to face the problem of shortage of human resources and unavailability of material at construction projects. Morgan formula has been used for the calculation of sample size which is based on target population. It is the simplest formula and provides identical sample sizes in all cases where t value can be adjusted accordingly. For data collection purposes the projects working within Islamabad were selected due to the diverse nature of the projects within region and easy access. Construction projects were targeted who were operation before the pandemic. Consultant, contractors and client firms were selected for the data collection purposes. Due to the normal distribution pattern of the data parametric testing has been used.

1.5 Novelty of Work, Research Significance and Practical Implementations

The outbreak of COVID-19 halted the construction operations around the globe. To develop recovery strategies because of the loss from the COVID-19 pandemic to construction sector extensive research is required to analyze the impacts of the pandemic on construction sites. But little research has been carried out for investigating the impacts of covid 19 on construction sites. In a previous study the impacts of COVID-19 pandemic were analyzed to assess the cost impact on the construction projects [9]. The impacts of COVID-19 pandemic in terms of construction demand, output, prices and project performance were investigated [7]. To the best of author's knowledge, no research has been conducted in local construction sites on the impacts of COVID-19 on construction activity execution and resource management. Thus, current research analyses the impact of pandemic on activity execution and resource management challenges faced by management during COVID-19. In result this study will propose strategies to respond any COVID-19 like future pandemic at the construction projects.

As the effects of Covid-19 were around the world and almost every industry faced the challenges to keep their operations on track, construction sites also faced similar condition. Unfortunately, the management found it tough to analyze the impacts and plan the recovery strategies due to the complex nature of construction sector and spreading pattern

of the pandemic. Moreover, to develop some recovery plans it is important to analyze COVID-19 pandemic and construction sector together. On the other hand, it's tough to measure the direct loss to construction industry because of its complex nature of construction industry and spreading pattern of the pandemic. Unfortunately, very limited studies are available on the impacts of COVID-19 on construction activity execution and resource management. Therefore, it is important to develop strategies to counter any COVID-19 like pandemic at construction projects in future. Hence there is need to investigate the impact of COVID-19 on construction sites.

Pandemics usually effects the population on larger area for longer time and in most cases, they disrupt the routine life of public. As a results of this research work, it present guidelines for government level, organization level and project level to tackle any future pandemic similar to COVID-19 at construction projects. If there is any pandemic having severity and spreading pattern like COVID-19 these developed guidelines will be useful to continue the construction work in pandemic. The developed guidelines will help to create a safe working environment with in construction project in case of future pandemic similar to COVID-19.

1.6 Brief Methodology

In this structured qualitative study, the impact of COVID-19 on the construction industry is analyzed. The overall impact of COVID-19 on the local construction industry and the challenges faced by management while managing the resources at construction projects are investigated by a questionnaires survey. The questionnaire survey is based on rating survey question type. The rating ranges from 1 to 5 (1 for very low and 5 for very high). The survey is divided into three parts, The first part consists of the information that the management has about the COVID-19 and its impacts on common life and society, The second part consists of the COVID-19 impact on the construction industry and how it affected the performance of the construction projects, The third part is specific about the management it includes the challenges faced by management while managing resources during COVID-19. The Respondent's personal information is only limited to Age, Gender, Education, and Experience. After formulating the questionnaire Delphi

Technique is applied to refine the question and identify the error. The data is collected physically and by using online resources (social media and Email addresses). The brief description of current study is shown in the **Figure 1.1**.

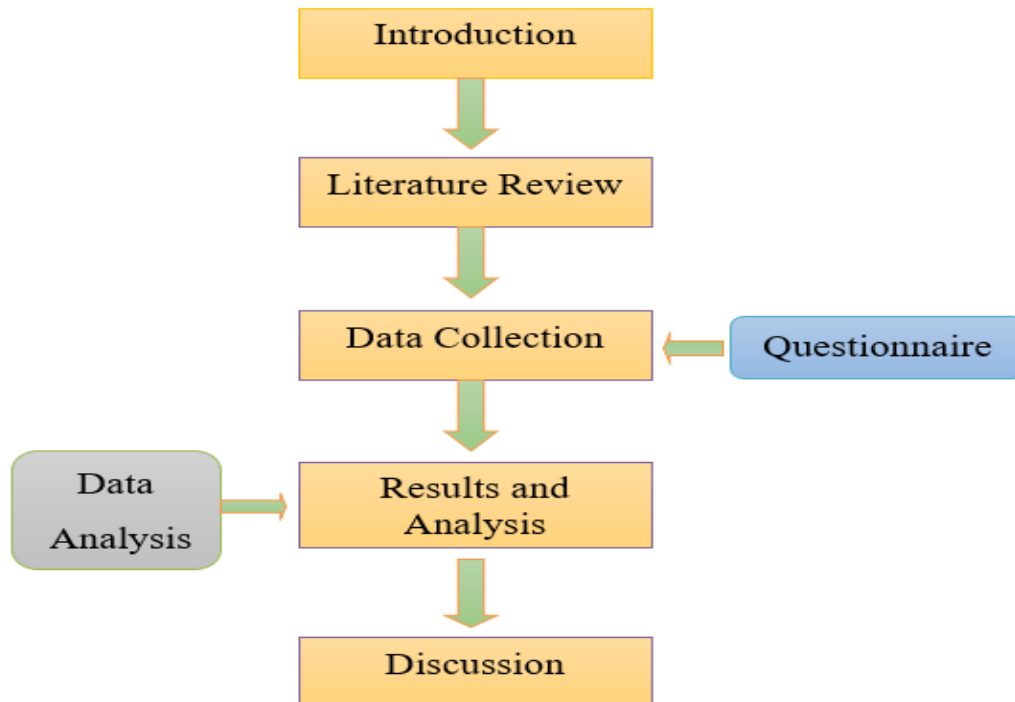


Figure 1.1: Flow Chart of Current Study

1.7 Thesis Outline

There are a total of six chapters in the thesis. The overview of these chapter is provided below:

Chapter 1 is introduction which covers the background, research motivation and problem statement, overall objective and specific research aim, scope of work with study limitations, Novelty of work, brief methodology, and thesis outline.

Chapter 2 Chapter 2 contains the literature review. It compromises of background, The COVID-19 pandemic, Overview of COVID-19 pandemic, Impacts of COVID-19 on society, Impact of COVID-19 on construction sites, COVID-19 and construction sites, Management of construction work during COVID-19, Resource management during COVID-19, Human resources, Material resources, and Summary.

Chapter 3 Is about the methodology. It includes Research design, Preliminary study, Data collection, Literature review, Questionnaire development, Data acquisition, Data analysis, and summary.

Chapter 4 consists on results which are obtained from questionnaire survey and their analysis. It describes the background, impact of COVID-19 on Construction industry, Challenges while managing resources during COVID-19, Status of the Ongoing projects, Future of New projects, and summary of the chapter 4.

Chapter 5 consists on practical implementations of study, background, Guidelines at government level, guideline at organization level, guidelines at project level and summary.

Chapter 6 Consists of Conclusions and future recommendations.

Chapter 2

Literature Review

2.1 Background

Construction industry is considered as a backbone for any country. It plays a significant role in uplifting the economy of nations. The success of the construction sector within a country describes the worth of the country. It is a major contributor for providing the earning resources to public in developing countries. In this study it has been discussed that COVID-19 along with the other industries impacted the construction industry severely. Construction projects faced multiple barriers in operating system due to the pandemic, which forced the halation and postponing of construction work at sites. In this study it has been reported that within construction projects COVID-19 made it tough to manage the resources.

2.2 The COVID-19 Pandemic

Pandemic usually causes economic downturn, and also causing income level to decrease and job loss. COVID-19 is the latest pandemic which hit the world, it is caused by the severe acute respiratory syndrome coronavirus 2. It affected people of different ages in different ways. The common symptoms of pandemic in humans are fever, dry cough, fatigue and they may range from undetectable to deadly. It also triggered severe social and economic disruption around the globe, pandemic also caused the largest global recession.

It completely changed the life style of the public for the longer time, initially authorities were helpless to assess the situation and react accordingly. The disruption of supply chain caused widespread shortage including food shortage, medical facilities shortage etc. It also created alarming situation at the medical centers, a huge number of patients turns to hospitals due to the infection from COVID-19 pandemic.

2.2.1 Overview of COVID-19 Pandemic

Pandemics affects the population over a larger area and usually reduces the direct human contact. Pandemics bring challenging situations for governing bodies as they alter and disrupt the whole working processes within the country and considered the biggest danger to the global economy. The severity of a pandemic depends upon its nature and spreading pattern; however, it is considered that developing countries are more vulnerable to the pandemic as they have fewer resources. While in some cases the pandemics may affect equally across the countries regardless of the available resources and facilities as a counter measure against pandemic with in a country or region. Viral infections are the major reasons behind the morbidity and mortality of humans worldwide [10]. Coronavirus is the latest viral infection of respiratory pathogens which caused high morbidity and mortality around the globe in recent years. COVID-19 originated in December 2019 in Wuhan, China and World Health Organization (WHO) declared it a pandemic in March 2020[11].

The initial cases of COVID-19 were reported in Wuhan, China in December 2019, while the first case outside China was reported in Thailand in the mid of January 2020[12]. After this, it started to spread quickly along the other countries of the world and in very short time it spread all over the world. COVID-19 is an RNA virus, because of the presence of glycoproteins spikes on its envelope it has a crown-like appearance under an electron microscope [13]. COVID-19 spread in quick succession around the globe, it considered a lethal disease due to its infectious nature. Based on Severity, Scope and Cause COVID-19 is totally different from the previous crises [12]. The symptoms of COVID-19 appeared in two categories which are shown in **Table 2.1**. These are the common symptoms which were reported in the patients infected from the COVID-19. The appeared symptoms in patients were the results of early diagnostic and these mild

symptoms may trigger the patient health in to severe condition depending upon the age and immunity of patients. The symptoms were divided into two types depending upon the condition of the patient Mild symptoms and severe conditions.

Table 2.1: Symptoms Types in COVID-19

Types of Symptoms	Symptoms
Mild Symptoms	Fever Cough Sore throat Myalgia
Severe Condition	Failure of Multiple organ Acute respiratory distress syndrome (Building up of the fluid in lungs) Pulmonary edema (The abnormal building up of fluid in lungs) Pneumonia (Infection which is the reason for the air sacs in single or both lungs)

There were mild symptoms of severe fever, high Cough, Sore throat of severe condition and Myalgia (Cramps and pain in muscles) and the other category includes the severe condition of multiple organ failure (failure of two or more organs), acute respiratory distress syndrome (Building up of the fluid in lungs), Pulmonary edema (Building up of fluid in abnormal way) and Pneumonia (Infectious nature of one or both lungs which is the reason for air sacs). These all symptoms were the indication of the presence of virus in human respiratory system. The patients may recover from the mild symptoms after quarantine and some medication, while recovery from severe conditions is tough and may

lead towards death. The virus may be transmitted through different modes, transmission may be well established or unclear Table 2.2 sums up the situation. The virus may be transmitted from the person to person via direct contact due to droplet transmission, this happens when there is close contact with the infected person. The virus may also be transmitted from animals to humans due to airborne transmission.

Table 2.2: COVID-19 Virus Transmission Modes

Transmission Well Established	Transmission Unclear
The transmission of virus via direct contact due to droplet spread from human to human	The transmission of virus via direct contact due to airborne transmission from human to human
Animal to human transmission due to airborne transmission	Human to human transmission via indirect contact

Different complications due to the cytopathic effect of the virus, dysregulated immune response, co-infections and pulmonary embolisms are the reasons behind the respiratory symptoms [16]. Most of the infected persons have a mild illness (80%), 14% have serious and 5% have a critical illness, the mortality appeared to be more common in older people and those with comorbidities [17]. Infecting a body on continuous bases coronavirus may cause autoimmune disease, some of the autoimmune disease which are triggered by the coronavirus are Multiple Sclerosis, Rheumatoid Arthritis, Systemic Lupus Erythematosus etc. [18]. In addition to the direct health impact on humans COVID-19 pandemic also caused serious disruption in healthcare facilities of other diseases such as human immunodeficiency virus (HIV) and tuberculosis (TB) [19]. As medical staff received the instruction from the authorities to pay full attention to the patients suffering from the COVID-19. The schematic diagram of COVID-19 infection and its prevention includes a series of functional processes, main scheme of the COVID-19 Decision-Making System (CDMS) is shown in **Figure 2.1**. **Table 2.3** lists the main blocks with CDMS functions.

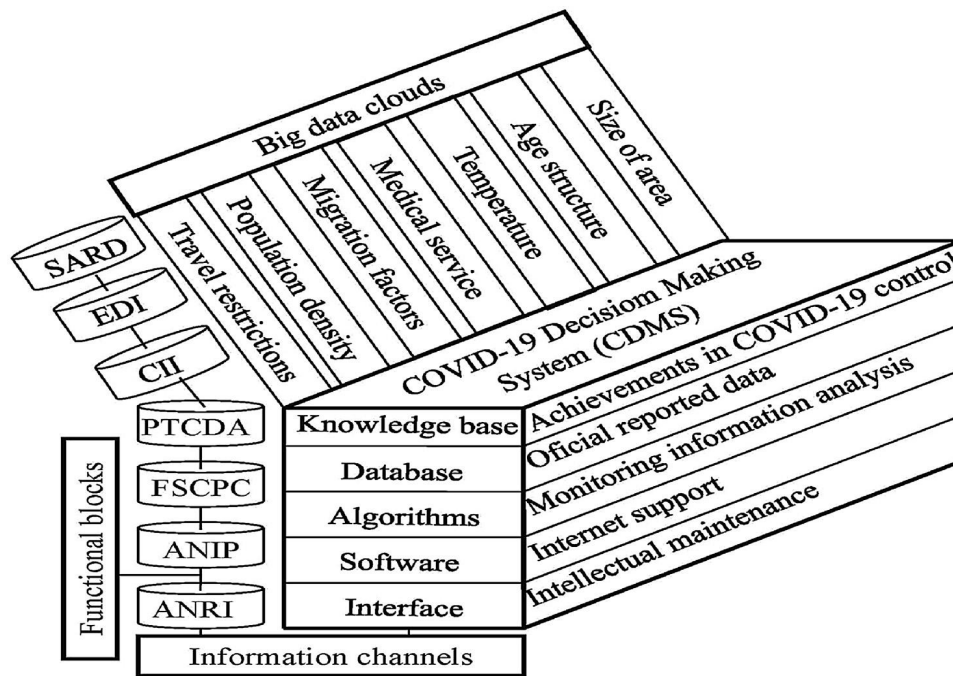


Figure 2.1: Main Structure of COVID-19 Decision Making System (CDMS) [20].

2.2.2 Impact of COVID-19 on Society

COVID-19 not only effected the personal lives of many across the world, but also the entire economics, industries and nations around the globe. There were severe healthcare delivery

Table 2.3: CDMS Functional Blocks and their Characteristics

Block	Block Function
SARD	Statistical analysis of the reported data
CII	Calculation of the instability indicator
ANIP	Assessment of the number of infected people
ANRI	Assessment of the number of recovered individuals
EDI	Estimate of dead individuals
PTCDA	Prognosis of trends in COVID-19 pandemic aftereffects
FSCPC	Formation of scenarios for COVID-19 pandemic control

disruptions around the globe because of the COVID-19 pandemic [21]. Distribution of healthcare and imported related services across the patients were non-universal and people with pandemic related income changes may be a vulnerable subgroup [22]. COVID-19 also impacted the use of technologies, **Table 2.4** Comprises the technologies which were evolved as a result of pandemic. The importance of the usage of technology in routine life can't be denied, it has become a major part of human lives. It is assumed that when there is a crisis its impacts are negative on society, but COVID-19 pandemic impacted the use of technology in a diverse way. The pandemic provided the opportunity to use the technology in more efficient way to gain maximum out from it. For example, pandemic forced the shutdown of manufacturing industry but at the same time it forced the more production of medical equipment as per requirement. However, the consequences may be debatable either they are short time or long time. The pandemic of COVID-19 created a problematic situation for the organizations, they faced new business challenges, with individual employees adopting to new ways of working, and the alterations of interpersonal interactions and relationships [24].

Supply chain disruptions and widespread shutdowns crimped production, however, demands seem to have hit hard, as the emergency shutdowns also forced the people to stay in homes, there was a dramatic decrease in consumer spending and business spending has dried up [25]. The direction of staying at home or self-isolation, as well as the duty of care by essential workers, puts immense hassle on transportation requirements and stream [26]. It's challenges to enumerate the precise dimension of this pandemic as it is mandatory to signify the all cases incorporating not just critical and indicative cases but also minor ones [27]. It's important to have community understanding about disaster stipulating rational judgement of probable risks without building hassle and worry [28]. International Airlines suspended their operations due to the imposed restrictions. During the initial period of lockdowns, there were remarkable reductions in Carbon dioxide emissions because of the restrictions which were imposed on international air transportation and industrialization [29].

Covid-19 is the latest pandemic which hit the world severely and created the challenging situation for the authorities. It originated in China in December 2019 and quickly spread to the other parts of world. First case outside china was reported in Thailand. The

Table 2.4: Short-Term Consequences of COVID-19 Crisis on Technology

Sr.No	Technology	Short Time Consequences (1 to 18 months)
1	3D printing	Increase in the manufacturing of the medical equipment (which will be used for patients of COVID-19 on priority bases) for hospitals and medical organizations including medical NGOs
2	Flexible manufacturing systems	Quick modification of invention procedure to assemble immediately required medical expedients during epidemics
3	Big data analytics	Influence to the quicker progress and supply of new vaccines
4	Health care wearables	Detachment diagnostics, handling, and supervising of patients
5	E-learning	Temporary choice for schooling beneath quarantine.
6	E-gaming	Substantial rise in e-gaming events and contributions molded on offline game
7	Videoconferencing	Additional of in-person consultations due of quarantine
8	Internet Streaming	There were no opportunities to visit cinemas, etc., heading to melodramatic damage of incomes for all subdivisions of the culture industry, particularly live presentations such as concerts, operas, etc., as well as the belated launch of new artists and work
9	Cashless payment	Fall in the rate of infection through the reduced use of cash, there were more of tax collection
10	E-commerce and home delivery	Bigger mandate for e-commerce in all exaggerated countries while corporeal supplies are controlled or smooth closed.

WHO declared it pandemic in March 2020. Even in developed countries it created sudden pressure on healthcare and forced the shortage of medical facilities. The situation was worst in developing countries due to less facilities and insufficient planning. People were forced to stay in homes to avoid the human contact. Industries were closed which also forced the unemployment. The borders were closed, Airlines suspended their operations, this put enormous pressure on demand to supply ratio.

2.3 Impact of Covid-19 on the Construction Sites

Construction industry is considered as a backbone of economy for any country. The pandemic of COVID-19 created challenging situation for the management of construction projects. Due to the pandemic construction projects faced the problem of labor shortage, supply chain issues, and financing pressure. New working methods were adopted to manage the work during the pandemic.

2.3.1 COVID-19 and Construction Sites

The role of construction industry is significant in shaping the existing built environment [30]. Construction sector is considered as one of the most employment provider sector around the globe. The outbreak of COVID-19 impacted the construction work management worldwide. The construction work may cause serious risks to workers' health because of the pandemic [9]. Even in developed countries COVID-19 created challenging situation for the management and impacted the ongoing activities at construction projects. However, the impacts of COVID-19 on the construction sector of developing countries were severe due to the traditional working methods. The impacts of COVID-19 were significant on organizations and the construction sites as there was Social, Economic, Financial and Operational disturbance because of the pandemic [31]. The replacement of construction activities with online activities is impossible, as construction activities must be performed on field where the construction workers are going to interact with each other, this increases the risks of getting COVID-19[32].

The interaction of workers at field is mandatory because multiple workers are required for performing task purpose. The pandemic caused many challenges and delays in the completion of projects because of Changes in law, Financing pressure, Supply chain disruptions, Lack of Human resources, Workforce restrictions, Unavailability of materials and equipment, Contractual implications, Claims and Suspension of Construction projects [33]. It's a challenge to deliver safety in construction on normal days, working with hazardous material and exposure to a harmful condition that impacts respiratory function may trigger health problems related to COVID-19[34]. Complex systems often take the form of hierarchies in the sense that they are composed of multiple subsystems that further consist of subsystems of their own, and so on. In the absence of occupational and public health measures, the construction ecosystem and nature of construction work activities pose a risk of communicable disease transmission [35]. There for proper health and safety guides were necessary to continue the construction work during the pandemic, but unfortunately most projects of developing countries were facing lack of guidance and medical facilities. It is impossible to quantify the exact and subsidiary effects of COVID-19 pandemic on construction industry because of the exceptionality of the sector to both advanced and emerging countries and regions [36]. Because of the severity and duration of COVID-19, it's hard to recover quickly from the loss caused by the pandemic to the construction sites.

2.3.2 Management of Construction Work During COVID-19

During the pandemic of COVID-19, it was a challenge for the managers to maintain the level of job satisfaction for employees, proper coordination with employees and encourage them to have the required level of performance in tasks [37]. It is assumed that the internal marketing has a key function in maintain and boosting employees job gratification enhancing organizational engagement and increasing performance beneath unknown situations [38]. A study proposed an enquiry of the impact of internal marketing on job satisfaction, mission performance and counterproductive job actions in perspective of COVID-19 pandemic **Figure 2.2**.

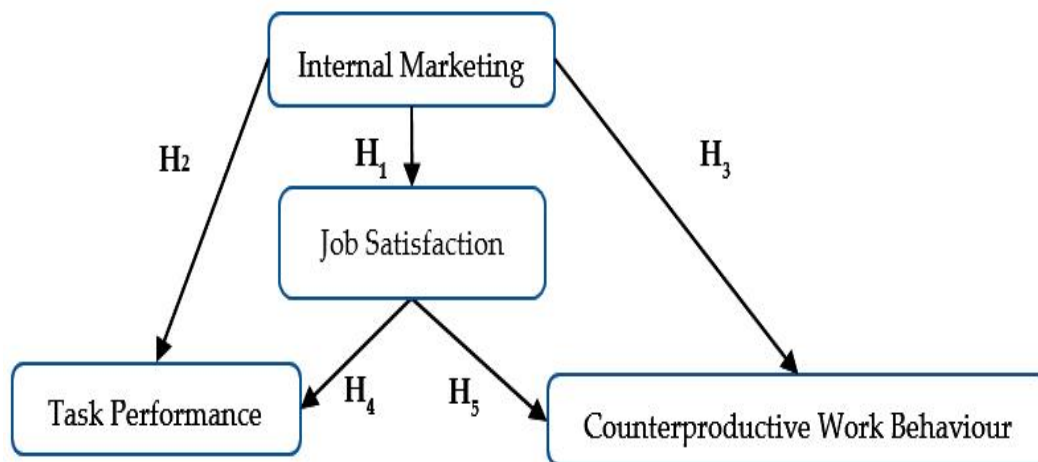


Figure 2.2: The Influence of Internal Marketing on Job Satisfaction, Task Performance and Counterproductive Work Behavior [37]

H1: The job satisfaction influenced by internal marketing

H2: Task performance influenced by internal marketing.

H3: Counterproductive work behavior influenced by internal marketing.

H4: The task performance influenced by internal marketing.

H5: The counterproductive work behavior influenced by internal marketing.

Highly volatile, uncertain, complex and ambiguous environments perform the dual function for the organizations, such situations create threats and opportunities for the organization to be innovative and creative that how they address the challenges of the unpredicted events [39]. The outbreak of COVID-19 pandemic is the prime example of such a condition, there are social distancing parameters, shortage of workforce, work in shift, unavailability of materials and challenges of managing resources properly, at the same time there is room for rapid adjustment. In the COVID-19 pandemic case, organizations were unable to provide sufficient required information to employees about the management plan and intended reaction to the pandemic, whereas clear information about the task to employees is mandatory for better performance [40]. The establishment of better communication is important for the success of the project [41]. A higher level of Human resource management practices is important to increase labor productivity while predicting the productivity associated with implementations of HRM is vital for the projects [42].

Araya 2021, proposed Agent-based modelling to recognize the effect of employing several labor shifts to reduce the reach of COVID-19 amongst construction workforces, Figure 2.3 shows the concept of the model and its component. The model accounts for the health position of workforces concerning the spread of COVID-19. Agent-based modelling approach is a study approach which is used to study the complicated schemes which are established on the concept that by modelling the discrete fundamentals of a complicated system [43]. ABM eases the execution of modelling tactics focused on the discrete components.

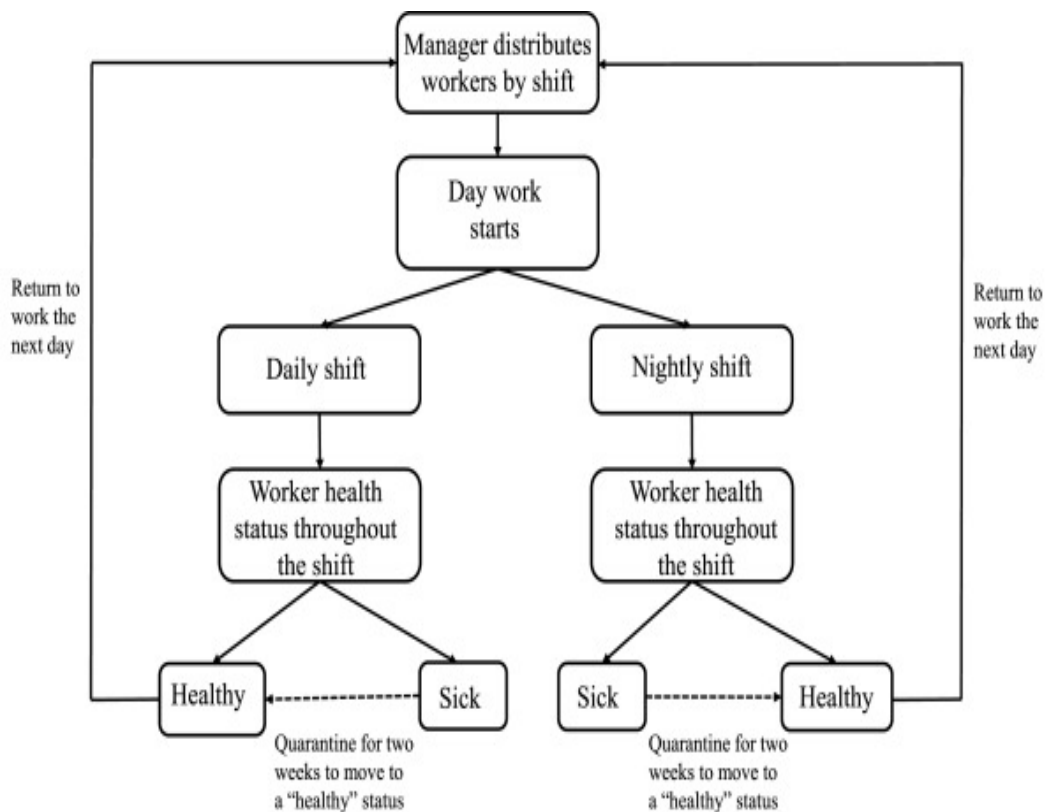


Figure 2.3: Abstraction of the Model along with Components[44]

The model includes one type of agent which represents construction labors inside the project. The agent changeover amongst being employed on the project and departure from the project for the next working day. The simulation begins for each working day, with the assignment of corresponding day and night shifts to workers from manager. Once the construction worker agent arrives at the working period, the status of health is simulated, with the two outcomes of results either healthy or sick due to COVID-19. The worker which is categorized as unwell must go to quarantine for 14 days (two weeks),

once this period is over and the health status of worker changes from sick to healthy, he can return to the project on next operational day at project. As the COVID-19 spread through the contact of human, it is supposed adding of shift in working system could decrease the likelihoods of becoming infected by the COVID-19 as the same workers are performing the same work in different times. This assumption is taken from the public policy of minimizing the COVID-19 by applying the social distancing [45]. He used only two shifts in this model as the existing pandemic requires the operations of cleaning and disinfecting as one shift ends.

Impacts of COVID-19 pandemic were diverse on the construction projects. Either the work of construction projects was halted or changed, new projects were paused to avoid the problems in future during the pandemic until the situation becomes satisfactory to start the project. New methods were adopted to continue the work, and the adoption of these new construction methods changed the direction of the whole process. There were social distancing implications, the use of personal protective equipment, work in shifts and a lot of new strategies were implemented in construction projects to recover from the loss.

2.4 Resource Management During COVID-19

Depending upon the nature and type of work construction projects are the temporary organizations, they demand the availability of resources on time, to the correct site and according to the rules set by management [46]. Five types of resources are involved in construction projects which are Human resources, Material resources, Equipment resources, Information resources and Financial resources. The outbreak of COVID-19 pandemic impacted the management of every resource but its effects were severe on Human resources and material resources. The management of resources is crucial for the success of the project, improper management of resources may lead to the wastage of material, conflicts, cost overrun, delays etc. Therefore, it is important to manage the resource properly within projects to gain maximum output out of them. While during the pandemic of the COVID-19 the proper management of resources was major concern for the project management team.

2.4.1 Human Resources

The progress of construction process is restrained by either work or resource accessibility, however resource availability is established by resource strategies and supervisory choices, which can be completed separately of the construction system [47]. Construction workforces are considered as one of the supreme flexible resources which are immersed in construction projects [48]. HR is the practice through which management sizes the workforce and attempts to produce the human performance that the organization desires [49]. The availability of human resources and their involvement is crucial for the success of the project. Fig. 2.4 presents the structural model for the human resource planning framework. During the pandemic, construction projects were facing the problem of both unavailability and involvement of the workers. With the outbreak of COVID-19 a condition of abrupt and volatile estrangement and crisis of the previous models have emerged which clearly demonstrated the need to understand the challenges ahead in interpreting the future roles of HR [50].

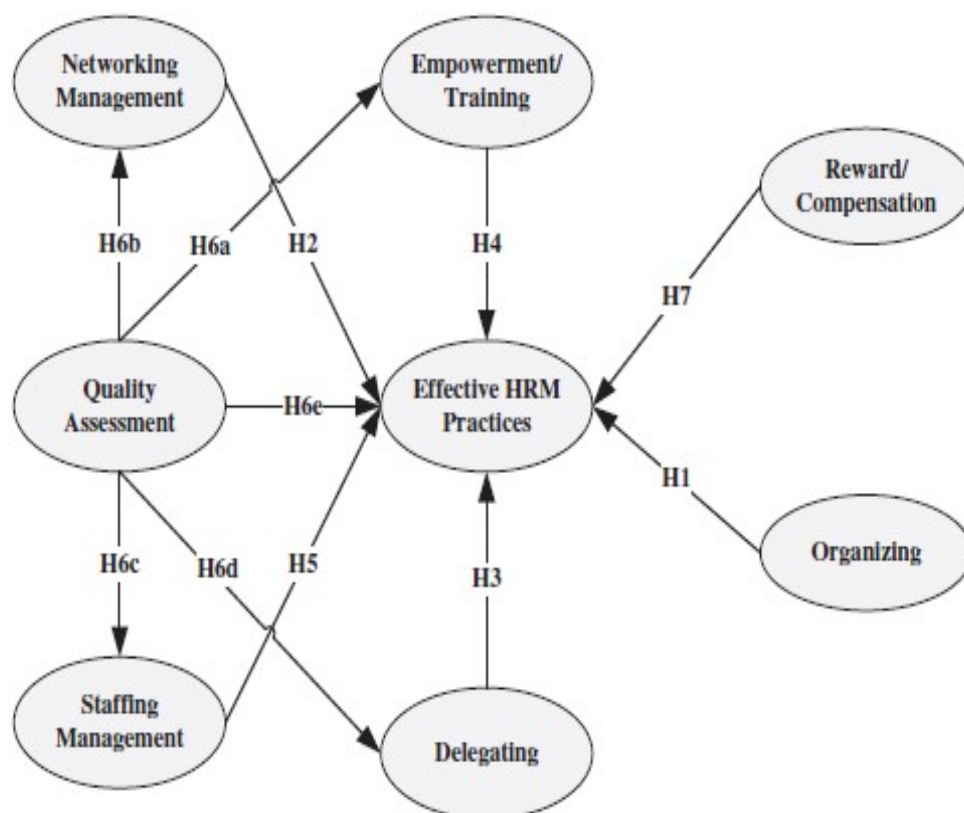


Figure 2.4: HR-Planning Framework Structural Model [51]

It is inflated to ascribe the responsibility of the pandemic negative social and economic consequences to people management practices [52]. The other factors may be more significant in all negative consequences of pandemic, like poor judgement of policy makers, slow reaction of public health officials and nature of virus. In the presence of the pandemic, it is important for the management of construction workforce to shift from the outdated objective of workforce operation to accomplish a prolific and cost-effective project and integrate how the spread of COVID-19 may stimulus the workforce executing various construction activities all the way through a construction project [53]. Human resource management is of strategic importance in all organizations, it's contribution in the success of organization is significant, it also creates competitive advantages for the organizations [54]. The aggressive and variable condition expects new human resource practices (NHRM) to counter the problems in the organizations to boost their performance [55]. The unpredictable situation of Covid-19 and its competitiveness demands new human resource practices in order to manage the human resources at construction projects to recover from the loss. Employee training, one of main ways for an enterprise to improve its core competitiveness, plays a vital role in the performance, survival and development of an enterprise. The educational programs of information technology companies can bring youth people into the corporative environment

2.4.2 Material Resources

Management also faced the problem of unavailability of material. Since the impacts of COVID-19 were worldwide and the manufacturing and materials industries were also closed which effected the supply chain process. The addition of the non-value adding activities and processes in the supply chain of the construction sector results in inefficiencies and low productivity [56]. A lot of activities were added to the construction process during the pandemic, those activities have zero value in the construction process but are important for the health from a COVID-19 perspective.

Energy requirements for buildings are directly related to the construction technology and the type and amount of used construction materials [57]. To increase the productivity of the construction projects the practices like controlling the status of materials, assigning

material procurement team, and maintenance of the received material may be helpful [58]. In Construction projects, one of the major causes of delaying project completion is the delayed delivery of materials [59]. Because of the closure of manufacturing industry during Covid-19 construction projects faced the problem of late delivery of material at site which affected the on-time completion of project. Material management is the process of management which includes planning and controlling the necessary steps to make sure that the right quality and quantity of materials in a timely manner and are obtained at a reasonable cost and are made available when needed [60].

Supply chain “process digitalization” is an active introduction of digital tools for strategic and operational management of information and material flows along the chain in all supply chain processes [61]. For the effective implementation of CSCM application for the successful achievement of the project’s goals, simultaneous consideration of the lifecycle approach and stakeholders associations are necessary [62]. There are multiple unexpected events in real life, the supply chain management may encounter uncertainties due to these unexpected events [63]. However, supply chain management (SCM) is difficult, to obtain the full potential of SCM it is important that all participating supply chain actors strive towards a joint supply chain orientation [64] as visualized in **Fig. 2.5**. Advancements in information technology can enhance the process of information management within the project, with the help of these technologies smoother construction process can also be assured by the management of supply chain information [65]. An argument was made in a study that timely collection and dissemination of information to project teams will eliminate risks and mitigate unexpected construction problems [66].

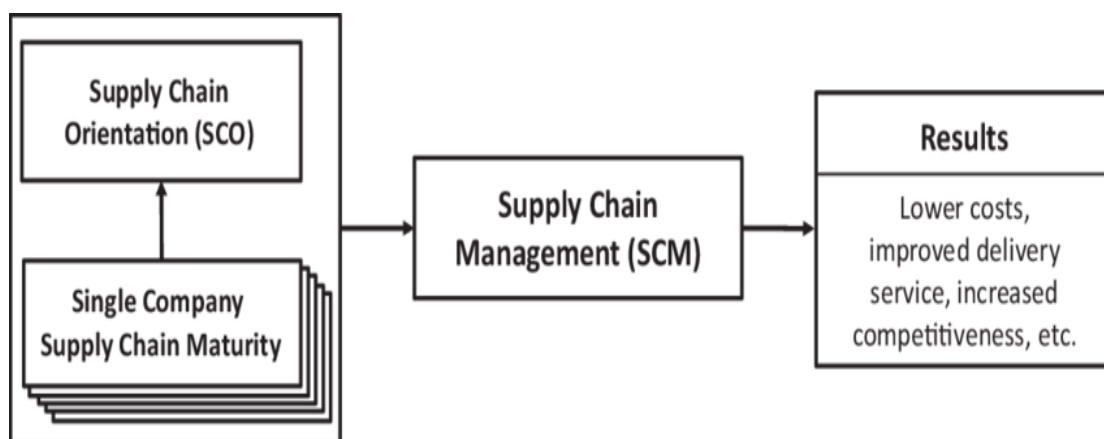


Figure 2.5: Results of SCM are Based on SCO [66]

Due to the complex nature of construction projects and severity of the COVID-19 pandemic managers found it tough to manage the resources properly during construction projects. The management of human resources and material resources was the toughest of all. New strategies were adopted to overcome the shortage of human resources and unavailability of material resources.

2.5 Summary

From the above discussion, it is concluded that the outbreak of COVID-19 pandemic impacted the entire world severely, there were lockdowns social distancing measures and shutdown of industry. Uneven distribution of medical facilities was also reported specially in developing countries. COVID-19 hit construction sites very hard there were halation and postponing of construction work. COVID-19 impacted the on-going construction activities at projects and management found it tough to properly manage the resources. From this chapter it is concluded that COVID-19 effected the ongoing operation at construction projects, there should be proper planning to continue work in such environment, for this it is important to analyze the impact of pandemic on construction sector. Recovery plans are tough to execute during the pandemic due to the complex environment of construction industry and spreading pattern of the virus.

Chapter 3

Research Methodology

3.1 Background

The COVID-19 pandemic impacted the construction sites severely, it created the challenging situation for managers to manage the construction work at sites. In this research, the impact of pandemic on local construction sites is analyzed. To establish the research gap a comprehensive literature review was conducted. A questionnaire survey was prepared. Delphi technique was applied on the initial prepared questionnaire in order to collect data. Gathered data was analyzed using statistical software and results were discussed. The detailed research methodology implemented in current research is described in the following sections.

3.2 Research Design

This research work has been designed to analyze the impacts of COVID-19 on local construction sites in terms of challenges to manage the construction work and challenges faced while managing the resources at construction projects during COVID-19. Based upon research objective literature was critically reviewed to study the corresponding areas of research work and the impact of COVID-19 on construction sites along with the challenges to resource management at construction projects were analyzed. Initially a questionnaire survey was developed. Delphi technique was applied to short list substantial factors and

to establish data acquisition instrument. Survey questionnaire was implemented as data collection tool based on the responses from respondents. The findings from the survey were observed using statistical software and impact of COVID-19 on local construction sites was analyzed. After thoroughly analyzing the data results conclusions were made. Methods adopted in the current research are graphically presented in Fig. 3.1. This study has been divided into four phases.

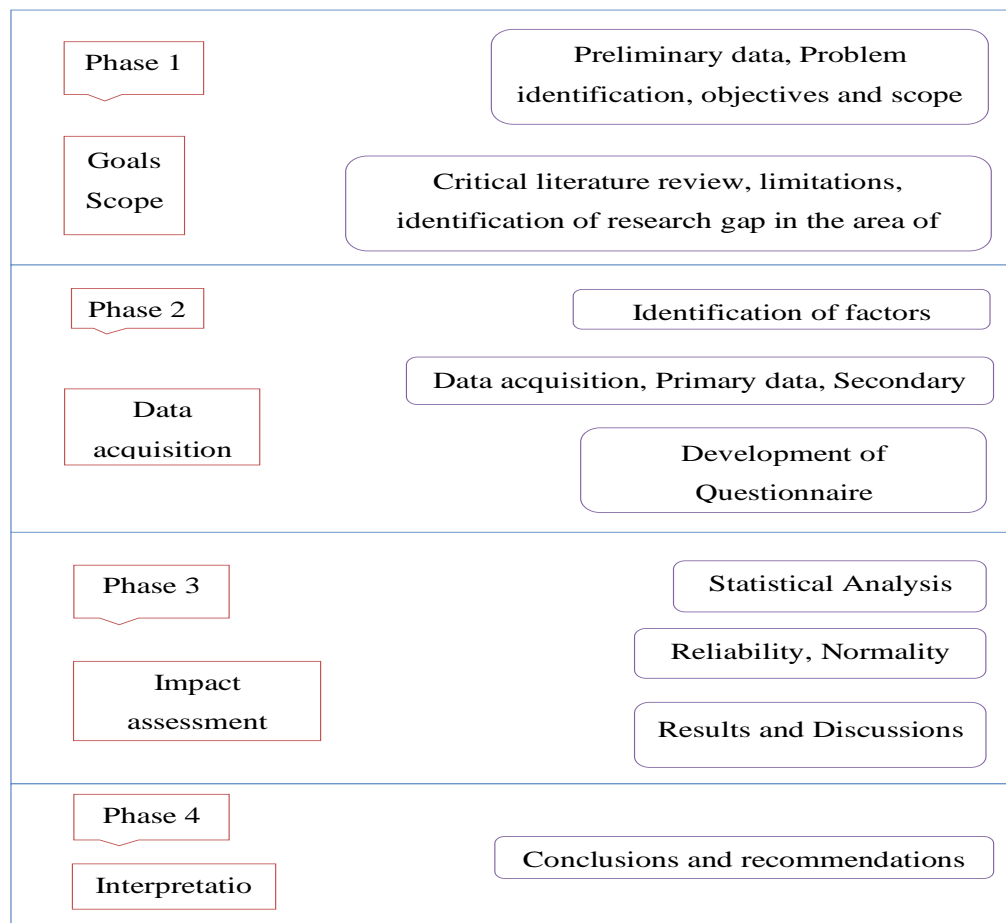


Figure 3.1: Flow Chart of Adopted Research Methods

3.2.1 Literature Review

Critical literature review was performed to find out the global and overall impact of COVID-19 on construction industry. Literature was also critically reviewed to find out some basic information about the pandemic and its impact on society in order to provide the base for the research goal. Literature provided the way for describing and guiding the

methodology for specific research. It also provided the base for the analysis which are the research methods adopted for conducting the research, multiple articles were reviewed to understand the process and approaches. For reviewing literature relevant articles of well reputed journals were collected. After gathering the relevant research articles and other relevant publications impact factors of COVID-19 according to research were identified. These factors were analyzed and further classified into groups.

3.2.2 Data Collection

Data is the most crucial part for any research, while in survey-based research it becomes more important because the outcome of the whole work are dependent on the validity of the data. For this it's important to clearly describe the data types its collection methods and usability. For collection it's important to clearly define the medium from which data will be collected. Data consists of two types; first one is primary data and the other is secondary data. Primary data was obtained through survey tool, with the aim to get information about the impacts of COVID-19 on construction sites in terms of managing work at sites and resource management challenges faced by management at construction products during COVID-19 in order to develop future strategy in case of COVID-19 like pandemic. Secondary data has been collected by critically reviewing the literature of previous work and published relevant articles of well reputed journals.

3.3 Questionnaire Development

After critically reviewing the literature, initial questionnaire was developed. The developed questionnaire consists of three sections, one section of independent variable and other two sections are of different dependent variables. The purpose of section 2 is to analyze the COVID-19 pandemic and its impact on society. Section 3 is about the pandemic impacts on execution of construction work at local construction sites. There were multiple factors within section 3 for example use of technology to manage construction work, the impact of COVID-19 on construction industry. Multiple projects started the advance systems of technology to manage the construction work at projects during pandemic [67].

This aspect is reflected in question 5 of section 3. Construction industry faced huge loss due to severe challenges of managing construction activities at projects because of COVID-19 [68]. This aspect is reflected in question 12 of section 3. Section 4 deals with the resource management at construction sites during pandemic as shown in Appendix.

Then, Delphi techniques was used to develop a survey questionnaire for data attainment. Delphi technique is a process in which a group of researchers, specialist and identified experts interacts for the improvement purposes. Its purpose is to create debate and facilitate a verdict on a stated topic to be made so that policy evaluations can be reserved which can privilege to epitomize a given group's wants and views [69]. However, Delphi technique enables debates, indirect contacts along with retrace-able transcribed response procedures and condensed social pressure makes it more inclusive, flawless and capable procedure compared to other approaches [70]. The Delphi technique which is used in the development of the questionnaire survey proceeds by the following steps as shown in figure 3.2. In current study two rounds of Delphi technique were adopted. The background of industry professionals involved in this study to provide their valuable feedback for the questionnaire development is presented in Table 3.1. The questionnaire was developed on the bases of responses from the experts.

3.3.1 Response Measurements

To measure the impact of COVID-19 on construction sites and resource management during Covid-19 Likert rating scale response was used. The feedbacks from industry professionals of different organization were collected on the given values of scale. Likert rating scale has been used in this questionnaire. Table 3.2 represents the rating scale adopted for this research.

3.4 Data Acquisition

Data acquisition is the most important part of survey based reaserch beacuse the whole outcome depends upon the data. Hence methods of data acqusition defines the succes of the processes. A survey was conducted after the development of data acquisition

instrument. The distribution of questionnaire was made among industrial professionals both in public and private organizations. Respondents were briefed about the objectives and purpose of the conducted questionnaire survey.

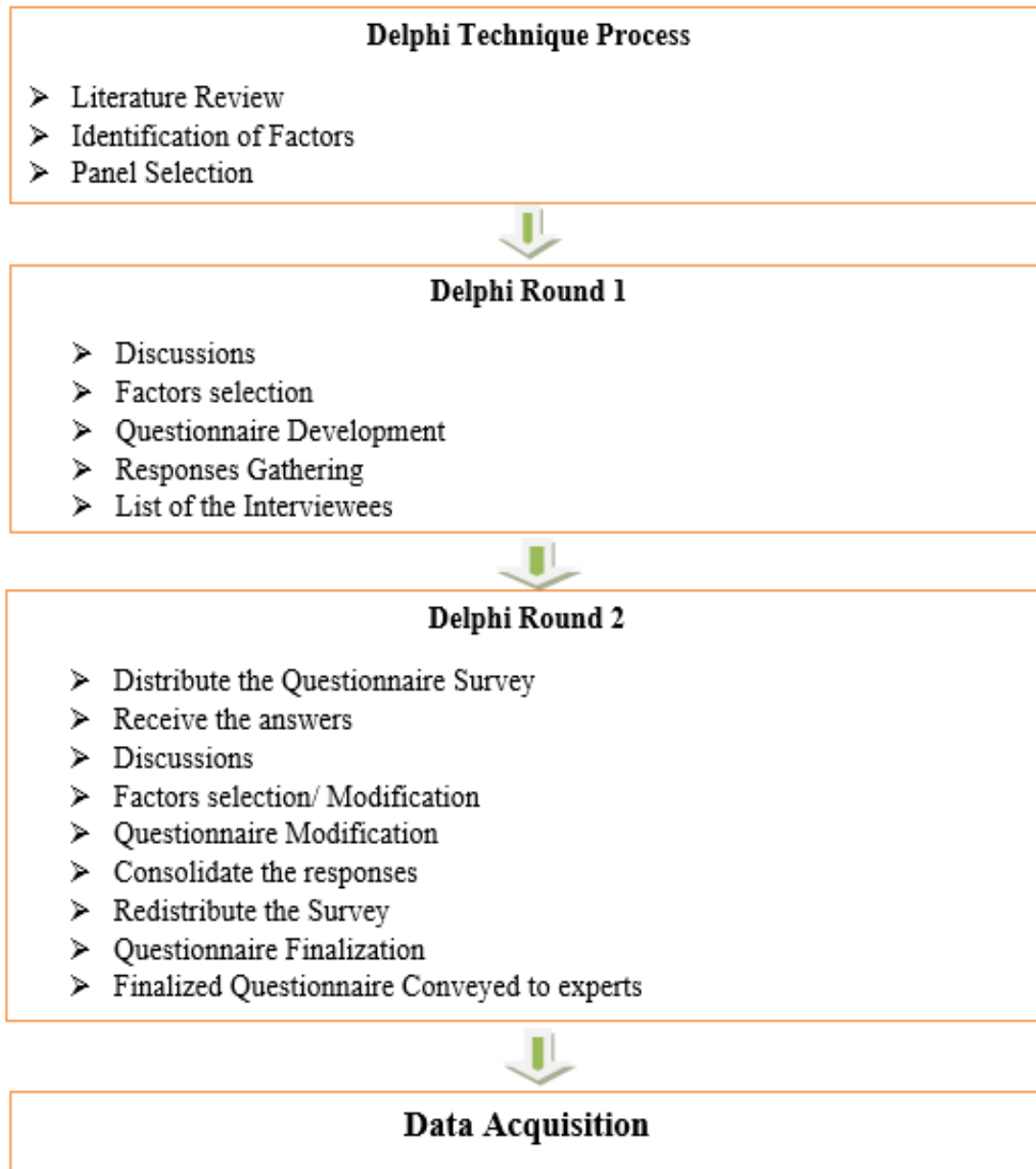


Figure 3.2: Delphi Technique Process Adopted

3.5 Data Analysis

After collecting data by questionnaire, it was statistically analyzed. The SPSS software was used for the statistically analysis of the data. The cycle which is used for the data

Table 3.1: Participants Background

Participants	Designation	Experience	Group
A	Professor Construction Management	More than 10 years	Academia
B	Assistant Professor Construction Management	More than 10 years	Academia
C	Director Planning	More than 15 years	Client
D	Project Manager	More than 20 years	Contractor
E	Chief Engineer	More than 20 years	Contractor
F	Design Engineer	More than 10 years	Consultant

Table 3.2: Likert Scale

Values/Score range	Term
1	Very Low
2	Low
3	Medium
4	High
5	Very High

analysis purpose is presented graphically in figure 3.3. SPSS (Statistical Package for the Social Sciences) has been used to carry out the statistical analysis of the data. SPSS can create organized reports, diagrams, plots of allocation and developments, descriptive statistics and complex statistical analysis by utilizing the information collected from the record [69]. SPSS has edge over the other well-known statistical packages due to its ability of performing highly complex data analysis by using only easy input commands by either through interactive or non-interactive users.

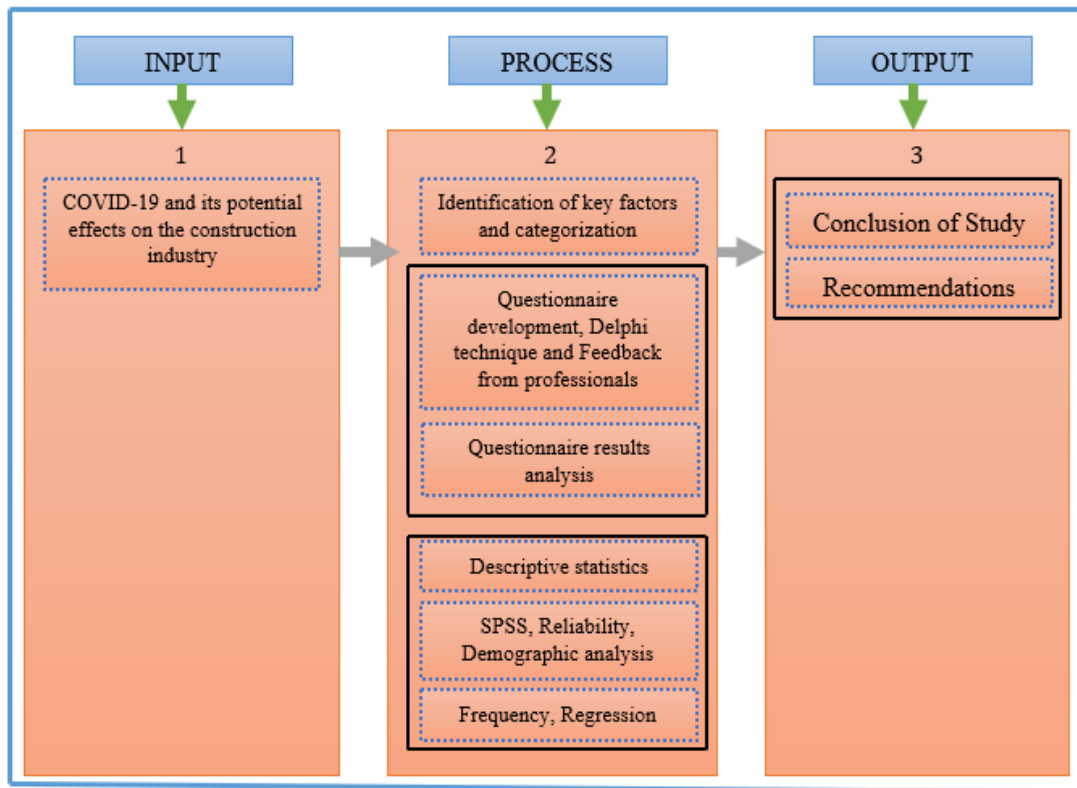


Figure 3.3: Data Analysis Cycle

3.5.1 Data Reliability

Reliability test is carried out to determine the internal consistency of a research tool, that instrument would give the same results under the same condition in case measurement were taken again. The reliability of data is expressed usually in terms of Cronbach's alpha along with a scale ranging from 0.0 to 1.0. The value of 0.0 means lack of consistency while the value of 1.0 means high consistency. While the value above 0.7 is considered reliable and indicates that the data acquired is reliable for further analysis [70].

3.5.2 Normality Test

To check whether the data is distributed normally or not (normal distribution pattern of the data distributed), a normality test called Shapiro-Wilk test has been applied to the data in this study. The significance value larger than 0.05 indicates that the data is normally distributed (parametric data), while value less than 0.05 indicates that the distribution pattern of data is not normal (non-parametric). The distribution pattern

not only provides the information about the survey tool but it also decides the further analysis testing for the data. In analysis sometimes situation comes where it has to decide for parametric and non-parametric analysis.

3.5.2.1 Parametric and Non-Parametric Analysis

While performing statistical testing, if the data fails to meet the assumption of the test the situation occurs where have to choose between parametric and non-parametric tests. Based upon the characteristics and nature of data which includes data distribution, sample size, data measurements (continuous, ordinal, and ranked) it's important to select valid test. When there is linear behavior in the data (continuous, normally distributed, and spread of each group is different) the parametric tests perform well in such a situation. While non-parametric tests are used when non-linear behavior is observed in data (Measured in ordinal, ranked scale, and distribution is not normal).

3.5.3 Demographic Analysis

Demographics originally refers to the eccentricity of human population. The common examples of demographic used in analysis are age, gender, profession, qualification, experience etc. While maneuvering a review, the inquiries should evaluate who to examine and how to categorize general research response data into main gathering of respondents. The demographic data included in this study are organization, age, experience and qualification.

3.5.4 Correlation Analysis

Correlation analysis is used to identify correlations between variables, or it is used to study the link between variables. Relationships may be classified as positive when the variables are pointing in the same direction, and as negative when the variables are pointing in the opposite way. Furthermore, the value 'r' shows the bond's strength. The Pearson coefficient threshold values are as follows:

- Values ranging from 0.1 to 0.3 suggest a modest association.

- A number in the range of 0.3 to 0.5 suggests moderate correlation.
- A value range larger than 0.5 indicates a strong association.

3.5.5 Regression Analysis

Correlation between the variables is considered identical due to the lack of evidence, but it is not as significant as it could provide the confirmation of the existence of relationship between variables, depending upon the correlation analysis method. There must be a causal relationship between the two variables being compared for the correlation to be beneficial. As a result, regression analysis was used to determine the nature of the causal link between one and another variable.

Following hypothesis are considered.

Hypothesis 1: Increase of COVID-19 pandemic causing increase of challenges in managing construction work at sites.

Hypothesis 2: Increase of COVID-19 pandemic causing increase of challenges in managing resources at projects.

3.5.6 Frequency Analysis

Frequency analysis is a descriptive statistical approach which presents the number of occurrences of each response as chosen by respondent and analyses the results in a way that would draw the final conclusion. Frequency analysis is an approach which gives the idea to know the perception of the respondents. In more detail the trend followed in the survey can be observed by this technique. The cumulative percentage versus various variables assists in revealing the percentage value for data plus percentage for all values that precede it. In this study the frequency analysis was performed against selected factor and the number of occurrences of each response were measured as chosen by the respondent. Factor selection has been made on the base of mean score value, SPSS has been used for the calculation of the mean. After calculating mean factors are arranged in descending order of mean and factors from top, middle and bottom are being selected for further analysis.

3.6 Summary

Delphi technique is applied on the development of questionnaire survey which is used for the data collection purpose. For the statical analysis of data SPSS has been used. After reliability analysis of data, the distribution pattern of data is also examined. Correlation between the variables is also examined. While the number of occurrences of multiple responses chosen by the respondents are also described by frequency analysis. The results are presented and discussed in next chapter.

Chapter 4

Results and Discussions

4.1 Background

The pandemic of COVID-19 created challenging situation for the managers to manage the construction work as there were supply chain disruption, unavailability and management problem of resources at site etc. The current research focuses on analysing the impact of COVID-19 on the local construction sites. For this purpose, the data was collected from experts who were involved in any construction projects during the of COVID-19 pandemic. Questionnaire survey was used as a data collection tool. Data was statically analysed after collection of data; SPSS software is used as data analysis tool. Various type of testing was applied on the data and the results were obtained and interpretations were made. This chapter presents the analysis of the collected data, various demographic analysis, frequency analysis, reliability analysis, correlation and linear regression.

To analyse the impact of COVID-19 on local construction sites, the developed questionnaire was distributed among 150 professionals from various organizations. Various organisation in Islamabad were visited and respondents were first briefed about the research and its purpose. The organizations were targeted which continued their work during the pandemic of COVID-19 according to the revised strategies of working environment. A total of 112 responses received out of which 12 were incomplete. Hence, they were discarded. A total of 100 responses were further analysed. And the analysis of those responses is presented in this chapter.

4.2 Reliability Analysis

According to Cronbach (1951), a significant range is 0 to 1. The higher the value, the more accurate the measurement of any structure will be. The scale is considered reliable if the value is greater than 0.70, while the scale values are less than 0.70, the scale is less reliable. A low alpha value may be due to a small number of questions, poor interconnection between elements, or heterogeneous designs. The results of reliability analysis are shown in **Table 4.1**. For the current study, Cronbach's alpha of 0.86 for COVID-19 pandemic, 0.81 for Activity execution and 0.80 for resource management was obtained. The alpha observed higher value than 0.7 which confirmed the consistency of data achieved. According to reliability analysis the results would be same if we recollected the data from construction projects under similar conditions. This indicates the consistency of the data, which means the used tool for the data collection purpose is reliable under the given circumstances and it serves the intended purpose. For the tool to be valid it is important that it should serve the intended purpose by achieving the internal consistency otherwise there is need to improve the data collection tool [73].

Table 4.1: Reliability Statistics of Main Components

Main Components	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No of Items
COVID-19 Pandemic	0.860	0.866	11
Activity Execution	0.813	0.820	12
Resource Management	0.802	0.801	15

4.3 Normality Analysis

After the reliability of data, it was essential to examine the distribution pattern of the data. Shapiro-Wilk test and Kolmogorov-Smirnov test was performed in this regard to assess whether the data was normally distributed (parametric) or not (non-parametric). The results of normality tests are shown in **Table 4.2**. From the results of Shapiro-Wilk test and Kolmogorov-Smirnov test, it was noted the p value .141 and .118 for COVID-19 pandemic, .016 and .226 for impact on Activity Execution and .200 and .199

for resource management challenges both are greater than 0.05 which imply that it is acceptable to assume that the weight distribution is normal (or bell shaped). Normality analysis indicates that the respondents observed similar impacts of COVID-19 pandemic within their respective projects. Responses from the participants are more frequent near to mean hence curve obtained is bell shaped. The purpose of normality analysis is to differentiate between the distribution pattern of the data which will decide the analysis tests [74]. Which means the distribution pattern of the data is normal the interval in scale is ordinal and parametric testing will be used for the further analysis. Some of the responses from the participants were in different directions which shows the complex nature of the construction industry while more responses having score value near to mean of different questions indicates the similar impacts of the pandemic on local construction site.

Table 4.2: Results of Normality Tests

	Kolmogorov-Smirnova		Shapiro-Wilk			
	Statistic	df	Sig.	Statistic	df	Sig.
Covid-19 pandemic	0.078	100	0.141	0.979	100	0.118
Activity Execution	0.100	100	0.016	0.983	100	0.226
Resource management	0.062	100	.200*	0.982	100	0.199

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

4.4 Demographic Analysis

The results of demographic analysis are included in following Figures. **Figure 4.1** represents the overall distribution of the respondents. Out of the 100 respondents 41% were contractor, 39% were consultant while 20% belonged to client. The age of respondents reported different age level i.e., 20% from 21-25 years, 37% from 26-30, 22% from 31-35, 6% from 36-40 and 15% 40 above participants who participate in the study, the results are shown in **Figure 4.2**. To give the real time assessment of an impact study the role of

respondent experience and education is critical. The level of respondent education and experience were also addressed to have real time assessment. There were 46 participants with experience 1-5 years, 26 with 6-10 years of experience, 15 with 11-15 years of experience, 5 with 16-20 years of experience and remaining 8 with experience more than 20 years, the results are shown in **Figure 4.3**.

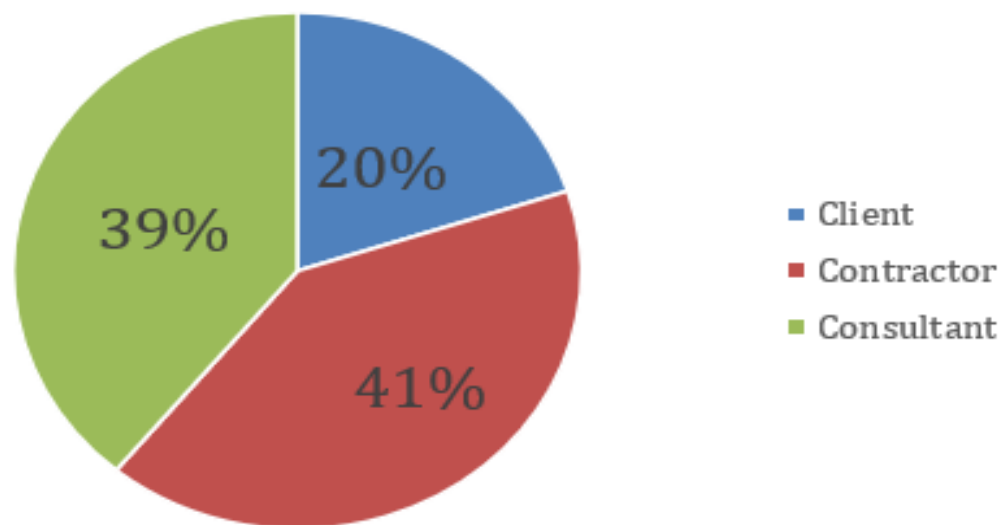


Figure 4.1: Type of Organization

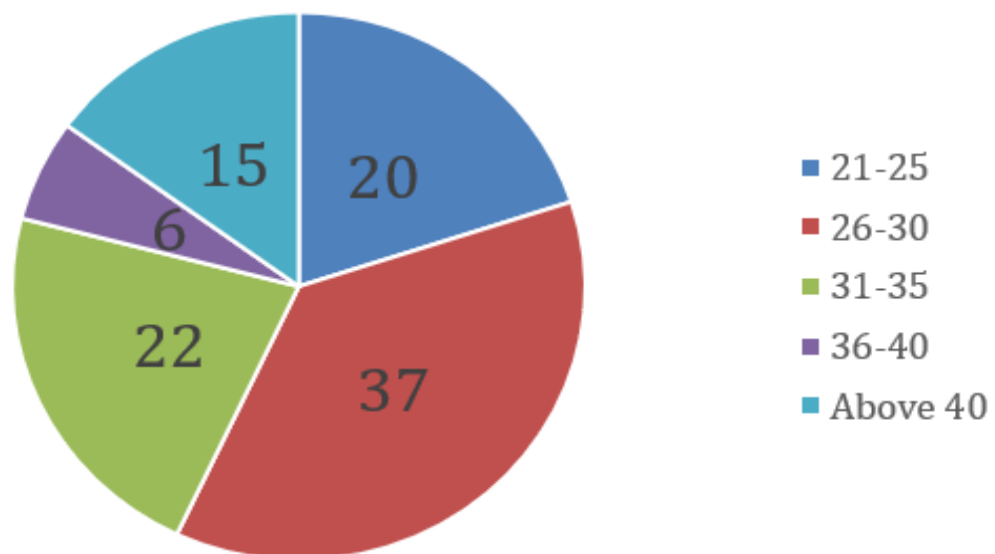


Figure 4.2: Age of Respondents

The participants were reported with different level of educational qualifications. 18% had DAE, 45 % had degree of Bachelors, 17 % had the degree of Masters, 4 % had PHDs and

remaining 16% were including in other qualifications, the results are shown in **Figure 4.4**.

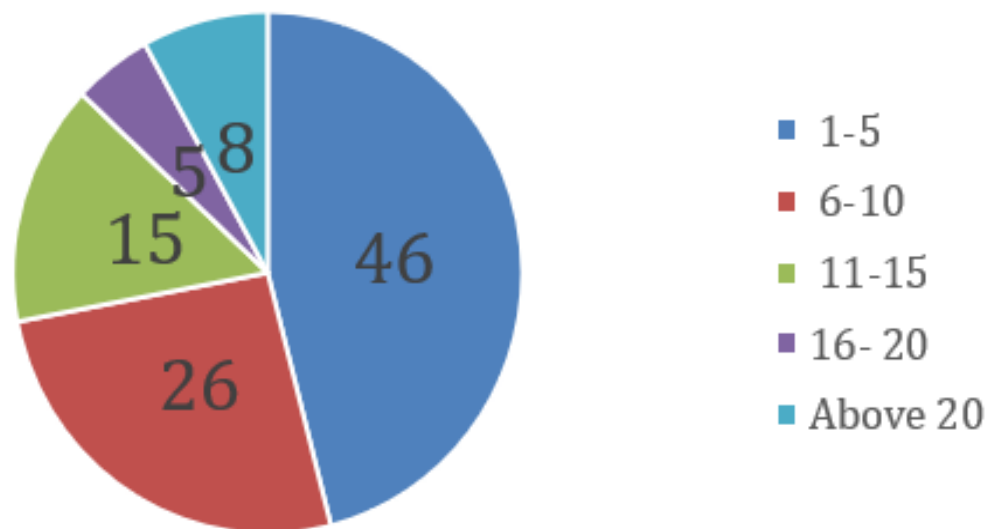


Figure 4.3: Experiences of respondents

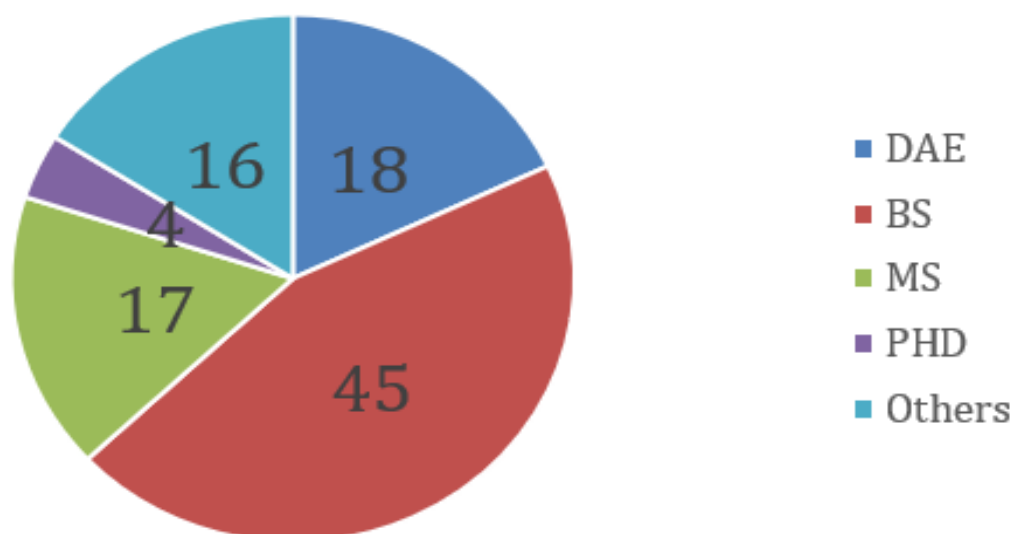


Figure 4.4: Different educational qualification of participants

54 % respondents with experience more than 5 years and 64 % with professional degree indicates that they have sufficient knowledge and experience to properly respond questionnaire survey. Demographic information of respondents is parameter for data tool which is critical for understanding the maturity of data obtained [75]. The background of respondents demography is critical for the validity of the data obtained. The experience qualification are the most important aspects for any respondent to respond any

questionnaire efficiently. In our research respondents sufficient number of respondents are with professional degree and enough experience which enables the observer to trust the maturity and validity of the data.

4.5 Correlation Analysis

After analyzing the distribution pattern of the data, the correlation between the variables has been identified. The value 'r' shows the bond's strength. The Pearson coefficient threshold values are as follows:

- Values ranging from 0.1 to 0.3 suggest a modest association.
- A number in the range of 0.3 to 0.5 suggests moderate correlation.
- A value range larger than 0.5 indicates a strong association.

The correlation result can be seen in **Table 4.3**.

Table 4.3: Correlation Results of Variables

Variable	Mean	SD	CP	AE	RM
Covid-19 pandemic (CP)	36.72	5.487	1		
Activity Execution (AE)	34.78	5.706	.503**	1	
Resource management (RM)	49.47	6.135	.380**	.455**	1

** p

<

0.01 (two-tailed)

Above table revealed that there is strong positive correlation of Covid-19 pandemic with Activity Execution ($r=.503^{**}$), moderate positive correlation with Resource management ($r=.380^{**}$) and activity execution correlation of activity execution with Resource management challenges ($r=.455^{**}$). According to correlation analysis with the increasing impact

of COVID-19 pandemic on society there is increase of its impacts on activity execution and resource management. It's important to know the correlation between the variables because it defines the direction and environment of independent variable on dependant variable [76]. The direction and environment is more important because the production of medical equipment seen a high increase while other industries were facing shutdowns.

4.6 Regression Analysis

To define the statistical relationship between two variables in a regression study, the standard error (SE), t-value, and p-value are all coefficients that are employed. The t-value shows if there is a difference in standard error units between the two variables. Lower and upper confidence intervals are used to assess significance levels in relation to these intervals, and the values associated with these intervals are referred to as LLCI and ULCI. It is possible to do a regression analysis using two kinds of variables: simple regression or linear regression, which establishes a causal relationship between two variables; and multiple regression, which establishes a causal link between more than two variables. Regression equations has been developed for both hypothesis and results are analysed. In this study, we used a linear regression analysis to determine the frequency with which the independent variable influenced the dependent variable. The results of regression analysis of Impact of COVID-19 pandemic on activity execution are presented in Table 4.4a, Table 4.4b, Table 4.4c. The results of regression analysis of Impact of COVID-19 pandemic on resource management are presented in Table 4.5a, Table 4.5b, Table 4.5c.

The analysis shows the impact of COVID-19 pandemic on construction activities execution. The R^2 value of .25 revealed that the predicted variable explained 25% variance in the outcome variable with $F(1, 98) = 33.24$. The findings revealed that covid-19 pandemic positively predicted activity execution ($\beta = .52, P < .001$). The value of β (0.50) which is positive and less than 1 indicates the volatile environment. Which means the change may be unpredicted and unexpected. Now if we consider an increase of one unit of in COVID-19 pandemic there is an increase of 0.52 unit of impacts on construction activity execution, it can be observed from following equations, Where, $Y = \text{Activity Execution}$, $\beta = \text{Constant (Other factors)}$, $\beta = 0.52$ $X = \text{COVID-19 pandemic}$.

$$Y = + X \dots\dots\dots (1)$$

$$Y = +0.52X \dots\dots\dots (2)$$

The analysis shows the impact of covid-19 pandemic on resource management. The R2 value of .14 revealed that the predicted variable explained 14% variance in the outcome variable with $F(1, 97) = 16.34$. The findings revealed that covid-19 pandemic positively predicted resource management challenges ($\beta = .38, P < .001$). The value of β (0.49) which is positive and less than 1 indicates the volatile environment. Which means the change may be unpredictable and unexpected. Now if we consider an increase of one unit of COVID-19 pandemic there is an increase of 0.49 unit of challenges in resource management, it can be observed from following equations, where;

$$\begin{aligned} Y &= \text{Resource Management} \\ &= \text{Constant (Other factors)} \\ &= 0.49 \end{aligned}$$

X = COVID-19 pandemic

$$Y = + X \dots\dots\dots (3)$$

$$Y = +0.49X \dots\dots\dots (4)$$

Unexpected and unpredictable environment of pandemic caused an increase of 0.52 units of impacts on activity execution for every single unit of its increased impacts on society. Unexpected and unpredictable environment of pandemic caused an increase of 0.49 units of impacts on resource management challenges for every single unit of its increased impacts on society. Regressions analysis is essential for the correlation analysis to be beneficial, and it provides the nature of the relationship between the compared variables [77]. Every single unit of COVID-19 pandemic causing 0.52 units of impacts on respective factors, SOPs on working environment, halation of work on project completion, technology use to manage construction work, effectiveness of work in shifts, workplace safety and challenge of managing construction work on progress of projects. Every single unit of COVID-19 pandemic causing 0.49 units of its impacts on respective factors, inclusion of new strategies to manage resources, variance in resource management compared to normal days, lockdowns impact on supply chain, closed border impacts on material availability and resources management due to pandemic.

Table 4.4: Results of Regression Analysis of Impact of COVID-19 Pandemic on Activity execution; a) Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change in R Square	F Change	df1	df2	Sig. F Change
1	.503a	0.253	0.246	4.956	0.253	33.244	1	98	0.00

a. Dependent Variable: Activity Execution

b. Predictors: (Constant), COVID-19 Pandemic

b) ANOVA^a

Model	Sum Squares	df	Mean Square	F	Sig.
1 Regression	816.433	1	816.433	33.244	.000b
1 Residual	2406.727	98	24.558		
Total	3223.16	99			

a. Dependent Variable: Activity Execution

c) Coefficients^a

Variables	Unstandardized Coefficients		Standardized Coefficients		t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta				Lower Bound	Upper Bound
1 (Constant)	15.56	3.37			4.617	0	8.873	22.248
Covid	0.523	0.091	0.503		5.766	0	0.343	0.704

a. Dependent Variable: Activity Execution

The analysis shows the impact of COVID-19 pandemic on construction activities execution. The R^2 value of .25 revealed that the predicted variable explained 25% variance in the outcome variable with $F(1, 98) = 33.24$.

The findings revealed that covid-19 pandemic positively predicted activity execution ($\beta = .52, P < .001$).

Table 4.5: The Results of Regression Analysis of Impact of COVID-19 Pandemic on Resource Management a) Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	F Change	df1	df2	Sig. F Change
1	.380a	0.144	0.135	5.705	0.144	16.335	1	97	0

a. Predictors: (Constant), COVID-19 Pandemic.

b) ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	531.658	1	531.658	16.335	.000b
	Residual	3157.029	97	32.547		
	Total	3688.687	98			

a. Dependent Variable: Resource Management Challenges

b. Predictors: (Constant), COVID-19 Pandemic

c) Coefficients^a

Variables	Unstandardized Coefficients		Standardized Coefficients	Sig.	95.0% Confidence Interval for B		
	B	Std. Error	Beta		Lower Bound	Upper Bound	
(Constant)	30.788	4.659		6.608	0	21.541	40.035
Covid	0.493	0.122	0.38	4.042	0	0.251	0.736

a. Dependent Variable: Resource Management Challenges

The analysis shows the impact of the covid-19 pandemic on resource management. The R² value of .14 revealed that the predicted variable explained 14% variance in the outcome variable with $F(1, 97) = 16.34$.

Values are taken at 95% confidence interval for beta (Lower and Upper bound).

The findings revealed that covid-19 pandemic positively predicted resource management challenges ($\beta = .38, P < .001$) (Value of beta is positive and less than 1).

4.7 Frequency Analysis

After identifying the correlation of COVID-19 pandemic with activity execution and resource management the frequency analyses is carried out and results are presented below. Frequency analysis is carried out to know the perception of the respondents against certain factors.

4.7.1 Mean Score Value

To further explain factors, mean score value of all factors is calculated in order to find the criticality of factors. Then factors are arranged in descending order of mean score value. The factors from start, middle and end of all three variables are selected for further explanation. The weighted average of all factors is presented in table 4.4a, 4.4b, 4.4c according to the variables.

4.7.2 Impact of COVID-19 Pandemic on Society

In order to understand the environmental impacts and nature of the COVID-19 pandemic respondents were asked to provide their valuable feedbacks on different questions. On being asked the impact of COVID-19 on society 41% respondents rated it very high, 39% with high, 15% with medium and 5% with low, while no one rated the very low impact of COVID-19 on society. This indicates that COVID-19 impacted the society highly. The results are shown in figure 4.5a. Respondents were asked to provide their valuable feedback about the efficacy of vaccine, what they think about the vaccine as a protection against the COVID-19. 14% respondents rated it very high, 47% with high, 28% with medium, 8% with low and 3% with very low. The results of this analysis are presented in figure 4.5b. The given analysis shows that vaccines proved to be beneficial against protection from virus. Respondents were asked to rate the impact of lockdowns on controlling the spread of COVID-19, there were 13% respondents with rating of very high, 33% with high, 30% with medium, 21% with low and 3% with very low. This indicates that lockdowns strategies played a vital role in controlling the spread of COVID-19. The results are shown in figure 4.5c.

Table 4.6: Mean Score Value; a) COVID-19 Pandemic Items, b) Construction Sites items, c) Resource management items

Sr.No	Factors	Mean Score Value
1	The impact of COVID-19 on society	4.16
2	Impact of vaccine as a protection against Covid-19	3.61
3	Availability of vaccines in your town	3.5
4	Information provided by the authorities about Covid-19	3.41
5	Efforts you made in gaining information about the COVID-19 pandemic to protect yourself	3.35
6	Impact of lockdowns on controlling the spread of Covid-19	3.32
7	Availability of medical facilities in your town	3.31
8	The impacts of COVID-19 on your life	3.28
9	Impact of surgical masks in the prevention of Covid-19 spread	3.28
10	Health information available about COVID-19	3.28
11	Impacts of Covid-19 on your family, friends and colleagues	3.24

b Construction Sites items

Sr.No	Factors	Mean Score Value
1	The impact of COVID-19 on the construction industry.	4.17
2	The impact of halation and postponing construction work during Covid-19 on the completion of the project.	3.53
3	The halation's impact of the transport and aviation industry due to COVID-19 on the construction industry.	3.47
4	The impact of workplace safety guidelines related to pandemic such as social distancing, sanitizers etc. on the increase of project completion time.	3.47
5	The emphasis from management to follow the SOPs at construction projects during COVID-19.	3.36
6	The available information provided by the higher management about working conditions during COVID-19.	3.21
7	Impact of SOPs on the working environment of construction projects.	3.14
8	Effectiveness of work in shift process to continue the construction work during Covid-19	3.03
9	The seriousness displayed by the workers in following instructions provided by management.	2.78
10	Impact of revised strategies on the performance of the construction project in the perspective of Covid-19.	2.76
11	Adoption of new strategies in the operating system of the construction project to counter the pandemic.	2.59
12	Use of technology to manage construction work during Covid-19.	2.36

c Resource management items

Sr.No	Factors	Mean Score Value
1	The impact of COVID-19 on human resource management.	3.78
2	The impact of COVID-19 on resource management.	3.73
3	The impact of COVID-19 lockdowns on the supply chain.	3.71
4	Impact of travel restrictions on the availability of human resources.	3.67
5	Impact of resource management challenges because of Covid-19 on the completion of the project.	3.63
6	The impact of COVID-19 on the construction material manufacturing industry.	3.6
7	Impact of the closed borders on the availability of imported construction material.	3.52
8	Variance in resource management challenges during COVID-19 compared to normal days.	3.45
9	The impact of COVID-19 on material resource management.	3.45
10	The control management had on resource management during the Covid-19.	3.06
11	The impact of newly adopted strategies on construction projects to deal with pandemic situations.	2.99
12	Availability of material stock to execute ongoing construction projects.	2.91
13	Early preparation from management to manage resources at construction projects in response to warnings by the authorities.	2.72
14	The progress made by your project towards completion during COVID-19.	2.59
15	Inclusion of new strategies from management to manage resources at the project during COVID-19.	2.57

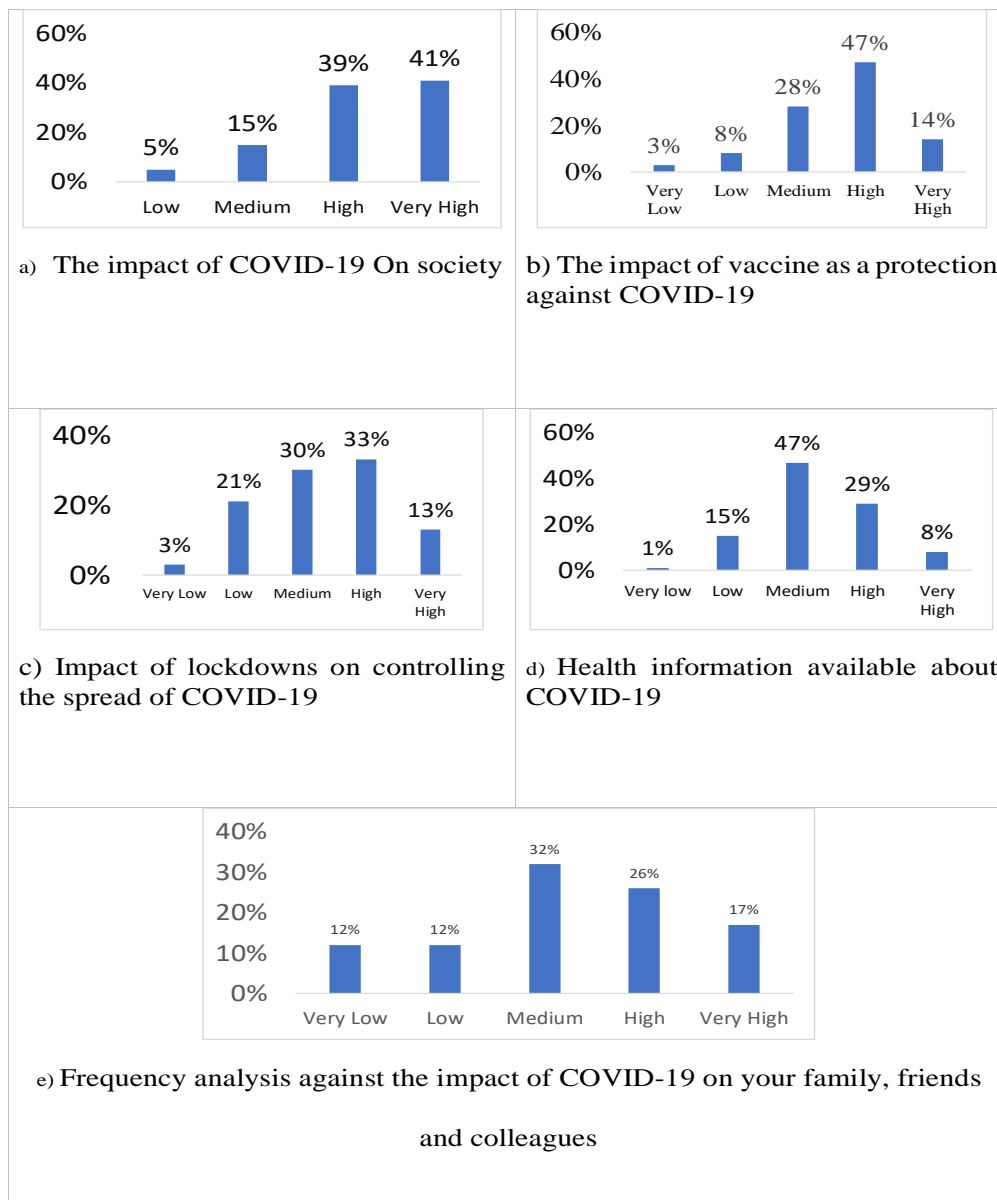


Figure 4.5: Frequency Analysis against the Pandemic of COVID-19 Items

On being asked the health information available about COVID-19, there were 8% respondents with very high rating, 29% with high, 47% with medium, 15% with low while 1% with very low, results are shown in figure 4.5d. According to this analysis little health information was available about the COVID-19 to deal with the circumstance. Respondents were asked to rate the impact of COVID-19 on your family, friends and colleagues, 17% respondents with high, 26% with high, 32% with medium, 12% with low and also

12% with very low. On the base of the higher percentage of responses the impact of COVID-19 on the families, friend and colleagues of respondents varied from mediocre to higher level. Figure 4.5e presents the results of the given analysis.

COVID-19 had a major impact on the society due to the spreading pattern and contagious nature of virus, overall consensus was observed that it affected social, economic and environment dynamics. The pandemic brought a complete turn over in routine life of public, authorities found it tough to maintain the system within the region. It was observed that vaccines proved to be the major element for the protection and cure of this pandemic, they were introduced after several phases of testing and they proved more than handy as a protection mechanism. As a pandemic of COVID-19 was completely different from any previous pandemic so it took long time to introduce vaccine, so initially there was no vaccine available. While the distribution of vaccines was another problem due to the insufficient information about the regions where virus attacks were severe. This made the unavailability of vaccines in certain regions. Governments made many efforts to provide the sufficient information about the pandemic to the public, they used different medium for this purpose there were advertisement on television, newspaper, advertisement boards were placed on different points, social media, calls etc. Despite many efforts by government and media in most of rural areas health information and medical facilities were insufficient due to the quick spread of the virus. The pandemic of COVID-19 affected the people of different ages in different ways there were health problems, lockdowns, job losses, economic problems, loneliness, work from home, downfall of business and many more.

4.7.3 Impact of COVID-19 on Construction Sites

Respondents were asked to provide their valuable feedback about the impact of COVID-19 on construction sites. Multiple questions were asked from the respondents based of factors; explanations of some critical factors are presented below. Respondents were asked to rate the impact of halation and postponing construction work during COVID-19 on the completion of the projects, 18% respondents with a rating of very high, 34% with high, 33% with medium, 1%3 with low and 2% with very low. There were significant impacts

of halation of work on project completion. Results are presented in figure 4.6a. On being asked the impact of revised strategies on the performance of construction project in the perspective of COVID-19, there were 5% respondents with very high, 4% with high, 59% with medium, 26% with low and 6% with very low, figure 4.6b presents the results of the analysis. Revised strategies were not impactful due to lack of planning behind them. 15% respondents rated the halation's impact of the transport and aviation industry due to COVID-19 on the construction industry very high. 38% rated it high, 32% rated medium, 9% rated low while 6% with a rating of very low. The results of this analysis are shown in figure 4.6c.

On being asked on the adoption of new strategies in the operating systems of construction projects to counter the pandemic 3% persons rated it very high, 16% with high, 32% with medium 35% with low and 14% with a rating of very low. Results indicates that low number of new strategies were adopted in the operating system of construction projects to counter pandemic. The results are shown in figure 4.6d. On being asked the available information provided by the higher management about working conditions during COVID-19, there were 7% respondents with a rating of very high, 29% with high 44% with medium, 18% with low and 2% with very low. Insufficient information provided by the higher management about the working condition at sites. The results of the analysis are presented in figure 4.6e.

5% respondents rated the use of technology to manage construction work during COVID-19 very high, 15% rated high, 19% rated medium, 33% rated low and 28% with very low, the results are shown in figure 4.6f. The use of technology to manage construction work was minimum. Respondents were asked to provide their feedback on impact of SOPs on the working environment of construction projects, 6% respondents went with a rating of very high, 26% with high, 47% with medium, 18% with low and 3% with very low. According to responses above results indicates that SOPs impact on most of the projects was medium. Results of the analysis are provided in figure 4.6g. On being asked the impact of COVID-19 on construction industry 44% respondents rated it very high, 33% high, 19% medium and 4% low while no one rated it very low. Responses indicate that construction sector faced significant challenges due to COVID-19 pandemic. The results are shown in figure 4.6h.

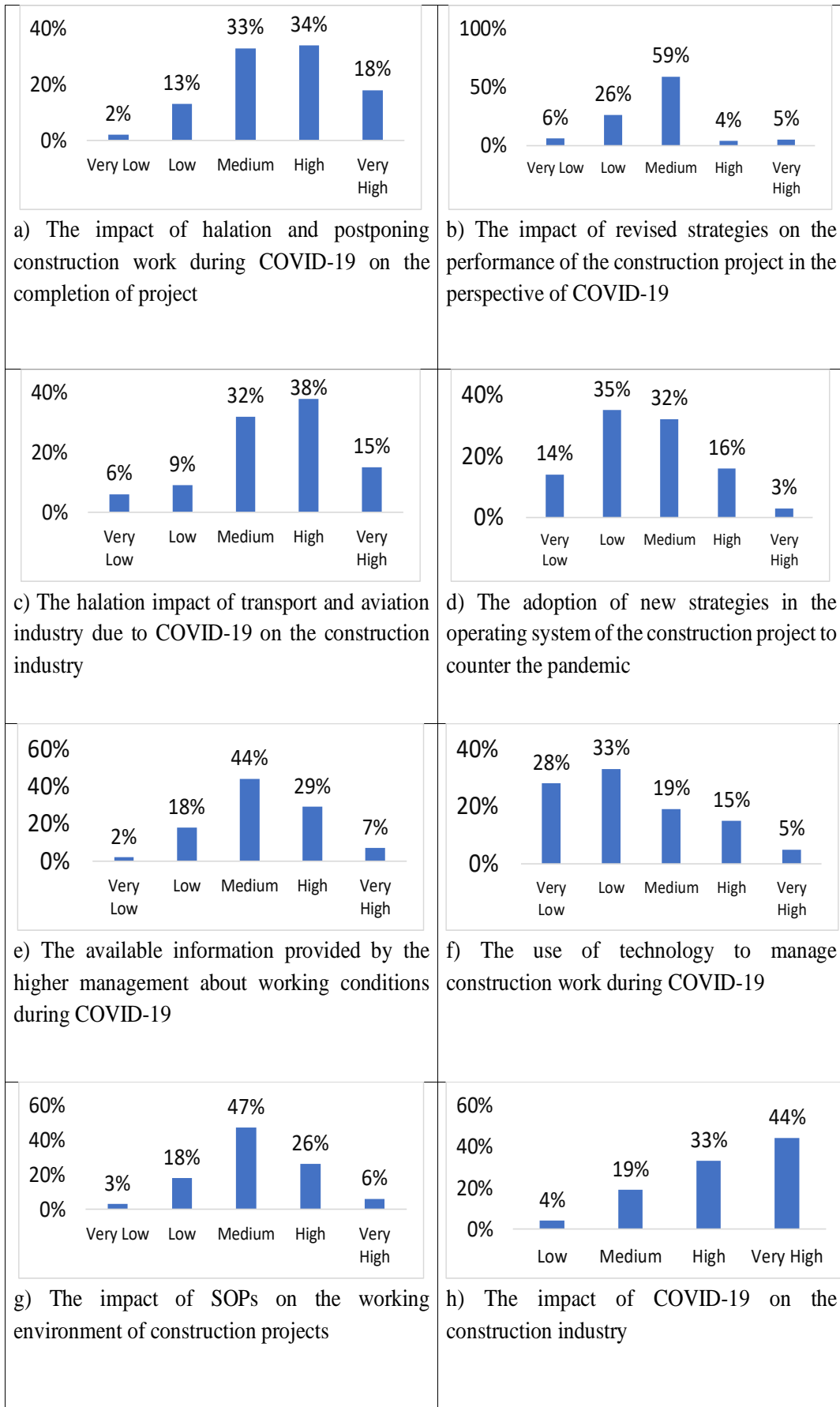


Figure 4.6: Frequency analysis against the Impact on Construction Sites Items

COVID-19 impacted the construction industry in a major way due to the closure or suspension of the construction work because of the disturbance in supply chain and government's lockdown policies. Pandemic forced towards a reduced interactions between the workers, change in type of construction work, closure of material industry and some other factors which slowed the progress of the projects. This resulted in delayed completion time as there were no or minimum activities on construction sites. Construction projects demands the required quantity of material on time as per given quality at the site, while the closure of freight, transportation and export items resulted in the unavailability of materials at site.

To counter the tough environment due to the pandemic new approaches and methods were required at sites, but very few new strategies were adopted in the working system which show the poor planning from management. Initially due to lack of information and procedures government adopted strict policies regarding COVID-19 as they want to control the spread of the virus. But with passage of time these strategies were refined in order to create safe working environment where spread of virus can be controlled, however, these revised strategies from the management also were not good enough to tackle the impacts of pandemic. Human work force was unavailable during the pandemic due to the measures imposed by the management this led to new creative ideas where the processes and methods can be shifted in a smart way, for example using technological advancement to manage the construction work. But, the use of technology to manage the construction work during the pandemic of COVID-19 was minimum because of the traditional working environment of local construction sector.

4.7.4 Resource Management during COVID-19

The feedbacks of industry professionals were collected on the resource management during COVID-19. Factor selection has been made on priority. For this different question related to resource management were asked and their results are presented below. There were 23% respondents with response of very high, 37% with high, 31% with medium, 8% with low and 1% with very low on the impact of COVID-19 on resource management. Above analysis indicates that the impact of COVID-19 on resource management was high.

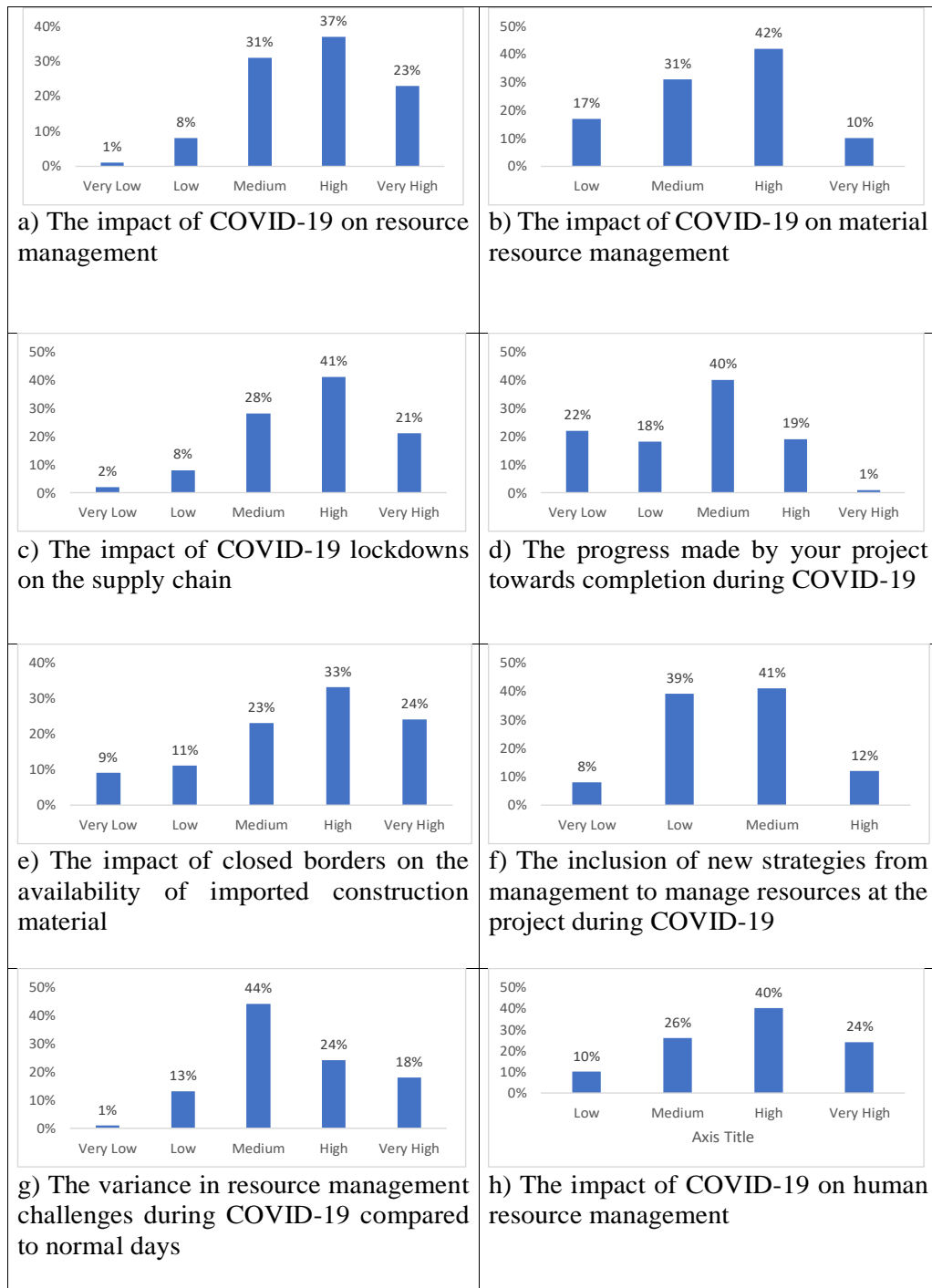


Figure 4.7: Frequency Analysis against the Resource Management Challenges Items

The results are shown in figure 4.7a. On being asked the impact of COVID-19 on material resource management there were 10% respondents with rating of very high, 42% with high, 31% with medium and 17% with low however no one rating of very low, the results are

presented in figure 4.7b. COVID-19 highly impacted the material resource management. 21% respondents responded very high on the impact of COVID-19 lockdowns on the supply chain, 41% responded with high, 28% with medium, 8% with low and 2% with very low. . The impacts of lockdown were severe on supply. The results are presented in figure 4.7c.

Respondents were asked to rate the progress made by your project towards completion during COVID-19, 1% respondent rated it very high, 19% rated it high, 40% rated it medium, 18% rated it low and 22% rated it very low. Results indicates that the low progress made by the projects towards completion during COVID-19. The results are presented in figure 4.7d. 24% Respondents rated the impact of closed borders on the availability of imported construction material very high, 33% rated high, 23% rated medium, 11% rated low and 9% rated very low, the results are shown in figure 4.7e. Closed borders highly impacted the availability of imported construction material. On being asked the inclusion of new strategies from management to manage the resources at the projects during COVID-19, no one rate it very high, 12% with rating of high, 41% with medium, 39% with low and 8% with very low. According to above results medium level of new strategies were adopted to manage the resources at the projects during COVID-19. The results are shown in figure 4.7f.

On being asked the variance in resource management challenges during COVID-19 compared to normal days, there were 18% respondents with response of very high, 24% with high, 44% with medium, 13% with low and 1% with very low, the results are presented in figure 4.7g. Above results indicates that the variance in resource management challenges during COVID-19 compared to normal days was of medium level. Respondents were asked to rate the impact of COVID-19 on human resource management, 24% respondents rated it very high, 40% rated it high, 26% rated it medium and 10% rated it low while no one rated it very low. COVID-19 highly impacted the management of human resources. The results are shown in figure 4.7h.

In construction projects proper management of resources is crucial for the success of the project, COVID-19 effected the management of resources seriously because of the change in working environment due to the pandemic. COVID-19 impacted the management of

human resources severely due to travel restrictions, SOPs and health condition of workers. These factors led towards the unavailability and management challenges of human resources for the management team. Material industry and manufacturing industry which are the major contributor of construction sector have to stop their operations due to the pandemic which effected the supply chain. When there are new challenges, it demands quick planning according to the situation and execution, due to traditional working methods and quick spread of virus management of construction projects were unable to plan and execute. Very few strategies were adopted by the management to manage the resources, which means there were not any available alternative to provide help in managing the resources properly. Very slow progress made by the construction projects which shows the severe impacts of the pandemic on construction projects and industry. Progress of construction projects depends on many factors but the pandemic of COVID-19 impacted the important factors of planning according to situation and execution of the plans and resource management.

Pandemics effects to population over larger area for longer time, COVID-19 is the latest pandemic of respiratory pathogens. It affected the different types of people in different ways and created challenges for them. It originated in December 2019 in China while first case outside China was reported in Thailand. WHO declared it pandemic in March 2020. Frequency analysis enables to measure the number of occurrence of responses for a specific factor as result of participants responses [78]. Participants found that the distributions of information and medical facilities were unavailable lockdowns were significant in controlling the spread of the virus. The unavailability of some proper vaccine created the doubts in the mind of public. Due to the improper planning of authorities economies were flatterring. Like other industries construction industry was also vulnerable to the pandemic of COVID-19. There were lockdowns, conflicts, contractual problems due to the pandemic which affected the performance of projects and eventually projects were closed. Proper resource management is crucial for the success of the project, during pandemic construction projects were facing the problem of both management and availability of resources at sites. Human resource were facing the illness, travel restrictions and work in shifts, while material resources were unavailable at site due to the closure of material and manufacturing industry.

4.8 Summary

This chapter includes the Demographic analysis, Reliability test, Normality test, correlation analyses, and Frequency analysis. Demographic analysis includes the percentages of the Organization, Age in years, Experience in years and Qualification of respondents. Reliability tests refers the reliability of the sample while normality test indicates the normal distribution pattern of the data. Corelation analysis is performed to identify the type of correlation between the variables. At the end frequency analysis is performed, factors are arranged in descending order based upon weighted average. Although all the factors are important but only selected factors are furthered explained and conclusion is presented in chapter 5.

Chapter 5

Guidelines for Practical Implementation

5.1 Background

The analysis of the results provides an overall picture of the impact of COVID-19 pandemic on the local construction sites. The results are based on identified factors which may vary under different circumstances. The factors selection process has been refined on the base of Delphi technique. In this research correlation analysis defines the type of correlation between the variables. Regressions analysis presents the results of the impact of independent variables on the dependent variables. While the frequency analysis presents the number of occurrences of each response for the selected factors as chosen by respondent. The guidelines for the practical implementations are made in this chapter. As a result of the study guidelines are provided for the Governments, Organizations and Projects levels to manage the construction work at sites in case of any future pandemic similar to COVID-19.

5.2 Guidelines at Governments Level

- First of all, it's important to have an idea about the nature of the pandemic, it's spreading pattern and overall impact on the society.

- A visual correlation between the pandemic and construction sector may help in revising the planning and control over the execution of plan.
- Awareness about the situation is most important in any case to respond accordingly. So, it's the responsibility of authorities at higher level to provide the sufficient relevant information to the relevant person.
- Follow the international standard processes of well reputed and advanced organizations in order to minimize the impacts of pandemic on construction sector.
- Authorities should prepare alternatives for avoiding the pandemic impacts on the supply chain of construction sector according to possibility.
- There should be free and easy access of vaccines among the workers of economy supporting sector like construction sector.
- Follow the international standard processes of well reputed and advanced organizations.
- Take the information from lower levels and plan strategies accordingly.
- Use of smart lockdown is a good option to control the spread of virus without compromising the work at projects. The terms and conditions of smart lockdown should be clearly defined.
- There has to be very strict planning and approach towards such pandemic. There should be responsible persons who can take lead upfront. In case of high number of cases lockdown should be implemented.

5.3 Guidelines at Organization Level

- Awareness about the situation is important, its responsibility of the organizations to gain the maximum information about situation.
- There should be physical and mental health session in future for employees. Employees need to understand that a pandemic can add work and home related stress due to different factors.

- When the pandemic is spreading there are the warnings from authorities about the situation before the implementation of complete lockdown, organizations should respond to these early warnings and plan accordingly.
- Interpret and set guidelines of government guidelines into lay more terms as well as establish organization specific one that can be easily adopted by the organization.
- Organization should provide the sufficient level of health information to the employees. Organizations can consider medical consultant in this regard.
- Upgrade the new revised strategies according to situation on regular bases in order to increase their effectiveness.
- Organizations should prepare alternatives plans and strategies for the on-time completions of projects.
- New strategies should be implemented in the system, regular monitoring of the process can increase the chances of success.
- Planning should be flexible so that strategies could be moulded according to the situation. Revise the strategies according to the conditions. Don't create too much hype react effectively and calmly.
- It should be the responsibility of the organization to make the commination and coordination with the project teams in more efficient way. Because in case of pandemic planning should be updated on regular bases for this proper communication between the execution team and planning team is required.
- Work with the client to keep everyone on the same page and informed.
- Plan the processes and planning on regular base in order to increse effectiveness.

5.4 Guidelines at Project Level

- Project management teams should arrange training sessions for the workers, where professionals will train them that how to perform at site during the any future pandemic.

-
- Make the management practices more efficient.
 - Make sure that everyone follows SOPs at site (social distancing, wear mask, use of sanitizers etc).
 - Make the vaccinations mandatory for everyone at site.
 - Worker's health should be inspected on daily bases, the worker which is classified as sick must go to quarantine for two weeks, once this period is over and the health status of worker changes from sick to healthy, he can return to the project on next working day.
 - Regular briefing to workers about the working condition, provide sufficient information about infectious disease, precautions and safety measures, such as social distancing and use of tools and equipment.
 - Stock the materials as a response to early warnings and look for the alternatives to make the availability of materials at site.
 - Make the communication system more effective and proper coordination with the workers.
 - Use of technology and modern construction management software like BIM. The use of Building information modelling can help to determine the daily progress of project to easily find out the risks and barriers that might affect project in terms of cost or time delays. Such tool may help in managing the construction work during the pandemic.
 - Divide the work in shifts and keep the workers separate where possible, in order to avoid the halation of construction work at sites.
 - Higher management should provide the sufficient information about the working environment in order to speed up the process.
 - Divide the work in shifts and keep the workers separate where possible.
 - Make sure that the project team work with their organization to identify backup plans.

- There should be regular visits from the project management team to site in order to monitor the working environment.
- Processes like screening before the entry of workers in working area this will help to control the spread.
- Report any safety and health concerns to higher management, more attention to the places where more workers are involved.
- Add any missing point from our factors depending upon the situation.

5.5 Summary

The guidelines are made for any future pandemic similar to COVID-19 at Government level, organization level and project level in order to manage construction work at sites. These guidelines are the results of the current research and will help to create safe working environment at construction projects during pandemics similar to COVID-19. Guidelines are provided for different levels in order to clarify the responsibility of everyone. Government authorities are dealing on multiple aspects with in region or country, guidelines provided in this research for government level specifically concerned with construction industry. Usually, multiple projects are operating in organizations, the guidelines provided here are only for the construction projects working under organizations. Guidelines for project level are presented by taking the COVID-19 pandemic environment and condition into consideration. These developed guidelines will be part of the planning will act as preventive instrument in controlling the spread of virus and maintaining the construction work. Though it is not possible to completely deal with the pandemic impacts, however with the help of these guidelines it can be significantly minimized.

Chapter 6

Conclusions and Recommendations

6.1 Conclusions

The scope of this research was limited to analysis of the COVID-19 pandemic impact on local construction sites and challenge that construction projects faced regarding resource management. The objective of this study was to identify the challenges faced by management while executing the construction work during the COVID-19 pandemic. The variables were identified and further divided to into sub categories (factors) to find out the impact of COVID-19 pandemic on local construction sites. With the help of Delphi technique, a comprehensive questionnaire was prepared. Prepared questionnaire was distributed among industry professionals for response collection purpose. Statistical testing was applied on the received responses. According to demographic analysis most of the respondents belonged to contractor firms (41%), while the age of mostly respondents (37%) is between 26-30 years, mostly (45%) had a degree of bachelor and experience of most respondents (46%) is between 1-5 years. Conclusions of the study are presented below;

According to the reliability analysis the data used for response measurement is complete and accurate and it is all set for further analysis.

The results of normality tests indicated linear behaviour in the data (Continuous, normally distributed, and spread of each group is different) which means parametric tests will perform well in this situation.

There is a strong correlation of the COVID-19 pandemic with the activity execution, and moderate correlation with resource management challenges.

According to the preliminary results of this research, activity execution and resource management are important parameters in construction sites.

- Activity execution and resource management were statistically significant at the 1% level and had positive signs which indicate that with the increase of COVID-19 pandemic, the activity execution and resource management challenges increases. If COVID-19 pandemic is increased by one unit the activity execution and resource management challenges will increase by 0.52, 0.49 units respectively.
- Management faced unexpected and unpredicted challenges while managing resources at construction projects due to COVID-19 pandemic. With the increase of every one unit of pandemic there is an increase of 0.49 unit of challenges in resource management ($\beta = 0.49$).

Frequency analysis has been used to observe the perception of the respondents.

- COVID-19 impacted society severely, virus have contagious nature and quick spreading pattern, the introduction of vaccines took long time, it affected people of different ages in different ways there were health problems, lockdowns, job losses, economic problems and many more.
- COVID-19 impacted the construction sites highly, there were halation and post-pending of the construction work which increased the completion time of projects, very few new strategies were adopted in the working system, the use of technology to manage the construction work was minimum. Very low progress made by the construction projects which shows the severe impacts of the pandemic on construction projects and industry.
- COVID-19 impacted the management of resources at construction projects as there were changes in working environment. Human resources suffered a lot due to travel restrictions, SOPs and health condition of workers. The un-functionality of transport and manufacturing industry made the unavailability of materials at site. Very few strategies were adopted by the management to manage the resources.

6.2 Recommendations

A few recommendations are presented here.

- Development of environmental risk factor matrix for sustainable construction practices during pandemics.
- This study is limited to only construction projects within Islamabad, similar kind of study can be conducted for a wider range of area like multiple regions.
- Future research can also be conducted to study impact of COVID-19 from occupation health and safety perspective on local construction industry with the modification of factors according to the study.

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Appendix-A

Questionnaire

Dear Respondent

My name is Faisal Yaseen and currently I am doing research as an integral part of MS Civil Engineering from Capital University of Science and Technology. This research is titled The impacts of COVID-19 on the local construction industry. This research focuses on the overall impact of COVID-19 on the construction industry and its related challenges with a particular focus on resource management. The outcome of this research will comprise strategies to deal with such circumstances in future.

A questionnaire has been developed in this regard. It comprises three sections in addition to the personal information section. Section one deals with collecting some basic information about COVID-19, its impact on daily life and preventive measure, section two majorly focuses on the impacts of COVID-19 on the construction industry whilst section three concentrates on the resource management during COVID-19.

Your contribution in this regard would be highly appreciated. Please be assure that the data will only be used for research purposes only and no personal information will be disclosed at any forum.

I sincerely appreciate your help, Thank you very much.

Faisal Yaseen,

MS Civil Engineering

Capital University of Science and Technology

Section 1: Demographics

Table generated by Excel2LaTeX from sheet 'Sheet1'

Gender	1- Male 2- Female
Age(years)	1(21-25), 2 (26-30), 3 (31-35), 4 (36-40), 5 (40-above)
Experience(years)	1 (1-5), 2 (6-10), 3 (11-15), 4 (16-20), 5 (20-above)
Qualification	1 (DAE), 2 (BS), 3 (MS), 4 (PhD), 5 (Others)

Section 02:

Covid-19 outbreak back in December 2019 and the World health organization declared it a pandemic in March 2020. Covid-19 disrupted the entire system of the world and created many challenges for the public and government authorities.

Keeping in view the pandemic situation, please select/tick (ρ) the right box. Here the scale used is as follows:

1= Very Low 2= Low 3= Medium 4= High 5= Very High.

Sr. No	Factors					
1	Information provided by the authorities about Covid-19	1	2	3	4	5
2	Efforts you made in gaining information about the COVID-19 pandemic to protect yourself	1	2	3	4	5
3	The impacts of COVID-19 on your life	1	2	3	4	5
4	Impacts of Covid-19 on your family, friends and colleagues	1	2	3	4	5
5	Impact of surgical masks in the prevention of Covid-19 spread	1	2	3	4	5
6	Impact of lockdowns on controlling the spread of Covid-19	1	2	3	4	5

7	Impact of vaccine as a protection against Covid-19	1	2	3	4	5
8	Health information available about COVID-19	1	2	3	4	5
9	Availability of medical facilities in your town	1	2	3	4	5
10	Availability of vaccines in your town	1	2	3	4	5
11	The impact of COVID-19 on society	1	2	3	4	5

Section 03

With the outbreak of COVID-19, there was a considerable loss to the construction industry. COVID-19 hit the construction industry very hard and created a challenging situation for the management to manage the construction activities.

Keeping in view the pandemic situation, please select/tick (ρ) the right box. Here the scale used is as follows:

1= Very Low 2= Low 3= Medium 4= High 5= Very High

Sr. No						
1	Impact of SOPs on the working environment of construction projects.	1	2	3	4	5
2	The impact of halation and postponing construction work during Covid-19 on the completion of the project.	1	2	3	4	5
3	Adoption of new strategies in the operating system of the construction project to counter the pandemic.	1	2	3	4	5
4	Impact of revised strategies on the performance of the construction project in the perspective of Covid-19.	1	2	3	4	5
5	Use of technology to manage construction work during Covid-19.	1	2	3	4	5

6	Effectiveness of work in shift process to continue the construction work during Covid-19	1	2	3	4	5
7	The emphasis from management to follow the SOPs at construction projects during COVID-19.	1	2	3	4	5
8	The available information provided by the higher management about working conditions during COVID-19.	1	2	3	4	5
9	The seriousness displayed by the workers in following instructions provided by management.	1	2	3	4	5
10	The halation's impact of the transport and aviation industry due to COVID-19 on the construction industry.	1	2	3	4	5
11	The impact of workplace safety guidelines related to pandemic such as social distancing, sanitizers etc. on the increase of project completion time.	1	2	3	4	5
12	The impact of COVID-19 on the construction industry.	1	2	3	4	5

Section 04

Proper management of resources is very important for the success of the projects. The outbreak of COVID-19 affected the availability of resources and also made it tough for the managers to manage the resources properly.

Keeping in view the pandemic situation, please select/tick (ρ) the right box. Here the scale used is as follows:

1= Very Low 2= Low 3= Medium 4= High 5= Very High

Sr. No	Factors					

1	Inclusion of new strategies from management to manage resources at the project during COVID-19.	1	2	3	4	5
2	Early preparation from management to manage resources at construction projects in response to warnings by the authorities.	1	2	3	4	5
3	Variance in resource management challenges during COVID-19 compared to normal days.	1	2	3	4	5
4	Impact of resource management challenges because of Covid-19 on the completion of the project.	1	2	3	4	5
5	The impact of COVID-19 on resource management.	1	2	3	4	5
6	The impact of COVID-19 on human resource management.	1	2	3	4	5
7	Impact of travel restrictions on the availability of human resources.	1	2	3	4	5
8	The impact of COVID-19 on material resource management.	1	2	3	4	5
9	Availability of material stock to execute ongoing construction projects.	1	2	3	4	5
10	The impact of COVID-19 lockdowns on the supply chain.	1	2	3	4	5
11	The impact of COVID-19 on the construction material manufacturing industry.	1	2	3	4	5
12	Impact of the closed borders on the availability of imported construction material.	1	2	3	4	5
13	The impact of newly adopted strategies on construction projects to deal with pandemic situations.	1	2	3	4	5

14	The control management had on resource management during the Covid-19.	1	2	3	4	5
15	The progress made by your project towards completion during COVID-19.	1	2	3	4	5

Sr.No	Factors	Mean	Median	Mode
1	Information provided by the authorities about Covid-19	3.41	3	3
2	Efforts you made in gaining information about the COVID-19 pandemic to protect yourself	3.35	3	4
3	The impacts of COVID-19 on your life	3.28	3	3
4	Impacts of Covid-19 on your family, friends and colleagues	3.24	3	3
5	Impact of surgical masks in the prevention of Covid-19 spread	3.28	3	3
6	Impact of lockdowns on controlling the spread of Covid-19	3.32	3	4
7	Impact of vaccine as a protection against Covid-19	3.61	4	4
8	Health information available about COVID-19	3.28	3	3
9	Availability of medical facilities in your town	3.31	3	3
10	Availability of vaccines in your town	3.5	4	4
11	The impact of COVID-19 on society	4.16	4	5

Sr.No	Factors	Mean	Median	Mode
1	Impact of SOPs on the working environment of construction projects.	3.14	3	3
2	The impact of halation and postponing construction work during Covid-19 on the completion of the project.	3.53	4	4
3	Adoption of new strategies in the operating system of the construction project to counter the pandemic.	2.59	3	2
4	Impact of revised strategies on the performance of the construction project in the perspective of Covid-19.	2.76	3	3
5	Use of technology to manage construction work during Covid-19.	2.36	2	2
6	Effectiveness of work in shift process to continue the construction work during Covid-19	3.03	3	3
7	The emphasis from management to follow the SOPs at construction projects during COVID-19.	3.36	3	3
8	The available information provided by the higher management about working conditions during COVID-19.	3.21	3	3
9	The seriousness displayed by the workers in following instructions provided by management.	2.78	3	3
10	The halation's impact of the transport and aviation industry due to COVID-19 on the construction industry.	3.47	4	4
11	The impact of workplace safety guidelines related to pandemic such as social distancing, sanitizers etc. on the increase of project completion time.	3.47	4	4
12	The impact of COVID-19 on the construction industry.	4.17	4	5

Sr.No	Factors	Mean	Median	Mode
1	Inclusion of new strategies from management to manage resources at the project during COVID-19.	2.57	3	3
2	Early preparation from management to manage resources at construction projects in response to warnings by the authorities.	2.72	3	2
3	Variance in resource management challenges during COVID-19 compared to normal days.	3.45	3	3
4	Impact of resource management challenges because of Covid-19 on the completion of the project.	3.63	4	3
5	The impact of COVID-19 on resource management.	3.73	4	4
6	The impact of COVID-19 on human resource management.	3.78	4	4
7	Impact of travel restrictions on the availability of human resources.	3.67	4	4
8	The impact of COVID-19 on material resource management.	3.45	4	4
9	Availability of material stock to execute ongoing construction projects.	2.91	3	2
10	The impact of COVID-19 lockdowns on the supply chain.	3.71	4	4
11	The impact of COVID-19 on the construction material manufacturing industry.	3.6	4	4
12	Impact of the closed borders on the availability of imported construction material.	3.52	4	4
13	The impact of newly adopted strategies on construction projects to deal with pandemic situations.	2.99	3	3
14	The control management had on resource management during the Covid-19.	3.06	3	3
15	The progress made by your project towards completion during COVID-19.	2.59	3	3
