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Impact of COVID-19 Pandemic on Triple Constrain Elements in the Construction Industry

Elizabath M[1], M Gayathri Devi[2], Dr. Kishor P[3]

[1]M. Tech in Structural Engineering and Construction Management, APJ Abdul Kalam Technological University, Saintgits College of Engineering, Kerala, India
[2]Assistant professor, Department of Civil Engineering, APJ Abdul Kalam Technological University, Saintgits College of Engineering, Kerala, India
[3]Dr. Kishor P, Managing director, Habilete Learning Solutions Private Limited, Kerala, India

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Abstract - *The ongoing pandemic has created several challenges for the construction industry and has seriously disrupted the economy. The major effects of the pandemic in the Indian construction industry were the mass migration of the immigrant workers (mostly unskilled) back to their respective native states. Apart from the labour shortage, the other problems faced by the construction industry were investment shortage, cancellation of upcoming construction projects, and reduction of foreign investment in the construction sector. Many projects are delayed and some works are canceled due to COVID-19. Accordingly, this project is focused to investigate the impact of COVID-19 on the triple constraint elements (Scope, Time, and Cost). The methodology adopted for this research includes both secondary and primary. The data obtained through primary analyzes have been evaluated using SPSS software employing statistical technique MANOVA. The results highlight the influence of the triple constraint element namely scope, time, and cost on the various independent factors of the construction projects. It is recommended to adopt latest technologies in the construction sector to manage the construction process and also to implement appropriate tools and techniques to reduce the impact of any pandemic situation or similar events that may arise in the future.*

***Key Words*: COVID-19 pandemic, Quantitative method, SPSS, MANOVA, Triple constraint elements**

1.INTRODUCTION

The construction industry of India is the third-largest contributor to the development of the economy and has a significant effect on the productivity and efficiency of other industry sectors by creating investment opportunities across the sectors. In the year 2019, the World Health Organization (WHO) declared a coronavirus virus (COVID-19) outbreak which is an infectious disease-causing acute respiratory syndrome. This global pandemic is originated in Wuhan, China (WHO,2020). As a result of this pandemic, most of the leading countries affected saw partial or full lockdown as the only solution to contain this virus. When the number of cases increased in India, by starting of march 2020 the Indian government declared a nationwide lockdown which was unplanned and without taking into consideration the feedback from the various industrial sectors.

In a global scenario, the ongoing pandemic has created several challenges for the construction industry and has seriously disrupted the economy. The construction industry in India was booming during the first quarter of 2020 and the pandemic has caused destructive havoc to several ongoing and initiated construction projects. The major effects of the pandemic in the Indian construction industry were the mass migration of the immigrant workers back to their respective native states. This mass migration has created an impact that was felt even after months when the lockdown was lifted. Apart from the labour shortage, the other problems faced by the construction industry were investment shortage, cancellation of upcoming construction projects, and reduction of foreign investment in the construction sector. Many projects are delayed and some works are canceled due to COVID-19. The supply chain and logistics associated with the construction industry were severely disrupted by the unexpected lockdown which eventually led to the shortage of resources and equipment. The combined effect of labour shortage and resource shortage lead the construction industry to a downfall. The Indian economy reduced to about 23.9% in the second quarter of 2020 which is much worse than market forecasts of an 18.3% drop. This is the biggest contraction on record as India imposed a coronavirus lockdown in late March and extended it several times affecting many economic activities Among this the biggest recorded fall is of the construction industry with a drop of 50.3% (Trading economics, 2020).

2. LITERATURE REVIEW

Wyngaard *et al.* (2012) defined that the project management triangle is a useful model to illustrate the consequences of change on the triple constraint to key project stakeholders. Triple constraint variables are project scope, time, and cost. Project time is related to the scheduling and duration of the project while the cost is dependent on the budget and resources of the project and scope is the requirements and work of the project.

Dziadosz and Rejment (2015) state that risk analysis enriches the decision-making process and provides

additional arguments, which help to select the optimal variant of a construction project using the multi-aspects approach. The most popular methods of project risk analysis are the methods for the identification and preliminary assessment of risk and the methods supporting the decision-making process in the assessment and selection of projects.

Gokulkarthi and Gowrishankar (2015) studied the impact of change in the order in the construction industry. Change in plans by the owner, material substitution, increase in project cost and duration are the prime factors causing a change in the order in the construction industry. The clarity in the change of scope orders is necessary for scope management.

Rugenyi (2015) assessed projects triple constraints through the project manager's perspective. Among the triple constraint elements, the project scope and project cost are the most common faced in project management. The constraints are mainly caused due to changes in scope, project risks, poor project planning, and project delays. Specifications in the project should be clearly expressed. Risk management enhances the ability of the project to face risk during its entire life cycle.

Raya and Prakash (2016) observed the cost and time overrun in the Indian construction industry. The main causes for the price overrun and time overrun during this case are frequent style changes, poor project management, inappropriate contractors, unskilled force, inaccuracy of material estimate, lack of acceptable software system, quality of works. To reduce these problems firms, need to target higher internal control and target activity primarily based on management.

Bayiley and Teklu (2016) stated that the five areas in PMBOK are vital for project management and are also known as the project life cycle. As the project is temporary, these five phases are beneficial and will help the project to manage the triple constraint elements. The methodology also noted that project life cycle elements will exclusively support the project management to adhere to the schedule as planned initially.

Akhund *et al.* (2017) observed time overrun in construction projects of developing countries. Time overrun causes a slowdown of construction works. Time overrun improvement causes both technical and project management-related factors. Effective site management and supervision, effective communication, effective planning, and scheduling are necessary to eliminate time overruns.

Ahady *et al.* (2017) identified that in developing countries fluctuation and an increase in material cost are the prime factors that cause cost overrun in construction projects. To control and mitigate cost overrun in construction projects continuous updating of material price and labour rates must be done. New policies, rules, and regulations must be generated to ensure the reduction of identified factors on cost overruns in construction projects in developing countries.

Rahman *et al.* (2017) investigated the impacts of design changes on construction project performance. Changes in design cause rework in construction projects while rework causes loss in productivity. Rework caused delay and disruption in construction projects leading to schedule delay and cost overruns. Prediction of impacts of design changes on project performance at the early phase of the project is necessary to deal with future claims and disputes.

Soliman (2017) observed that ineffective communication problems would lead to a delay in construction projects. The main problems of ineffective communication are because of usage of the old type of filling system instead of new ones, lack of progress site meetings, bad quality of drawings and document contractor's delay in preparing tables as well as drawings, and low experience of the supervision staff.

Hasan *et al.* (2019) investigated the effect of triple constraint elements namely cost, time, and quality in building projects. The studies show that triple constraint elements have a positive relationship with the construction company's projects. Time management is one of the main factors that affect the construction industry. The cost and quality of the projects must be maintained to achieve success in the building projects.

Amri and Pérez (2020) investigated the impact of COVID-19 on global and regional economies. The main reasons for the decline in construction volumes observed a suspension of constructing individual projects, interruptions in the supply of materials and equipment's, displacement of workers, suspension of transport links, reduced laborers' productivity due to increased security measures, and increased financial problems due to contractors and suppliers of materials.

Chaudhary *et al.* (2020) studied the COVID-19 impact on aviation, tourism, retail, capital markets, micro small and medium enterprise, and oil. The crisis witnessed a floating population of migrants because of the loss of a job, daily ration, and absence of social security net. The study highlights that the World Tourism Organization estimations depict a fall of 20–30 % in international tourist arrivals. Recovery in the economy depends on timings and the magnitude of government support, level of corporate debt, and how companies and markets cope with lower demand.

Gamil (2020) observed the major effect of COVID-19 on the construction industry's survival through exploratory interviews and questionnaire surveys. The major effects of COVID-19 are the suspension of projects, labour impact, job loss, time overrun, cost overrun and financial implications.

Construction planning and scheduling have been significantly impacted during the crisis. The infrastructural projects in hospitality and the other developments also face challenges like shortage of workers, the rise of materials price, shortage of materials, and supply chains.

3. RESEARCH METHODOLOGY

The research philosophy adopted is positivism. Positivism philosophy facilitate the researcher to understand the challenges, issues, and other factors that have an effect on the construction industry in Kerala due to the COVID-19 pandemic. The selection of positivism philosophy will also help the researcher to justify the content with a scientific approach. The research strategy used is survey method. It is the best strategy to justify the research subject by taking quantitative samples from selected organizations (Saunders et.al, 2012). Responses have been collected through closed-ended questions by distributing the questionnaires through emails. Primary data has been collected through quantitative methods. Quantitative research was carried out through a closed-ended question with employees selected from leading construction firms in Kerala. Secondary data has been collected from available sources such as books, e-books, journals, e-journals, websites, and desktop reviews. The questionnaire is based on 5-point Likert scale (1- not impacted, 2-slightly impacted, 3- moderately impacted, 4-very impacted, 5- extremely impacted). For quantitative respondents, this research study followed a convenience sampling process. For quantitative research, the sample size selected was 40 in size. According to the Central Limit Theorem, sample sizes equal to or greater than 30 are considered sufficient (Douglas 2012; Kennedy 2002) to measure the results. The finalized research methodology is shown in Fig -1.

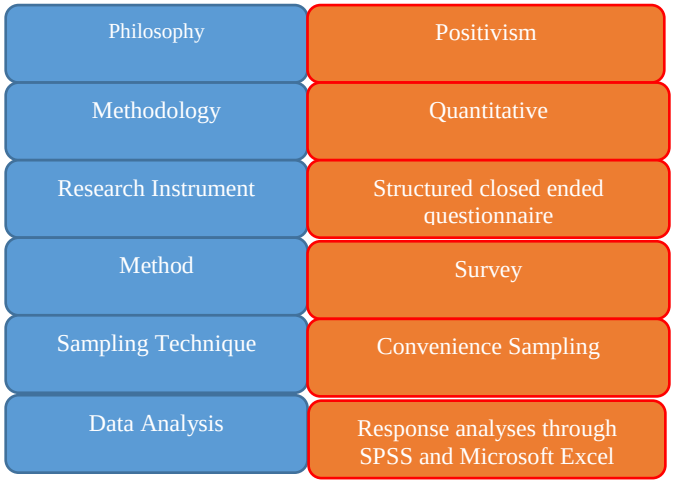

Fig -1: Research Methodology

4. DATA ANALYSIS AND RESULTS

The data collected from the surveys are analyzed with statistical technique MANOVA in IBM SPSS software. MANOVA in SPSS concerned with examining the differences between groups. It examines the group differences across multiple dependent variables simultaneously. The relation between the independent variables with the variables in scope, time, and cost constraints are acknowledged. The independent variables considered are suspension of projects, time overrun, cost overrun, financial impact, supply shortage, interruption of planning and scheduling, shortage of materials, interruption in contract terms, uncertainty of survival, impact on existing projects completed activities, labour impact. The dependent variables are the variables or the factors that cause scope, time and cost constraints in the construction projects such as change in time, change in cost and change in scope along with risk, delay, planning changes, specification changes, administrative issues and financial shortage. All the variables are tested at 95% confidence level. Based on the analysis between the independent variables and the dependent variables if there's a statistically significant value but or adequate to 0.05 then we will say that they're associated with one another and thus are statistically significant. The statically significant scope constraint MANOVA data is shown in Table -1.

Table -1: Statically significant scope constraint MANOVA table

Independent Variable	Dependent Variable	Sig. Value
Supply shortage	Risk caused by scope constraints	0.002
Interruption of planning and scheduling	Risk caused by scope constraints	0.006
	Planning change caused by scope constraints	0.048
Shortage of material	Scope change caused by scope constraints	0.001
Uncertainty of survival	Risk caused by scope constraints	0.005
Labour impact	Scope change caused by scope constraints	0.014
	Risk caused by scope constraints	0.004

The supply shortage as an independent variable has an influence on risk caused by scope constraints as a dependent variable with a statically significant value of 0.006. Similarly, Interruption of planning and scheduling has an influence on risk and planning change caused by scope constraints at a significant value of 0.006 and 0.001. Material shortage has an influence on scope change caused by scope constraints at 0.001 significance level. Uncertainty of survival has an influence on risk caused by scope constraints at a significance value of 0.005. Labour impact has an influence on risk caused by scope constraints at a significance level of 0.004.

Table -2: Statically significant time constraint MANOVA table

Independent Variable	Dependent Variable	Sig. Value
Shortage of materials	Specification change caused by time constraints	0.036
	Financial change caused by time constraints	0.014
Impact on existing projects completed activities	Specification change caused by time constraints	0.016
	Financial change caused by time constraints	0.037
Labour impact	Specification change caused by time constraints	0.015
	Delays caused by time constraints	0.028

The statistically significant time constraint MANOVA data is shown in Table – 2. Shortage of materials as an independent variable has an influence on specification change as well as financial change caused by time constraints at a significant value of 0.036 and 0.014. Similarly impact on existing projects completed activities has an influence on specification change along with financial change caused by time constraints at a significance value of 0.016 and 0.037. The labour impact also has an influence on specification change and delays caused by time constraints at a significant value of 0.015 and 0.028 respectively.

Table -3: Statically significant cost constraint MANOVA table

Independent Variable	Dependent Variable	Sig. Value
Financial impact	Financial change caused by cost constraints	0.027
Supply shortage	Planning change caused by cost constraints	0.044
Interruption of planning and scheduling	Cost change caused by cost constraints	0.002
Impact on existing projects completed activities	Cost change caused by cost constraints	0.038
	Resource change caused by cost constraints	0.043

The statistically significant cost constraint MANOVA data is shown in Table -3. Financial impact as an independent variable has an influence on financial changes caused by cost constraints at a significance value of 0.027. Similarly supply shortage has an influence on planning change caused by cost constraints at a significance value of 0.044. Interruption of planning and scheduling has an influence on cost change caused by cost constraints at a significance value of 0.002. Impact on existing projects completed activities also has an influence on cost change and resource change caused by cost constraints at a significance value of 0.038 and 0.043 respectively.

5. CONCLUSIONS AND RECOMMENDATIONS

The impact of COVID-19 pandemic on triple constraint elements in the construction industry is obtained through a series of quantitative questionnaire survey and analyzed with statistical technique MANOVA in SPSS. The following conclusions are drawn based on the analysis,

- The triple constraint elements namely scope, time and cost are affected by the COVID-19 pandemic.
- The MANOVA analysis tested at 95% confidence level indicate that all the variables having a significance value less than or equal to 0.05 indicate that there is a relation between them.
- MANOVA analysis indicates that the supply and materials shortage, interruptions of planning and scheduling along with labour shortage influences the elements of the scope constraints.
- MANOVA analysis shows that the shortage of material, interruption on existing projects completed activities along with labour shortage influences the elements of the time constraints.
- MANOVA analysis shows that financial shortage, as well as shortage of supply along with interruption of planning and scheduling, influences the elements of the cost constraints.

To reduce the impact of a pandemic on the construction industry, the companies must have a backup plan in place in the event of a shutdown. Companies must examine old contracts and improve internal and external communication. Contractors should check their active contacts to make sure they're doing all necessary efforts to protect and assert the contract. A sinking fund, or a set sum of money set aside to prevent financial instability inside the organization, is required. Companies should encourage employees to work from home. It is necessary to ensure that the workers follow the government's pandemic prevention methods and rules. The supply shortfall, as well as the cost, can be addressed by using the most effective construction methods such as design- build approach. Companies must ensure that all employees have adequate insurance coverage and that they can file claims when necessary. In addition, due to the risk and delays at the time of the pandemic, business interruption insurance should be considered.

Companies should apply modern technology applications like 5-Dimensional Building Information Modeling (BIM), which allows for real-time extraction or production of fully valued parametric building components within a virtual model. Proper project management process or methodologies which the company has adopted must be reviewed and followed. During a crisis, proper risk management procedures must be followed to eliminate risk.

REFERENCES

1. **Abbasbhai, M. J.** and **A. S. Patel** (2020), Factor Affecting Performance of Construction Projects, International Research Journal of Engineering and Technology, 7, 6, 2344-2351.
2. **Abazid, M.** and **H. Harb** (2018) An overview of risk management in the construction projects, Academic Research International, 9, 2, 73-79.
3. **Ahady, S., S. Gupta** and **R. K. Malik** (2017) A critical review of the causes of cost overrun in construction industries in developing countries, International Research Journal of Engineering and Technology, 4, 3, 2550-2558.
4. **Akhund, M. A., A. R. Khoso, U. Memon** and **S. H. Khahro** (2017) Time Overrun in Construction Projects of Developing Countries, Imperial Journal of Interdisciplinary Research, 3, 4, 1-6.
5. **Amri, T. A.** and **M. M. Pérez** (2020) Impact of Covid-19 on Oman's Construction Industry, Technium Social Sciences Journal, 9, 661- 670.
6. **Balamurugan, P., A. Nazir, K. Mathan** and **A. K. Rajith** (2020) Factors Influencing in Construction Industry, International Research Journal of Engineering and Technology, 7, 4, 3983-3989.
7. **Bayiley, Y.** and **G, Teklu** (2016) Success factors and criteria in the management of international development projects. International Journal of Managing Projects in Business, 9, 3, 562-582.
8. **Bekr, G. K.** (2017) Factors affecting performance of construction projects in unstable political and economic Situations, ARPN Journal of Engineering and Applied Sciences, 12, 19, 5384- 5395.
9. **Chaudhary, M., P. R. Sodani** and **S. Das** (2020) Effect of COVID-19 on Economy in India: Some Reflections for Policy and Programme, Journal of Health Management, 22, 2, 169-180.
10. **Douglas, B.,** (2012) The Sampling Distribution and Central Limit Theorem. 1st ed. Kirkland, WA: Kindle.
11. **Dziadosz, A.** and **M. Rejment** (2015) Risk analysis in construction project - chosen methods, Procedia Engineering, 122, 258 – 265.
12. **Gamil, Y., I. A. Rahman, S. Nagapan** and **N. Alemad** (2017) Qualitative approach on investigating failure, factors of Yemeni mega construction projects, MATEC Web of Conferences 103, 03002.
13. **Gamil, Y.** (2020) The Impact of Pandemic Crisis on the Survival of Construction Industry: A Case of COVID-19, Mediterranean Journal of Social Sciences, 11, 4, 122 – 128.
14. **Gokulkarthi, M.** and **K.S. Gowrishankar** (2015) A Study on Impacts of Change Order in Construction Projects, International Journal of Science and Engineering Research, 3, 4.
15. **Grebić, B.** (2019) Traditional vs Agile Project Management in the service sector, European Project Management Journal, 9, 2, 55-63.
16. **Hassan, A. K., A. Q. Adeleke** and **D. M. Taofeeq** (2019) The Effects of Project Triple Constraint on Malaysia Building Projects, Social Science and Humanities Journal, 3, 5, 1222-1238.
17. **Keng, T. C.** and **H. A. Rahman** (2011) Study of Quality Management in Construction Projects, Chinese Business Review, 10, 7, 542-552.
18. **Kennedy, C.,** (2002) The Sampling Distribution and The Central Limit Theorem, London, Distributed by ERIC Clearinghouse.
19. **Malhotra, N. K.** and **S. Dash** (2010) Marketing Research: An Applied Orientation, Pearson Education, Sixth ed.
20. **Paynter, R.** (2010) Data Mashups as collection management tools, Collection Management, 36, 1, 68–72.
21. **Popping, R.** (2012) Qualitative decisions in quantitative text analysis research, Sociological Methodology, 42, 1, 88–90.
22. **PMBoK Guide 6th Edition** (2017) A Guide to the Project Management Body of Knowledge Project Management Institute, USA.
23. **Raya, S. M. K. R.** and **S.S B. Prakash** (2016) Cost and Time overruns in Indian construction industry, Industrial Science, 2, 4, 1-9.
24. **Rahman, H. M., W. Chen** and **J. Y. B. Hui** (2017) Impacts of design changes on Construction project performance: Insights from a literature review, Journal of Quantity Surveying & Construction Business, 7, 1, 31-54.
25. **Rugenyi, F.** (2015) Assessment of the Triple Constraints in Projects in Nairobi: The Project Managers' Perspective, International Journal of Academic Research in Business and Social Sciences, 5, 11, 1-16.
26. **Saraf D. D.** (2015) Study of Factors Affecting Performance of Construction Project, International Journal of Science and Research, 4, 5, 1339-1341.
27. **Saunders, M., P. Lewis** and **A. Thornhill** (2012) Doing research in business and management. Harlow: Financial Times Prentice Hall.
28. **Soliman, E.** (2017) Communication problems causing governmental projects delay– Kuwait case study, International Journal of Construction Project Management, 9, 1, 1-18.
29. **Thomas, N.** and **A. V. Thomas** (2016) Regression Modelling for Prediction of Construction Cost and Duration, Applied Mechanics and Materials, 857, 195-199.
30. **Thomas, J. A.** (2015) Using unstructured diaries for primary data collection, Nurse Researcher, 22, 5, 25–29.
31. **Vaníčková, R.,** (2017) Application of PRINCE2 Project Management Methodology, Studia Commercialia Bratislavensia, 10, 38, 227-238.
32. **Vishweswar, A. R., S. Janani** and **M. C. Akilarasu** (2020) Study and Analysis of Time and Cost

Overrun in Construction Sector, International Journal of Advanced Science and Technology, 29, 3, 6682 – 6689.

33. **Waite, D.** (2011) A simple card trick: Teaching qualitative data analysis using a deck of playing card, Qualitative Inquiry, 17, 10, 982–985.
34. **Wyngaard, C. J. V., J. H. C. Pretorius** and **L. Pretorius** (2012) Theory of the Triple Constraint – a Conceptual Review, Proceedings of the 2012 IEEE IEEM.