Effects of the Pandemic on Construction Industry

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Abstract: Construction Industry has always been omnipresent for the betterment of the country and since past few decades it has reached new heights in India. Being second to only the Agriculture Industry and having a size of ₹10.5 trillion (As per National Account Statistics), its stability is critical to Indian's economic conditions. Many companies and various industries are dependent on this gigantic Construction Industry due to its enormous capabilities. Also, Construction Industry has one of the highest employment rates in India which is around 57.5 million people and that accounts to the GDP of 8 %. (As per Construction World Magazine). But recently, there's an impediment to the growth of construction industry, i.e., Coronavirus Pandemic. Because of which employment rate, growth and economy will see a huge hit. There will be huge uncertainties, loss of finance, development decline etc. in this phase of the pandemic. Fall in output, Supply chain and client – contractor relationships will also see a lot of ups and downs during the pandemic. Hence, a search in terms of this research has been done to know what has affected the construction industry during pandemic and post lockdown. Also, what were the effective measures that has been taken by the stakeholders during this period which helped them to ease down the problems caused by the effects of the pandemic. Triangulation method in terms of Qualitative and Quantitative Analysis has been undertaken in the research. Analysis for Qualitative method has been done by transcript analysis method and Henry Garett's ranking method and for the Quantitative method has been done by RII method with the help of SPSS software. Major contributing factors out of all the listed factors were ranked as per the responses to conclude the study.

Index Terms **– Construction Industry, Pandemic, Coronavirus, COVID-19, Effects, Impacts, Civil Industry.**

I. INTRODUCTION

Construction industry is an everlasting heartbeat which never stops and keeps on developing with time. Construction as a field is vast, with different areas like Roads, bridges, buildings etc. which are being constructed differently but are connected eventually as a unified body. For evolution of a country, the role of Infrastructure is gigantic, and with that Construction sector is forerunner in contribution with a prospected investment of around ₹ 2 Lakh CR of 99 cities with the plan of Smart City Initiative. (As per Ministry of Housing and Urban Affairs). Predicted development states the GVA (Gross Value Added) by the industry would be approximately $ 192 Bn in 2019-20 in comparison with 2018-19 which was $ 183.5 Bn (As per First Advance Estimates of National Income) and further ventures for the advancement of the infrastructure are valued at $ 965.5 Bn which will required by the sector by 2040 (As per India Infrastructure Sector). Construction sector is the essence of India's all-round augmentation and enhancement towards a rapid growing nation as in the past 5 years, it has devoted as manufacturing to around 8% of overall Gross Value added (GVA). (As per Monthly Income Review)

Being this fast paced, any hindrance to it will cause a domino effect from progress to finance to development. Construction sector which was already facing gritty challenges is now impaired with a global pandemic which is Covid-19 or Coronavirus, declared by WHO on March 11, 2020. As per World Health Organization "Pandemic is the transmission of the disease amongst the people around the world". Globally, to slow down the impact of Coronavirus, each country imposed partial to total lockdown for several months. These lockdowns hit hard, from delays of the project, disruptions in supply chains, to equipment and machineries staying put on site for days piling up cost of depreciation and rent and as it seems, construction industry has been facing an approximated impact of ₹ 30,000 CR a day due to the pandemic with a contraction of investments up to 13-30%. (As per Money Control)

Contractual confusions due to corrigendum and addendums happened due to delays, change in plans, alteration in the project increased due to the pandemic situation. Also, due to the ongoing situations, various restrictions have been put to curb the problems that are risen, which in turn have affected the availability of manpower as due to the aftermaths of the lockdown, this crisis has distressed around 8.5 million jobs across the country (As per Financial Express). Rising rates of raw materials, especially cement and iron prices which saw almost 50% increase in the first quarter of 2021 (As per Construction World), has contributed to the delays of the project to greater extent. But, safeguarding and preplanning for the inevitable or evaluating the contractual conditions if the inevitable did happen, to find the possibilities of reducing the degree of impact gives a new lifeline to the projects that are currently underway in this sector.

With divided funds with the Government for the Covid-19 relief, construction sector will have to take a backseat. Economic crunch to carry out the project, burden due to low in-come will have cumulative effect which will also be interrelated to many other branches of the industry. Adding to it, Labor Migration and Employee retention and management will be a headache as construction sector has the largest contribution to migrant workers and employees. During the lockdown, it was reported that there were around 6 Lakh workers that went on foot to their villages and 10 lakh workers were inducted in relief camps and were given jobs to discrete sectors. (As per Government of India). Therefore, with appropriate measures and situational analysis and decisions, current wrath of the pandemic can be minimized and that will be studied in this research.

II. NEED FOR STUDY

With construction industry grasping for breath in the initial stages of the pandemic and with its added effect on the infrastructure development and economic aid, there was a need of the hour for common effects of the pandemic that became a thorn in the path for this sector. And with a general idea of all the effects that has happened, it will be crucial to rectify that phase of

effect which will accelerate the healing of that impact on the construction sector. Also, these might help in predetermining and Pre-planning to battle any similar situation that may arise on the future.

III. Objective and Scope

The main objective of this research was to identify the effects that has happened over the course of time of the pandemic on the construction industry and also an overview on steps that has been taken by the respective stakeholders on their projects which will be helpful as proposition in current situation or any forthcoming situations.

IV. Research Methodology

4.1 Research Methodology

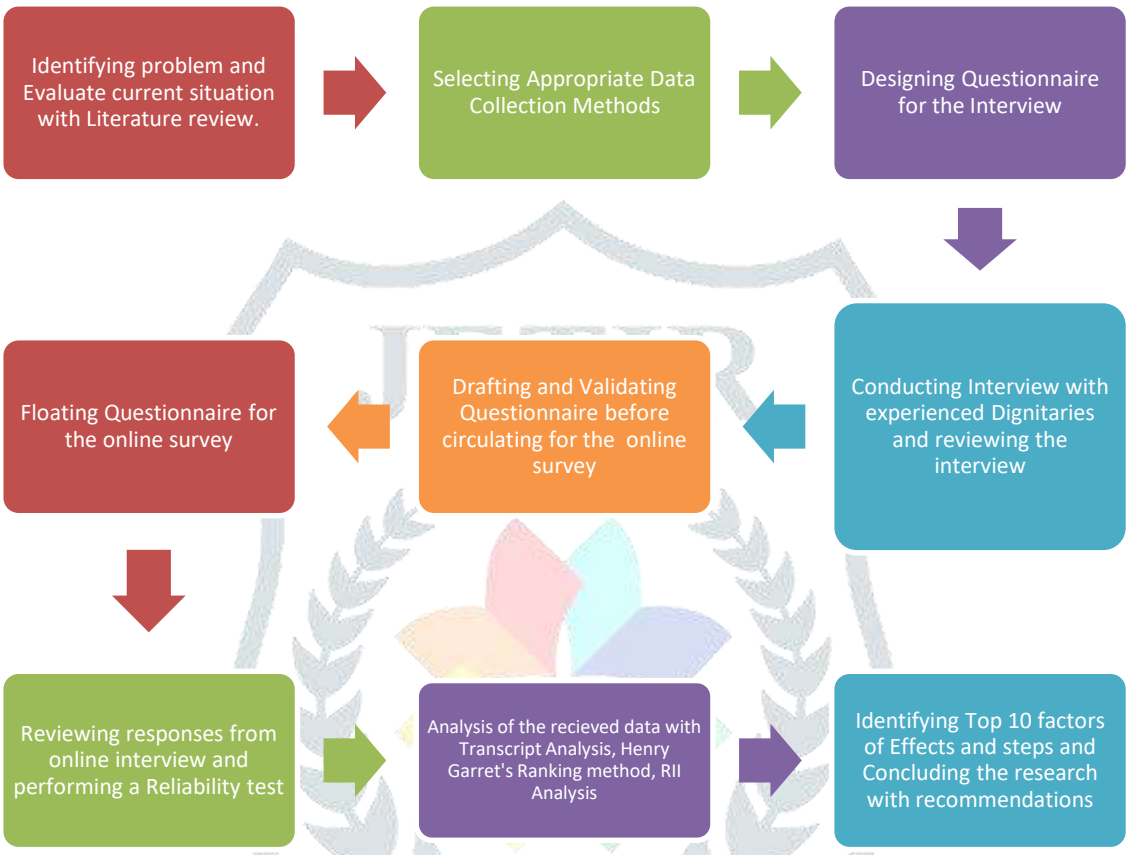


Chart 4. 1 Research Methodology

4.2 Learning from Literature

During the pandemic, construction projects have been delayed for quite a lot of time and some have been paused indefinitely due to time and cash crunches. Financial Capabilities and less labor force have been among the major issues during the period of the pandemic. Supply chain management has been dealt with the help of constant approach and relationships have been maintained. But that depended on the type of projects, small scale projects saw dip in supply chain department. Rate of transmission of the virus had different effect in different section of employees in work force and that depended on capacity of work, area of construction space, everyday productivity, population of labor in a group, etc. Training and raising awareness have helped to slowdown the transmission rate in the construction space but supply and distribution of PPE kits related to the coronavirus safety has varied rate of supply and availability.

Due to Prophylactic absenteeism, disruption in labor force and supply chain resulted depletion in the productivity. Also, there has been some problems on work places in implementation of COVID-19 related protocols as workforce resisted to wear masks or social distancing or other stringent rules. There has been fear of investment in the projects with stringent bank policies which affected the financial department of the construction industry. With all these factors identified from the literature, a base was created which helped in the data collection and analysis. A proper study of contractual conditions is needed to have a proper path of emergency exit from the current pandemic scenario. Apart from on-site cases, Individual's ability towards handling the crisis, their knowledge, attitude, practice towards the pandemic on their project should be assessed as a study to demonstrate how one should act to minimize the effects on their construction sites or workplaces.

There were certain limitations too in some of the papers that needed to be addressed like some papers had theoretical backing with slight practical facts to support their conclusions. Some papers missed out on financial and economic aspects of the impact on the construction projects. One of the important topics of mental health of the workforce or people involved in the project was least mentioned. Few papers had data collection revolved around the safety of workplace from the transmission of virus which had biased social responses. Less factors related to effects were covered in some researches in data collection.

V. DATA COLLECTION

Data collection is a process of gathering relevant information that gives a factual backing to the said topic. The steps involved asserts proper analysis of the problem statement of the topic. Here, Triangulation method was adopted, as shown in chart 5.1, where both Qualitative research method and Quantitative research method were undertaken. In Qualitative approach, Open end Interviews were undertaken which was adopted as a primary data. Separate Questionnaire survey was conducted for the Quantitative Research Method as secondary data collection for in depth data collection.

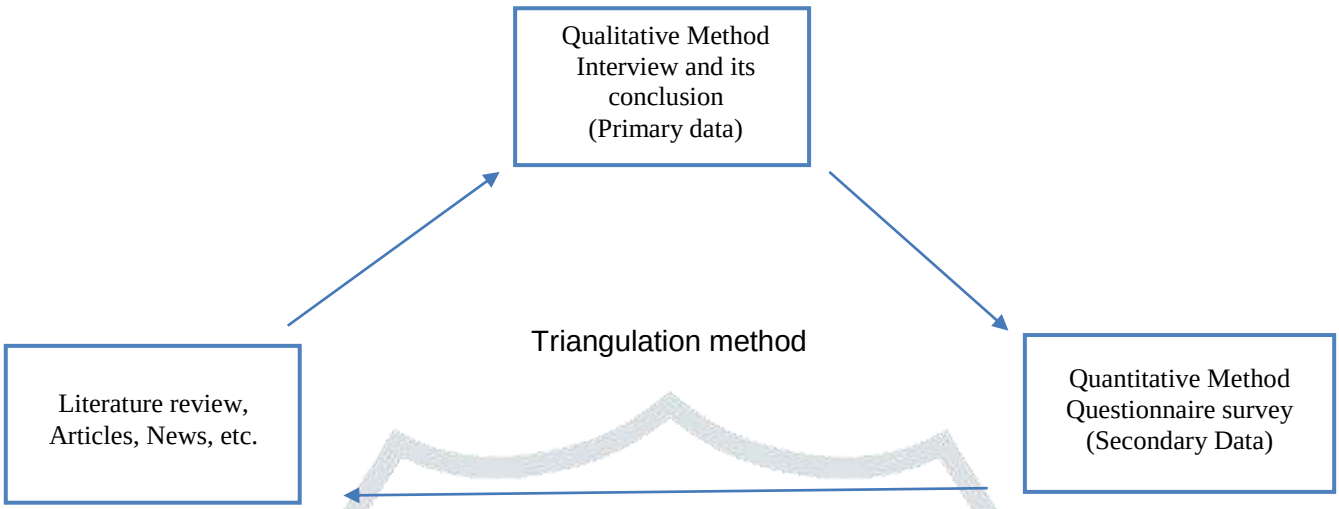


Chart 5. 1 – Triangulation Method

Agenda behind the survey was to gather relevant information on a larger scale with large number of audiences that will help to solidify the purpose of the research. Interviews were conducted via telephonic calls to maintain safety during the pandemic. To circulate the survey, online means where used which will help to reach questionnaire to required number of people.

5.1 Questionnaire Design

5.1.1 Qualitative Questionnaire Design

Questionnaire for the Open-End Interview was generated by reviewing various case studies, literatures, articles and various internet researches. Four categories or factors were identified as base of the questionnaire after which the interview was conducted, which were;

1. Financial
2. Human Resource
3. Operational
4. Marketing

At the end of the interview, Henry Garrett's ranking method was utilized to identify the most to least affected category as per the interviewee. Respondents were asked to rank the four categories in terms of their impact; 1 being the highest and 4 being the lowest hit impact on the industry.

5.1.2 Quantitative Questionnaire Design

Questionnaire survey for the Quantitative research method is structured based on Likert Scale Analysis after results that were analyzed in the Qualitative research. This survey was further validated with discussions and comments generated by the respective professionals in the construction sector. Survey was divided into 2 parts, that were;

i. *Major effects that caused the hindrance*: Various factors were identified in terms of the effects that has hindered the construction industry. 21 of such Factors were pinpointed based on the experience shared by the stakeholders and other literature reviews and articles referred, those were:

1 Labor availability after Migration
2 Time Constraints
3 Cost Constraints
4 Credit Limit
5 Bank Policies.
6 Contractual Condition
7 Raw Material Price Escalation
8 Monsoon Delay
9 Supply Chain
10 Inventory Management
11 Project Location
12 Productivity and Output.
13 Labor hopping due to more wage on other site
14 Social Distancing
15 Safety hazards
16 Work Force Mental Health
17 Hesitation to work post lockdown
18 Infection on site
19 Workforce management Post Unlock.
20 Workforce retention
21 Permission for Cross Border Transportation

ii. *Favorable steps during this situation:* Helpful steps that were taken by the stakeholders in the construction sector were mentioned in terms of factors for the respondents. 21 of such steps as factors were identified in 4 categories and listed for the survey, those were:

I. *Financial*:

1 Reducing the profit margins of the project to pay salaries, rents, bill payments etc.
2 How beneficial is part rate pay for payment related obligations?
3 Long-term investments in digitization for construction activities

4 Price prediction and buying before price escalation of raw material
5 Just in time buying during price escalation for inventory
II. *Human Resource*:
6 Using trade validation, i.e., checking output of a labour twice a week to keep it above required rate.
7 Proper sanitization and medical facilities and training on site for improving assurance.
8 Fulfilment of high labour wages post lockdown for labour retention
9 Reducing no. of employees in offices and having shifts by providing work from home to avoid congestions
10 Using biometrics to track labours and employees on medical terms.
11 Digital record for workforce in case of an emergency
12 Co-vid 19 insurance for workforce to aid belief.
13 Increasing work force to recover the delay and reduce overheads at the end of the project.
14 Inducting Local labour forces instead of labours from different state for easing problems of labour migration.
III. *Operational*:
15 BIM as a software for tracking and monitoring delay.
16 Standardization in design of structures for easy procurement.
17 Increase in off-site or cast-in-situ construction for accelerating construction.
18 Opening all fronts and multiplying work by increasing working hours.
19 Re-scheduling in construction activities to avoid slowdown and bottleneck.
IV. *Marketing*:
20 Increasing profit margins for suppliers for supplier retention
21 Digitization for promotional activities of the project

5.2 Sample Size Calculation

Sample size calculation is necessary for determining the size of the population to whom the questionnaire survey will be distributed. Equation for the calculation used was:

$$SS = \frac{Z^2 * p * (1-p)}{c^2}$$

Where; Z = Statistic value of confidence level (1.96 for the 95% Confidence Level)
P = Percentage picking choice (If not known then use 0.5) (50% expressed in decimal)
C = Confidence interval 10% (0.1 in decimal)

$$New\ SS = \frac{SS}{1+\frac{SS-1}{pop}}$$

With the analysis, Population size was 70 where questionnaire was distributed via online mediums to the selected audience as per the sample size analysis.

VI. Data Analysis and Results

Three methods of analysis for the collected data were inherited. For the interview conducted in Qualitative method, Transcript analysis method was done along with Henry Garrett's ranking method and in the Quantitative method, Relative Importance Index (RII) was done with the help of a software named SPSS. A total of 70 respondents for survey and 7 for open end interview were approached for the data collection which ensured the goal to have a reach to every personnel possible with all kind of experience and post. Top 10 factors of Effects and favorable steps were mentioned for the study.

6.1 Reliability Test

Before Analysis in Likert Scale Questionnaire, Reliability test has to be conducted in the SPSS software to know the reliability and internal consistency of the scale. Cronbach's Alpha (α) value in reliability test ranges from 0 to 1 and the value near to 1 indicates very reliable data and consistency of the scale. Below is the range for Cronbach's Alpha (α) value:

0.91-1.00	Excellent
0.81-0.90	Good
0.61-0.80	Acceptable
0.01-0.60	Not Acceptable

Table 6. 1 - Range of Cronbach's Alpha (α) value for Reliability test

I. *Major effects that caused the hindrance:*

Case Processing Summary			
		N	%
Cases	Valid	70	100.0
	Excluded	0	0
	Total	70	100.0
Reliability Statistics			
Cronbach's Alpha		N of Items	
0.904		21	

II. *Favorable steps during this situation:*

Case Processing Summary			
		N	%
Cases	Valid	70	100.0
	Excluded	0	0
	Total	70	100.0
Reliability Statistics			
Cronbach's Alpha		N of Items	
0.906		21	

Table 6. 2 - Reliability test for section I and II

As per Table 5.1, Cronbach Alpha's value was **0.904** and **0.906** which shows immense reliability and consistency of the scale.

6.2 Transcript Analysis

These are some of the impacts being known from the transcript of the interviews taken:

6.2.1. Financial:

Cashflow on site increased post lockdown due to Sanitization, providing masks, labor facilities, etc.

Type	Cost increased
Small or Medium size project	Around 5%
Consultants	5-6%
Large Scale project	0.5 - 1 %

**These were tentative increase issued as per response.*

Table 6. 3 - Responses on Cashflow Impacts

Fulfilling all the payment related obligations were done by acquiring loss from the side of the payer. Some strategies were applied to reduce the loss inherited on the project. In raw materials, Cement and Steel had exponential growth in terms of cost where projects that have Cement and Steel use in abundance post lockdown saw 40% tentative increase in cost. Other than that, 5-10% increase in raw material cost. Post lockdown, labour wages were increased around 20-30% but it was manageable as per the respondents. Credit limit of contractors also took a hit post lockdown. Overall cost of the project had tentative increase, like:

Type	Increase
Private Projects	5-10%
Government Project	8-12%

**These were tentative increase issued as per response.*

Table 6. 4 - Responses on Increase Overall Cost of the Project

6.2.2 Human Resource:

Workforce in offices were reduced and Work from home was adopted. Shift changes were introduced for less people in confined spaces. Labour Migration had massive affect where firms with non-local labour had to use cross border transportation with required permissions for their labour force while others had to make use of local labour force. Counselling, Post-Lockdown Training, Health Tracking etc. were done on the projects. Labour hopping was a major issue post lockdown as they tend to leave the ongoing work for higher wages elsewhere. Manpower was increased where delays were significant. Post lockdown, 60-80% Manpower was retained for the project which seemed as a positive progress.

6.2.3 Operational:

Huge delay faced, even some projects were paused indefinitely due to lack of funds and manpower. Various Government projects seemed timeline driven and due to excessive delays, financial capabilities took a backseat. Reduced output ranged from:

Size	Reduced Output
Small Scale	10-15%
Medium Scale	20%
Large Scale	25-30%

*These were tentative decrease issued as per response.

Table 6. 5 - Responses on Reduced Input

6.2.4 Marketing

Small scale projects seemed to hamper supplier relationships due to rate of demand. Other project had no effect in supplier relationship. Promotion stopped and was affected as required finance was flushed in operation and human resource.

6.2 Henry Garrett's Ranking Method

Respondents were asked to rank these 4 categories from 1 to 4 with 1 being the highest and 4 being the lowest, and these were the results based on their responses:

Categories	Rank				Total Responses
	1	2	3	4	
Financial	4	2	1	0	7
Human Resources	3	2	2	0	7
Operational	0	3	4	0	7
Marketing	0	0	0	7	7

Table 6. 6 - Responses for Garrett's Value

Categories	Garret's Score	Avg. Score	Rank
Financial	448	64	**1**
Human Resources	419	59.85	**2**
Operational	344	49.14	**3**
Marketing	196	28	**4**

Table 6. 7 - Garrett's Ranking Table

As per the respondents, financial category seemed to be impacted the highest of all the factors with Human Resources category being close second. Operational seemed to be impacted after the two with marketing being the least impactful out of the four categories during the pandemic.

6.3 Relative Importance Index

In quantitative research after collecting the relevant data from only survey and performing successful reliability test, Relative Importance Index was performed to rank top 10 factors from both the sections of the questionnaire. Below was the equation to formulate RII method:

$RII = \sum \frac{W}{A*N}$, where; Where W is the weightage assigned to each response category.

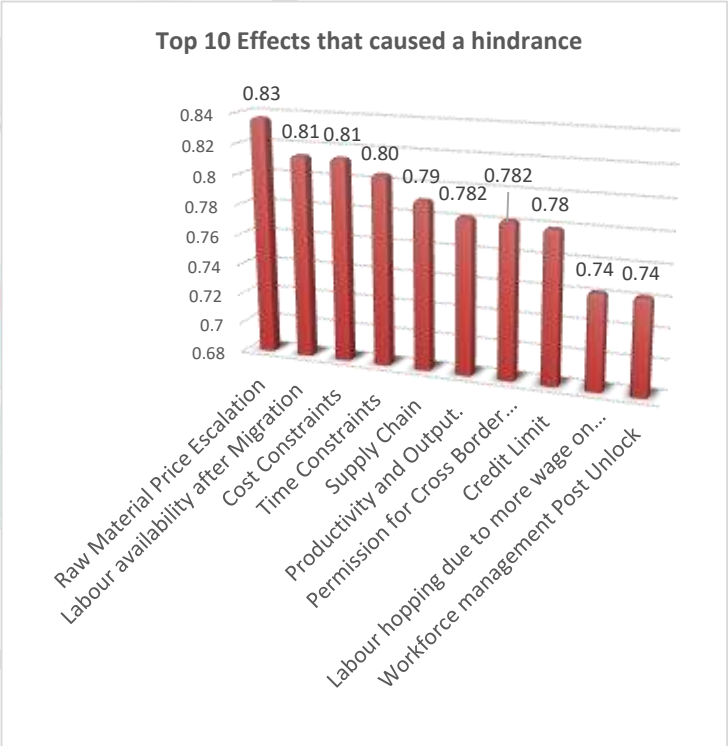
A is the maximum weightage and

N is the total number of samples.

6.3.1 Result of Relative Importance Index

Rank	Factor	Factor No.	RII
1	Raw material price escalation	7	0.837143
2	Labor availability after migration	1	0.814286
3	Cost constraints	3	0.814286
4	Time constraints	2	0.805714
5	Supply chain	9	0.791429
6	Productivity and output	12	0.782857
7	Permission for cross border transportation	21	0.782857
8	Credit limit	4	0.78
9	Labor hopping due to more wage on other site	13	0.742857
10	Workforce Management Post Lockdown	19	0.742857

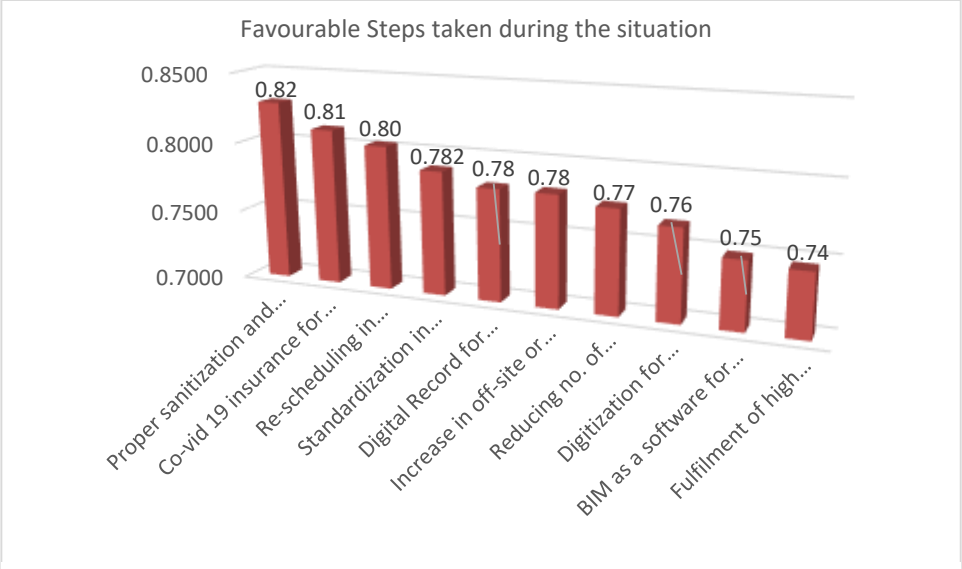
Table 6. 8 - RII for Effects that caused a hindrance



Graph 6. 1 - RII for Effects that caused a hindrance

Rank	Factor	Factor No.	RII
1	Proper sanitization and medical facilities and training on site for improving assurance.	7	0.8286
2	Co-vid 19 insurance for workforce to aid belief.	12	0.8114
3	Re-scheduling in construction activities to avoid slowdown and bottleneck.	19	0.8029
4	Standardization in design of structures for easy procurement.	16	0.7886
5	Digital Record for workforce in case of emergency.	11	0.7800
6	Increase in off-site or cast-in-situ construction for accelerating construction.	17	0.7800
7	Reducing no. of employees in offices and having shifts by providing work from home to avoid congestions.	9	0.7743
8	Digitization for promotional activities of the project.	21	0.7657
9	BIM as a software for tracking and monitoring delay.	15	0.7486
10	Fulfilment of high labour wages post lockdown for labour retention	8	0.7457

Table 6. 9 – RII for Favourable Steps taken during this situation



Graph 6. 2 - RII for Favourable Steps taken during this situation

VII. Conclusion

To curb the transmission of the disease on greater extent, Government took a decision of total lockdown of complete restriction on all the activities. This unfortunately had some serious consequences on this sector where many projects had to be delayed or locked shut indefinitely. And out of the possible damages, Financial Conditions were crippled the most followed by the problems of Human resource. High rise in raw material prices, which was around 5-10% after the unlock gave rise to the other payment related obligations where contractors were indebted in credit limits and eventually increasing project cost. In addition, miscellaneous cashflow on site rose approximately 0.5 - 5 % based on the type of projects which included sanitization and expense on safety protocols. Due to Labor migration, many projects saw their labor force depleted where labor force hopped on to other sites due to higher wages being offered as wages saw an increase of 20 – 30% post unlock. Consequently, many construction sites saw dip in productivity rates, which ranged from 10-30% based on the type of project, due to fear of transmission of the virus on the project, less workforce, new inductees which seemed incompetent and many amassed reasons. Workforce retention primarily aligned about 60-80% for many projects which seemed a positive sign as workforce went through major safety concerns and mental health issues post lockdown and management dealt rigorously to keep them on board.

Post-unlock during the pandemic, offices and sites had to work differently during their routine hours. Various trainings for awareness, SOPs, Social distancing, Masks, Constant temperature checks etc. seemed to be the new normal for the employees and workers. Work from home became a thing when office reduced their staff working capacity to 50% to maintain social distancing, employees were working from home and digital work space became mainstream during the pandemic. Supply chain also experienced irregularity as small-scale suppliers faced problems to survive during the pandemic.

To ease the impacts there were certain steps undertaken by the stakeholders which were mentioned in the study to which additional recommendations can be suggested such as profit margins can be reduced to content payment related obligations. Major focus should be laid on amending COVID-19 insurance and management should also full-filling labor wages for workforce retention. Work-hours can be multiplied by introducing dual shifts of workforce which will aid delays. Rescheduling activities by opening all fronts of work that will help in reducing the bottlenecks at the end of the project. Standardization of materials for easy and quick construction that will smoothen the flow of activities. Flexible contract rates can be implemented with suppliers for their retention. In case of medical emergency of a particular labor, well-structured Digital record will be helpful for proper guidance of their medical history and background.

VIII. Future Scope

Henceforth, this research will seek to alleviate the understanding of effects that has happened over the course of time with actions that are needed to be accomplished to abate the consequences on the projects or in the construction sector altogether. Digitization has been a drive for success to constantly streamline the activities on the project. Projects have also benefited from Pre-Fabricated construction which helped facilitate recovery of delays. Thus, future study on these two fields will be fruitful when unforeseen situations like pandemic arises.

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