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Construction Sector & Post Covid-19 Mitigation Practices

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Abstract: The construction industry plays a vital role in the country's economic development and growth. There would be a significant impact on the economy if construction projects are being delayed. As the pandemic of COVID-19 rose into our globe it affected the construction industry, including building projects. Identifying the underlying problems caused by COVID-19 can provide the best solution to reduce the pandemic's impact. Consequently, emphasizing the impact of COVID-19 and the strategies to address those problems in the building construction industry becomes vital.

The research objective is to identify problems caused by COVID-19 in the building construction industry and mechanisms to reduce COVID-19's negative impact. The data collection involved the online questionnaire survey and individual interviews with 3 individuals having area of expertise in civil engineering. After collection of data it was analyzed using the RII method approach. The findings show that supply chain disruption, shortage of material to running project, sudden fluctuation of material price and workforce reduction are the major impacts caused due to global pandemic on the construction sector. In addition to that, various in-situ working professionals faced difficulties in maintaining social distancing onto the construction sector and adjusting to newly formed working schedule. After recognizing the loophole and going into roots of the problem, it has been observed that major beneficiary remedial measures have to be taken by the construction industry to revive the construction sector i.e. providing health /covid 19 precautionary measures on the construction sites, implementing modular construction techniques and maintaining social distancing on the workplace, severity of the impacts will be minimized**.**

Index Terms **- Covid-19, Remedial Measures, Construction industry, Impact of Pandemic**

I. INTRODUCTION

There is no place in today's globalized world that has not been damaged by the Corona virus (COVID-19) pandemic. Almost all commercial, economic and social activities are suffering from the COVID-19 pandemic. Similarly, the construction and engineering industries are no different, they are also suffering from this crisis. Corona virus is an infectious disease therefore to stop the spread of this disease, the construction work has been temporarily stopped keeping in mind the concerns of the workers in the construction industry. as a result, construction industries are gaining nothing but losses, which have an impact on the world economy. It has also disrupted the transportation system which has disrupted the supply of materials.

This study aims to investigate the effect of COVID 19 on the construction industry. The impacts and fallout have been determined and evaluated through the interaction with construction experts. The impacts have been classified into different groups which include time overrun, Cost overrun, psychological impact and global impact. The study applied two methods viz. exploratory interviews and questionnaire surveys. This research shows that COVID-19 caused operational and financial issues, while financial aids and complete information was needed to overcome those impacts. These findings shed light on the consequences of the sudden occurrence of pandemic and raise awareness of the most critical impacts which can't be overlooked and will help policymakers improve existing strategic plans and create new policies to cope with the circumstances caused by COVID-19 among building construction organizations and implementing the roadmap for withstanding firmly if such kind of pandemic comes near in the future.

II.EVOLUTION OF COVID-19

It is necessary to know how the covid-19 global pandemic evolved in India and finding approaches to reduce the adverse effects of COVID-19 is crucial to avoid negative economic growth in the nation that can eventually result in an economic recession, and this necessitates a study for restricting the major onslaught.

Timeline

On 12 January 2020, the WHO confirmed that a novel coronavirus was the cause of a respiratory illness in a cluster of people in Wuhan, Hubei, China, which was reported to the WHO on 31 December 2019. On 30 January 2020, India reported its first case of COVID-19 in Thrissur, Kerala, which rose to three cases by 3 February 2020; all were students returning from Wuhan. Transmissions increased over the month after several people with travel history to affected countries, and their contacts, tested positive. On 12 March, a 76-year-old man, with a travel history to Saudi Arabia, became the first COVID-19 fatality of

India. In July 2020, it was estimated based on antibody tests that at least 57% of the inhabitants of Mumbai's slums may have been infected with COVID-19 at some point.

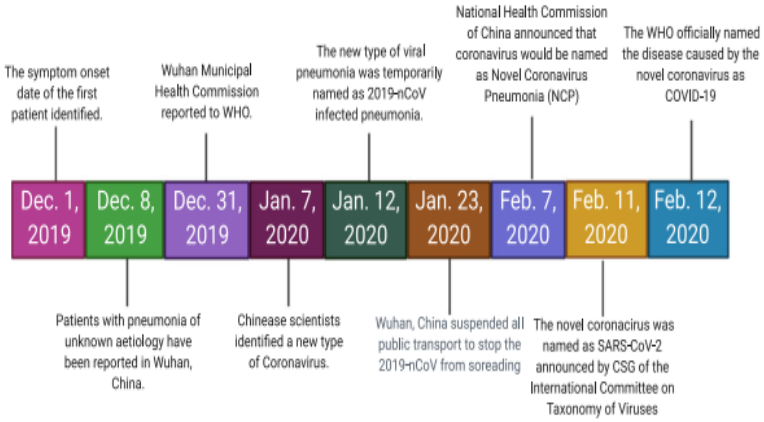

Fig 1. Pandemic Timeline

III.METHODOLOGY

This study adopted two methods to collect the data. The first method is quantitative data by associating construction practitioners to assess the level of impact and further assessment & analysis with the help of graphical studies. A total of 57 respondents participated in answering the questionnaire survey. The second method was by conducting an exploratory interview with five selected experts from the construction industry sectors to share and express their insights and opinions on the current state of the construction industry in the mid of pandemic freely. Additionally, the experts were asked to share the impact of the pandemic on the construction industry. Unfortunately, only three of the five responded.

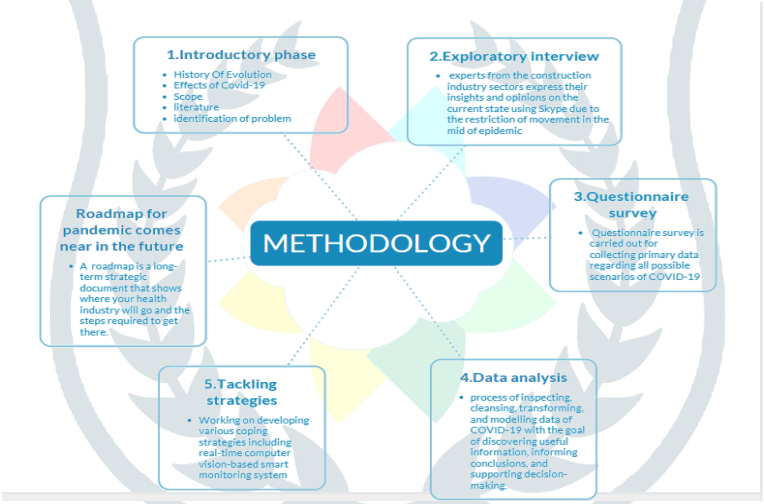

Fig 2. Methodology

Figure 2 demonstrates the process adopted to conduct the research. The introductory part focused on the literature to define and identify the scope, problem, and objectives of the study. The second part involves the process of exploratory interviews with construction experts to determine the impacts of the pandemic on the survival of the construction industry. The third phase is to evaluate the impacts by involving construction practitioners using a questionnaire survey. The respondents were asked to select the impacts, challenges and precautionary measures and effective management solution.

This study aimed to analyze the impact of COVID-19 on global construction industry performance, even though the case of the pandemic is currently less in developing countries. The study gives more explanation on various issue and effects arises during pandemic and their economic impact and also present a roadmap to tackle such kind of conditions if it comes in future.

3.1 Preparation of Questionnaire

To capture the responses from the various stakeholders of the construction industry such as Engineers, Contractors, Architects and Owners, a questionnaire was prepared. All the identified factors, effects and challenges were incorporated in the form of a questionnaire. An online Questionnaire survey was made via Google forms in two-stages.

1st Stage: The preparation and formatting of virtual form was done to collect the primary data of impact of covid-19 on the construction industry, challenge faced by in-situ workers and what were the precautionary measures taken in the middle of that scenarios for minimizing the damages.

2nd Stage: Site visit was carried out. The purpose of the site visit was to examine the damages and problems occur and try to approach this survey through those eyes which had seen the real-time scenarios. This would help us to work on identification of the problems and would help to formulate strategies to face better if such pandemic reappeared in future.

3.2 Data Collection & Analysis

Data Collection: data collection has been categorized into 4 different parts.

I. Impacts
II. Challenges
III. Precautionary measures
IV. Effective management suggestions

Firstly, the assessment, analysis and ranking of various impacts affecting the construction industry was done based on the parameters as to how majorly and minorly it had affected the sector. After that, challenges faced by the stakeholders during the Pandemic Situation has been evaluated based on the respective parameters. Later on various kinds of remedial measures adopted on construction sites to revive the construction sector against this Pandemic has been discussed.

Factor rating is used as 1-5 point Likert scale method. It's a type of psychometric response for surveying and this type of Likert scale is widely used in the market research. In this study the Likert scale is used to rate their opinion about constraints in the project scheduling. For collecting of data related to measures adopted by the construction industry to deal with the pandemic evaluated with condition levels i.e.1. Strongly disagree 2. Disagree 3. Neither agree nor disagree 4. Agree 5. Strongly Agree for ranking to the strategies to be adopted.

3.3 Data Analysis: Responses received from different stakeholders are analyzed using pie charts and bar charts. For ranking to the strategies RII method was used.

IV. RESULT AND DISCUSSION

The following results are mostly from preliminary data of the questionnaire survey via Google forms. The results of the impacts of covid-19 onto construction sector, challenges faced by the labors and in-situ workers have been discussed below. The tables contain precautionary measures analysis results calculated from graphical analysis and RII method.

Questionnaire Survey Analysis

Questionnaire survey was carried out for gathering statistical information about the impacts, effects on construction sector by a structured set of questions.

The questionnaire was been sub-divided into 5 different sections:

1.Respondents Details
2.Assessment of the Impacts of Pandemic on the construction Projects
3.Challenges Faced By the stakeholders during Pandemic Situation
4.Remedial measures
5.Effective Management Suggestions

4.1 Section 1: Respondents Details

Total 57 survey responses were received from the different stakeholders of Indian construction sector.

Fig 3 shows profiles of the respondent were a part of this study, mainly 44 Engineers (75.9%), 7 Contractor (12.1%), 4 Architects (6.9%), 3 clients (5.2%). The experts in the respective fields were given the option of responding Via online mode (i.e. Google form) designed in such a way that it is more easy to go through and scroll down to select the appropriate responses for each question as well as productive while generating primary research data. It was sent with crystal clear clarity of objective to the respondents who were the pillars of the research.

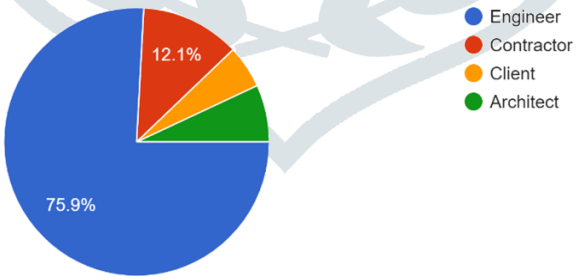

Fig 3: Respondents Profile

Fig 4 below shows that out of 57 participants 20 (34.5%) were from private organization while 19 (32.8%) belong from government authorized commodities and remaining 19 (32.8%) were from other parts of sectors.

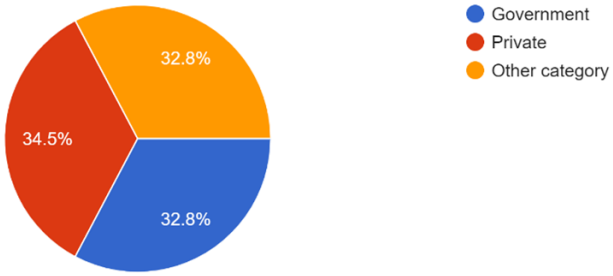

Fig 4: Category of organization

Fig 5 represents the role of participants into respective organizations. Out of 57 participants, 10 site engineers (17.2%),12 project engineers (20.7%), 9 architect/designers (15.5%),7 were project managers (12.1%) and remaining 18 (31%) were from other parts of industry.

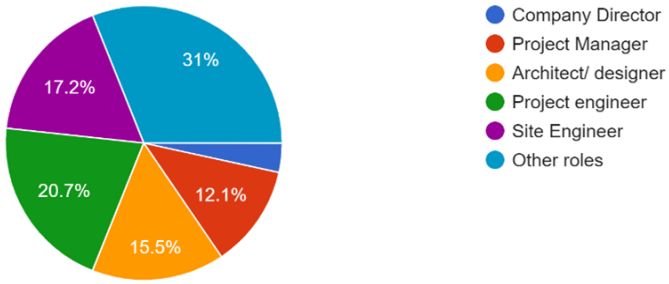

Fig 5: Role of a participant in the organization

Fig 6 below graphically shows the highest level of education of participants. Out of 57 respondents, 33 (56.9 %) were degree graduates whereas 13 (22.5%) were masters in different specialization of civil engineering, 12 (20.7%) were diploma holders. 54 (93.1%) respondents were having the experience in between 0-10 years. 3 respondents were having the experience of 11-20 years whereas 1 working professional having abundant experience in the field of construction which lies in between 21-30 years.

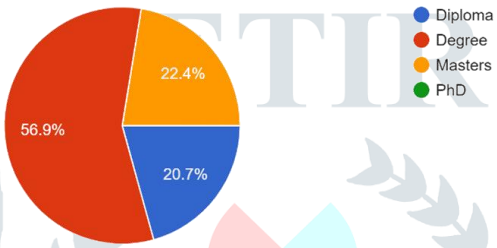

Fig 6: Highest level of education

4.2 Section 2: Assessment of the impacts of pandemic on the construction projects

Section 2 specifically works onto data assessment of the impacts of covid-19 onto the construction sector in which impacts have been categorized into 4 different parts i.e. Time Overrun, Cost Overrun, Psychological Impacts and Global Impact.

Table 1: Assessment of the Impacts of Pandemic on the Construction Project

SR NO	IMPACTS OF PANDEMIC ON THE CONSTRUCTION PROJECT	TOTAL (Out Off 57)	RANK
	Time Overrun		
1	Shortage of materials to support running projects and sudden fluctuation of material price.	45	2
2	Consideration of allowed working hours during COVID-19 Pandemic (Time Reduction)	42	4
3	Reducing number of workers on construction site to comply with social distancing (Workforce Reduction)	44	3
4	Reduced accessibility of updated tools and equipment needed to accomplish the tasks	32	13
	Cost Overrun		
5	Due to strict health protocols (Masks, Hand gloves, Sanitizers) increased project cost	40	6
6	Overtime schedule requirement	41	5
7	Supply chain disruptions	48	1
8	Material Prices tend to rise	40	7
9	Increase in labor price	38	8
10	High rental price of equipment	30	15

	Psychological Impacts		
11	Social isolation due to teleworking	33	12
12	Stress and burnout	29	16
13	Uncertainty of survival	37	9
14	Uncertainty regarding future of workplace	26	18
	Global Impact		
15	Socio- economic impact	36	10
16	Impact on research and technology	32	14
17	Effect of COVID-19 On Vulnerable groups (age)	28	17
18	Impacts on migrant workforce	35	11

Table 1 shows the graphical representation of the assessment of impacts on the construction sector by the respondent. The ranking was given based onto the severity or amount of damage done by the impacts onto the sector in which effect of COVID-19 on Supply chain was ranked first whereas shortage of materials to support running projects and sudden fluctuation of material price was ranked second. Reducing number of workers on construction site to comply with social distancing (Workforce Reduction) ranked as third out of eighteen impacts which have been sub-categorized into 4 different parts and the ranking goes on from major to minor.

4.3 Section 3: Challenges faced by the stakeholders during pandemic situation

Section 3 mainly focuses on the challenges faced by the stakeholders during the pandemic situation where the challenges have been categorized into 3 different parts:

- Challenges Faced by Workers
- Challenges Faced by Engineers
- Challenges faced by the Contractor

Challenges have been sub categorized into further parts: health and safety on-site; economic cost; possible legal exposures; manpower availability; instability of the supply chain and subcontractors; and the uncertainty related to the constant and unpredictable evolution of the pandemic. The magnitude of each challenge was also found to differ depending on the size of the site, labors involved and administrative interference. As table 2 represent the ranking was done on the basis of Priorities given by each respondent whereas it involves some social and emotional inference while decision making.

Major Challenges are as follows: (1) Difficulties while maintaining social distance on construction site (2) Difficult to comply with the government guidelines (3) Uncertainty of survival regarding ongoing situation (4) Lack of co-ordination and direction due to poor communication (5) Difficult to manage expenditure due to payment delay (6) Labor shortage (7) Arrangement of accommodation for workers, (8) Difficult for adjusting a new work schedule due to unpredictability about working condition (9) Difficulties arise to access new technologies for upgradation and betterment (10) Increase in labor price (11) Supply Chain disruptions (12) Material prices tend to rise (13) Contractual implication problems (14) Inaccessibility to tools and updated equipment (15) Supply Chain disruptions (16) Contractual implication problems (18) Inaccessibility to tools and updated equipment (19) High rental and transportation cost of equipment (20) Delivery and transportation of material problem.

Table 2: Challenges faced by stakeholders during pandemic situation

SR NO	CHALLENGES FACED BY STAKEHOLDERS DURING COVID-19	TOTAL (Out Off 57)	RANK
	Challenges Faced by Workers		
1	Facing difficulties while maintaining social distance on construction site.	51	1
2	Difficult to comply with the government guidelines	39	9
3	Uncertainty of survival regarding ongoing situation	30	14
4	Lack of co-ordination and direction due to poor communication	34	13
5	Difficult to manage expenditure due to payment delay	40	7
	Challenges Faced by Engineers		
6	Labor shortage	41	5
7	Financial Problem	45	2

8	Arrangement of accommodation for workers	27	16
9	Difficult for adjusting a new work schedule due to unpredictability about working condition.	39	12
10	Difficulties arises to access new technologies for upgradation and betterment	41	6
11	Increase in labor price	39	10
	Challenges faced by Contractor		
12	Supply Chain disruptions	40	8
13	Material prices tend to rise/Delay	44	3
14	Contractual implication problems	28	15
15	Inaccessibility to tools and updated equipment	26	17
16	High rental and transportation cost of equipment	42	4
17	Delivery and transportation of material problem.	39	11

Table 2 shows the graphical representation of the assessments of challenges faced by stakeholders during pandemic situation. The ranking was given based on challenges faced by workers, engineers and contractors during pandemic which harmed almost all the sectors including primary, secondary tertiary sectors.

4.4 Section 4: Remedial measures adopted on construction site

Uncertainty has been created all over the world by Corona virus. Work in all construction sectors has come to a standstill and in almost all countries the economy is going downhill. In this situation, some remedial measures have to be taken to revive the construction sector against this disease. Some remedial measures are discussed below. These all measures have been included into the online questionnaire survey in which respondent have to select 1 or more precautionary measures. After collecting all the responses from the respondents, particular ranking has been allotted to respective precautionary measures.

Table 3: Remedial measures adopted on construction site

SR. NO	MEASURES ADOPTED	WEIGHTAGE					TOTAL	∑W	A*N	R.I.I	RANK
		1	2	3	4	5	N				
1	Providing well sanitized workplace	4	5	4	4	2	57	212	285	0.7439	4
2	Maintaining social distance in the workplace.	4	4	3	3	2	57	213	285	0.7474	3
3	By following all the guidelines of WHO in addition with the government guideline	3	5	2	3	3	57	211	285	0.7404	5
4	Sourcing personal protective equipment (Mask, PPE kit, Sanitizer) during the COVID-19 pandemic to protect workers against transmission of the disease	5	4	5	1	2	57	206	285	0.7228	6
5	Permitting heavy vehicles transporting goods for the transportation of construction material.	3	5	4	4	3	57	204	285	0.7158	8
6	Arranging the accommodation for the workers on to the construction site	3	4	4	4	4	57	206	285	0.7228	7

7	Offering medical facilities with a wide range of medical services on to the construction site (such as thermal scanning, Pulse oximeter)	4	5	5	3	3	57	194	285	0.6807	9
8	By implementing modular construction technique which saves cost and time (such as 3D PRINTING, BIM Technology)	3	4	3	3	1	57	219	285	0.7684	2
9	Providing Health/COVID-19 Supervisors on-site for workers' inspection	4	5	4	3	3	57	220	285	0.7719	1

Table 3 shows the graphical representation of the Remedial measures adopted on construction site during pandemic situation. The ranking was allotted based on challenges faced by peoples into the construction sector. The purpose of the study is to examine the damages and problems faced and try to approach this survey through those eyes which has seen the real-time scenarios. This will help us to work on identification of problem and will help to present in formulating strategies to withstand against if such pandemic comes back in near future. By using the scale of 1 - Strongly disagree, 2- Disagree, 3- Neither agree nor disagree, 4- Agree 5 - Strongly Agree, the respondents were asked to which extent they thought these factors have affected the construction industry.

4.5 Section 5: Effective management suggestions

Due to working in proximity to other people and the possibility of coming into contact with potentially contaminated surfaces, steps must be taken to reduce the risks of exposure for employees in the construction industry. Employers have a duty to provide and maintain, so far as is reasonably practicable, a working environment that is safe and without risks to the health of employees. This includes preventing, and where prevention is not possible, reducing, risks to health and safety associated with potential exposure to COVID-19

❖ **Identifying risks at construction sites**

- Travelling in personnel hoists and lifts
- Work that requires employees to be in close contact with others
- Using shared tools or equipment
- Sharing facilities such as bathrooms, kitchens and communal break areas

The effective management solutions have been majorly divided into 3 different parts:

- **Work Force Protection**
- **Project Performance Protection**
- **Protecting Project Continuity**

Data is collected via online mode i.e., Google forms. Experts into the respective field were given a choice to select the effective management solution and the participants opt out for choices according to their social and emotional decisions. Further ranking was allotted according to the preferences given by the respondents. According to that rank 1 was given for the measure “expand use of technology”. whereas the last rank was given to “Teach employees to recognize and manage stress symptoms”.

Table 4: Effective management solutions

SR NO	MANAGEMENT SUGGESTIONS	TOTAL (Out off 57)	RANK
	Work Force Protection		
1	Redefine worksite safety	30	10
2	Support personnel who work remotely	37	8
3	Initiate flexible work schedules to promote social distancing	44	2
4	Teach employees to recognize and manage stress symptoms	29	11
	Project Performance Protection		

5	Expand use of technology	47	1
6	Educate the employees about COVID-19 policies and procedures, and train them to incorporate them	37	7
7	Establish a system to maintain effective communication.	37	6
	Protecting Project Continuity		
8	Allow longer timelines for project delivery	35	9
9	Perform a contractor assessment to increase productivity	41	4
10	Conduct a risk analysis	38	5
11	Create an end to end supply chain map	42	3

VI. CONCLUSION

The questionnaire was made for this research and results are drawn based on responses given by the respondents and conclusions are drawn as mentioned below;

From results it seems that Covid-19 pandemic has done a lot of damage to construction industry, mainly due to supply chain disruption, shortage of material and workforce reduction.

i. Due to spreading disease government had been forced to lockdown. As a result of this lockdown, all transportation systems had been shut down and supply chains had been disrupted & no materials were arriving on construction sites. This was a major impact faced by construction industry during covid.
ii. During Covid construction industry faced material shortage problems. Due to supply chain disruption and stoppage of manufacturing, price of materials got increased.
iii. Workers were not able to come to construction site because transportation system was completely closed even the workers were unwilling to come due to fear. As a result, construction industry faced labour shortage problem.

From this study it is found out that government protocols, Uncertainty about working conditions and material delay are the main challenges faced by construction industry during covid.

i. Maintaining social distancing on construction site ultimately reduces workforce on construction site which cause extra productivity loss.
ii. Second major challenge faced by construction industry during Covid-19 is facing difficulties while adjusting new work schedule due to unpredictability about working condition.
iii. Material delay affects financial position directly, the project does not complete according to deadline and this was one of the major challenges faced by construction industry during pandemic.

Major remedial measures taken by construction industry to revive the construction sector against pandemic, as calculated using RII method were,

i. Providing Health/COVID-19 Supervisors on-site for workers inspection.
ii. Implementing technology such as AI, design software etc.
iii. Reducing workforce during covid to maintain social distancing is another remedial measures adopted by construction industry during covid

Tackling strategies to overcome challenges and impact faced by construction industry during Covid are as following;

i. Construction industry uses technology at far basic level. It is necessary to adopt newly invented automation technologies to deal with such kind of pandemic situation in future. Using technology like BIM, AI, 3D printing etc., it becomes easy to work with such kind of pandemic situation by maintaining social distancing without hampering on productivity and quality of construction.
ii. Initiate flexible work schedule to promote social distancing.
iii. Supply chain disruption is one of the major impacts of Covid -19 on construction sector, this impact can be reduce if end to end supply chain map can be formed.

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