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Use of Artificial Neural Network for Cost Estimation of Building Projects

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Abstract – *the principal causes of delays in this research study were analyzed after data collection using a questionnaire survey with a wide range of construction professionals based in High-rise Projects. The findings of this study could help the construction industry better analyze not just the principal reasons of delays on construction projects, but also how to minimize the them through appropriate planning. Despite its importance in ensuring the safe application of working processes, safety leadership is occasionally overlooked in recommendations.*

Aside from addressing increased demand, good decision making during the construction phase can mitigate delay concerns, however additional research is required. This could involve research on decision making processes, the content of construction site management training programs in building a more skilled workforce, and the use of pre-cast materials. An investigation into construction project delays in India during the outbreak.

Because high-rise projects are vital to the city, they must be completed quickly. Almost all Indian projects are late. Delay is the most common, complex, and dangerous problem in construction. Most construction projects in poor countries run late. Regardless of size or complexity, deadlines and unpredictability abound. Every construction project has delays, and the severity on time and cost overrun drivers.

Key Words: **Low Rise & high-rise Buildings, Cost-Benefit analysis, etc.**

1.INTRODUCTION

1.1. Impacts of COVID-19 on High Rise construction sector

COVID-19 victims are becoming more numerous by the day, which is having an influence on the building industry. Government lockdowns are disrupting supply chain; labor shortages are emerging; companies are experiencing an economic downturn; and they are having difficulty keeping their contracts.

1.1.1. Management of the supply chain

In several places of the world, the supply chain has been interrupted in various ways. Various construction materials are necessary, but they are not reaching the construction site from the outside due to lockdown, which is causing delays in the construction processes. Various resources for construction work that come from various industries in the country or overseas via various vehicles, those items cannot come. Because all cars are unable to come to lockdown, the essential materials are unable to arrive, and the work is halted. IS has not only caused the construction sector to shut down, but is has also harmed the livelihoods of those who transport these materials in cars, as well as the factories that produce these products, which are losing a lot of money because they are not being sold.

1.1.2. An issue with transportation

All modes of mobility in the country have been hampered as a result of nationwide lockdown. As a result, no materials are being delivered to the construction company, and no workers are able to work from home. As a result, the work has come to a halt.

1.1.3. Labor scarcity

To begin with, workers are unable to get to work since the transit system is entirely shut down. Second, because the sickness is caused by a viral infection, workers who came into touch with another are more likely to spread it. As a result, many workers refuse to come to work. Furthermore, forcing workers to labor without any protection is impossible.

1.1.4. Financial difficulty

Companies are not making any profit as a result of the work stoppage; on the contrary, more losses are being incurred, and not only the company is losing money, but all the suppliers who provide the required materials to various companies for use in the construction sector are also losing a lot of money. Since the company's shutdown, the supply chain has been disrupted, and factories that create goods have ceased operations, resulting in several

job losses. Furthermore, the government is unable to collect adequate taxes from all of these sites due to the non-sale of factory-produced goods and the shutdown of the building sector, which has a direct influence on the country's GDP, which impacts the global economy.

1.1.5. Issues with contractual implication

It is primarily based on the 'force major clause'. This clause has a number of rules, one of which is 'Large Scale Epidemic'. This category includes the COVID-19 pandemic. Different contractors placed their various tools in various locations for usage in various machinery construction sectors, but because to the lockdown, all of this equipment have been laying around for a long period. Companies have contracts with the contractors to work with all of this equipment for a fee, and if the contract includes a 'Force Majeure' clause, the contractor will not be compensated by the agency if the project is delayed. When contractors stop working, the effect is a significant financial loss.

1.1.6. Unemployment

Because of the lockdown, businesses are losing a lot of money. As a result, businesses are unable to appropriately compensate their employees, and many people are laid off. Many people's jobs have been taken away as a result of this. Their families are also dealing with a lot of difficulties as a result of their job loss. Overall, a concerning scenario has developed.

1.2. Background Information

The building sector, the coronavirus pandemic and past research investigations are all included in this section.

1.2.1 Coronavirus Pandemic and the Construction Industry

COVID-19 had an impact on a variety of economic, social, and industrial activities. Despite the fact that the construction industry was one of the most hit by the pandemic, there was a lot of misunderstanding and uncertainty about how to deal with the pandemic on construction sites due to lack of clear construction-related guidelines and best practices. This section provides background information and statistics about the construction industry in order to put the paper's focus on this business in context.

The construction industry is a crucial driver of growth and prosperity in the United States, employing over 4.7 percent of the workforce. The construction business, on the other hand, is a project-based industry, with significant complexities and uncertainties. As a result, the construction industry is extremely sensitive to market conditions, posing unique challenges for businesses and their senior executives to survive and thrive (Hartono et al. 2019). A cascade of business failure in the construction industry might have a detrimental impact on the entire economy.

Furthermore, construction contractors are working in an industry that has been profoundly altered by the pandemic's public health and economic repercussions. The epidemic is prompting concern and significant changes in the construction and housing markets, particularly in terms of touring, building, financing, and settlement processes.

1.2.2 Research Gap

Literature Review of the Existing Studies and Identification of Research Gap this subsection provides an extensive literature review of existing studies related to the topic of this research to better identify and position the research gap. Industry Insights and ASCE performed recent surveys to provide updated and useful information and background on COVID-19 in the construction industry with input from more than members. According to these surveys;

1. Up to 63% of the organizations perceive that stay at home and social distancing measures are very important, and respondents in the Northeast expressed the most concerns;
2. 20% of the organizations have rescinded offers to entry-level employees and interns;
3. 14% of the organizations are facing potential contract penalties due to project delays;
4. Organizations are facing negative consequences including cancelation or delay of contracts, cash flow challenges, hiring freezes, absenteeism, supply chain shortage, layoffs, and furloughs(unpaid);
5. Despite the gradual reopening of the national economy the percentage of the companies expressing moderate to major concerns over their long-term viability increased from 16% to 29%, and the smallest organizations (less than 20 employees) and the largest organizations expressed the most concern over their long-term viability;
6. 50% of the companies have experienced corona virus-related delays in receiving material and products from suppliers;
7. Workforce reductions were experienced because one-quarter of the companies have furloughed,

laid-off, and terminated their employees since March 1, 2020;

8. A large percentage (41%) of the organizations reported that they did not apply for funds provided by the pay check protection program, and the reason was speculated to be related to their size, because 35% of the companies had 500 employees, which made them ineligible for the program;

9. In the most recent survey, companies were realizing that their operations likely will not return to normal until, and expectations for participations in large group activities, organizational travel, and a return to normal in office work have been pushed back significantly.

1.3. Problem Definition

To study the increased requirement, delay factors can be minimized by proper decision making throughout the construction process but further research is required. This could include research into the communication of decisions, the content of training programs for construction site managers, the value of apprenticeship schemes to provide a more skilled workforce, the possibilities of greater use of pre-cast materials etc. this study identified the causes of delays on construction projects in India during COVID-19.

1.4. Need for Construction

Further research can be conducted through case studies in construction projects and this will help to identify the other factors that may be causes of delay factors as well as to identify what procedures could be used to minimize the factors causing delays on construction projects in India during COVID-19, and beyond.

1.5. Aims and Objectives

1. To study an Economic, Environmental and Social attributes, while the factors which stimulate through the satisfaction, were incorporated into this methodology

2. To study the cost-benefit analysis process through sone High-rise projects

3. To evaluate the factors based on the questionnaire & case study through various programs. This includes identifying different parameters for delay & cost overrun in view of respondents & comparing them

4. Evaluate the impact of advance technology to improve construction activities that related to time

5. To find the factor that delays in construction activities in case of emergency and to overcome these factors with advance construction technology

2.RESEARCH METHODOLOGY

Research Methodology will be designing a questionnaire survey by which we can find out the factor affecting the construction cost which directly related with material use in construction projects in pandemic situation.

By operating advance technology at the construction project reduce delay in transporting of material and increase efficiency of work that ultimately reflect on time and cost.

From literature found that because of frequent change of project managers, Appointment of staffs in the site who are not experienced and also Non sequential progress of the works and that work was not followed as per procedure instead it was followed as per availability of resources caused delays in construction project on pandemic situation.

Unavailability of adequately trained health workers and lack of experience in managing an unprecedented emergency; the pandemic and the confinement measures created a psychosocial burden for the population and, especially the wellbeing of the health workforce.

The construction industry is the vehicle through which physical development is achieved, and this is truly the locomotive of the national economy. The more resources, engineering know-how labor, materials, equipment, capital, and market exchange provided from within the national economy, the higher the extent of self-reliance. The increasing complexity of infrastructure projects and the environment, within they are constructed, place greater demands on the construction managers to deliver projects on time, within the planned budget and with high quality.

Therefore, improving construction efficiency by means of cost-effectiveness and timeliness would certainly contribute to cost savings for the country as a whole. Efforts directed to cost and time effectiveness were associated with managing time and cost.

It also aims to identify the main factors that lead to project delays and to suggest recommendations on how to overcome or mitigate effects of the problem. Data is gathered from the responses from questionnaire survey and interviews with those involved in construction project.

The surveys and research findings indicate that delay incidents occur mainly during construction phase of

the project and one or more parties usually contribute to delay. This paper highlights the importance of having more experienced and capable construction managers as well as skilled labors to enable the industry to develop at a faster rate either nationally or internationally.

A questionnaire and personal interviews have formed the basis of the research. Factors analysis and regression modelling were used to examine the significance of the delay factors. From the factor analysis, most critical factors of the construction delay were identified as

- Lack of commitment;
- Inefficient site management;
- Poor site coordination;
- Improper planning;
- Lack of clarity in project scope;
- Lack of communication;
- Sub-standard contract.

Step 1
• Literature Review
• Problem Statement
• Objectives

Step 2
• Actual Case Study
• Primary Data Collection

Step 3
• Preparation of Questionnaire
• Data Collection
• Preparation Benefit Cost & Time Analysis for Particular case study

Step 4
• Analysis of Data
• Find Factors using RII & SPSS method

Step 5
• Result and Discussion

Step 6
• Recommendations

Step 7
• Paper Presentation and Report Writing

Step 8
• Submission and Approval of Dissertation

Figure 1. Methodology chart

Questionnaire construction

A questionnaire survey approach was used for this project to determine the impact of various factors affecting the project's cost. The questionnaire's design philosophy was based on the fact that it needed to be simple, clear, and understandable for the respondents while also being easily interpreted by the researcher.

Using a literature review

In terms of structure, it can be seen that a significant amount of research has already been done. In India, there is a scarcity of data on the use and the factors that influence the construction industry. As a result, preliminary research into various literatures around the world resulted in the creation of a preliminary list of factors affecting project cost and timeliness.

A preliminary survey of the site was conducted.

Following the identification of the fundamental factors through literature review, a preliminary survey of various sites was conducted to determine the nature and relative importance of those factors in Indian working conditions. The survey linked the effectiveness of global factors to the effectiveness of Indian sites, as well as provides practicing insights into a few additional factors, though they are area specific.

3.ANALYSIS WORK

SPSS software

Analysis of the questionnaire survey was done using IBM SPSS software. SPSS statistics is a software package used for statistical analysis. The software name originally stood for statistical package for the Social Sciences(SPSS), reflecting the original market. It is a window-based program that can be used to perform data entry and analysis and to create tables and graphs. It is capable of handling large amount of data and can perform all of the analysis covered in the text and much more. It is

widely used program for statistical analysis in social science. It is also used by market researches, health researches, survey companies, government, data miners and others. All the responses obtained from the questionnaires are entered in to the software. First the variables or the questions are entered in the data view, then the responses are entered into the software form the various data entered into the software, frequency can be found out which is used to determine the importance factor.

SPSS Data View:

The Questionnaire Survey responses were reported in excel file. After opening data, SPSS displays them in a spread sheet-like fashion as shown in below fig. the excel file was export in data view and check the values and other information in spread sheet.

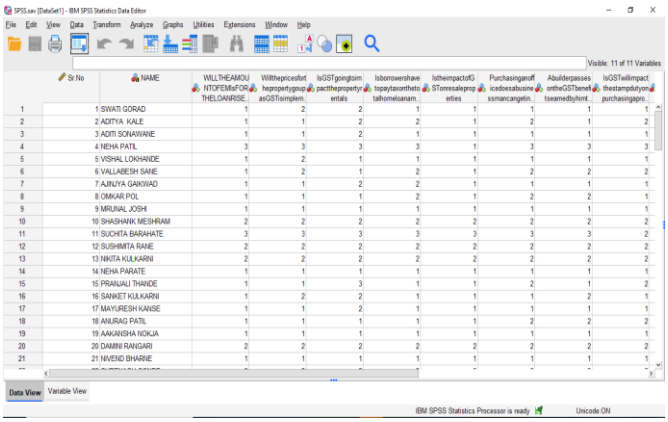


Figure 2. SPSS Data View

SPSS Variable View

1.	Do you believe that poor management system contributed to the High-rise structure late completion?
2.	Is it true that heavy rain causes building activity to slow down?
3.	Do you believe that using advance construction techniques to build a high-rise structure is the best option?
4.	Do you believe that this project's delays are due to government funding and payment issues?
5.	Do you think that project will be delayed as a result of the late release of the site, drawings and materials?
6.	Is the project team heavily reliant on one another for assistance, intelligence or enforcement to complete their tasks, causing a delay in the completion of the High-rise structure?
7.	Do you believe the errors in layout caused by incorrect data in drawings lead to further work being done?
8.	Do you believe the project team members and staff lack expertise in the construction of an emergency on site?
9.	Can you feel there is a lot of uncertainty on the project for the team members?
10.	Do you believe that if advanced building techniques were used , any of the above factors will be eliminated?
11.	Do you believe that India's health infrastructure is sufficient to solve the pandemic problem?
12.	Do you think that quality of work would suffer as a result of the fast-track construction?
13.	Do you think the best choice for construction a High-rise building is to use advance building techniques?
14.	Do you believe that the task of construction management is required to complete the project on time?
15.	Do you believe that a High-rise building should be built at the start of the pandemic situation on site?

An SPSS data file always has a second sheet called variable view. It shows the metadata associated with the data. Metadata is the information about the meaning of variables and data values. In variable view, different columns are displayed. Each line corresponds to a variable. A variable is simply a quantity of something, which varies and can be measured, such as height, weight, number of children, educational level, gender and so forth. Name of the variable is your own choice, but make it understandable and so not use numbers or symbols as the first letter since SPSS will not accept it. Moreover, you cannot use spaces in the name. The name of the variable was used such as EMI, construction material, etc. The variable view spread sheet is shown in the figure below.

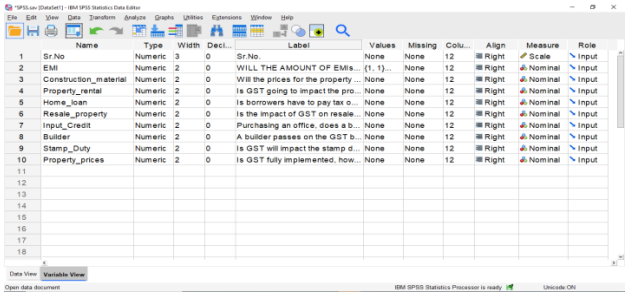


Figure 3. SPSS Variable View

SPSS Data Analysis:

SPSS can open all sorts of data and display them and their metadata in two sheets in its Data Editor Window. In our data contain a variable holding respondents on GST related questions, we can compute the frequency by navigating to Descriptive Statistics as shown in figure below. For more better understanding and detailed study pie chart and bar chart option is also selected.

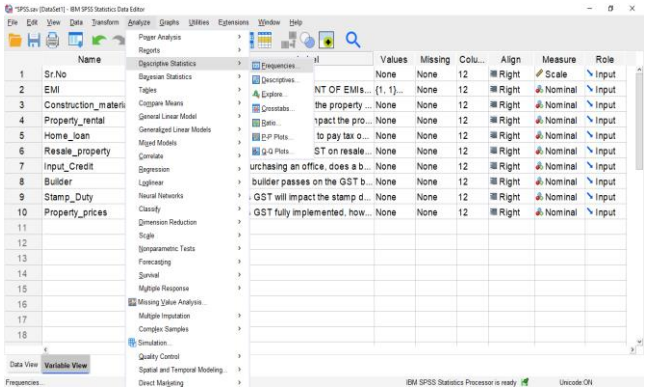


Figure 4. SPSS Data Analysis

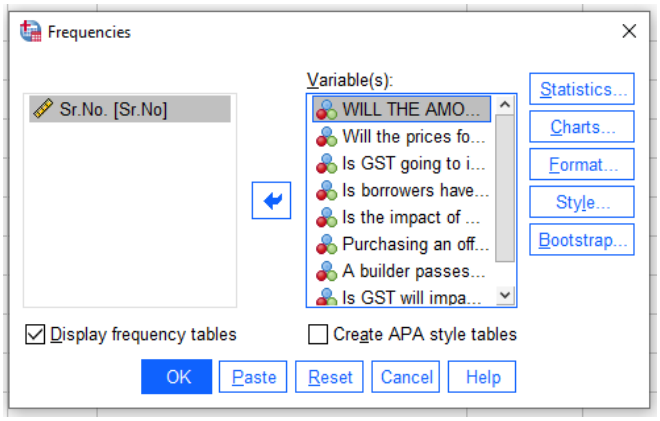


Figure 5. Variable Selection for Calculating frequency

SPSS Output Window:

After clicking Ok, a new window opens up, SPSS output viewer window. It holds a nice table with all statistics on all variables we chose. The screenshot below shows what it looks like. As we see, the output viewer window has a different layout and structure than the data editor window we saw earlier. Creating output in SPSS does not change out data in any way; unlike SPSS uses different windows for data and research outcomes based on those data.

Survey Report

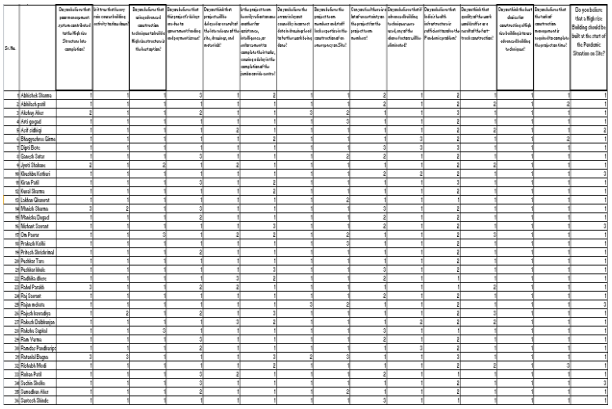


Figure 6(a). Survey Reports

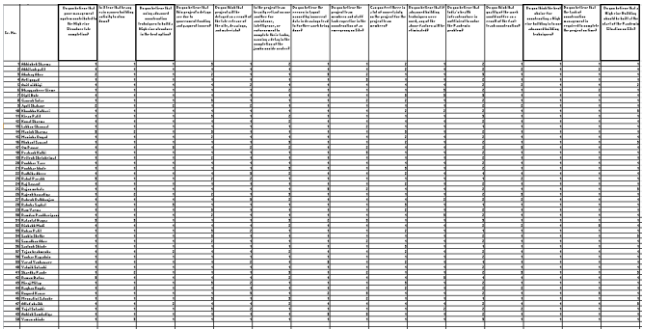


Figure 6(b). Survey Reports

Frequency Table

Do you believe that poor management system contributed to the High-rise structures late completion?

	Frequency	Percent	Valid percent	Cumulative percent
Valid yes	44	88.0	88.0	88.0
No	2	4.0	4.0	92.0
Other	4	8.0	8.0	100.0
Total	50	100.0	100.0	

Is it true that heavy rain causes building activity to slow down?

	Frequency	Percent	Valid percent	Cumulative Percent
Valid yes	44	88.0	88.0	88.0
No	4	8.0	8.0	96.0
Other	2	4.0	4.0	100.0
Total	50	100.0	100.0	

Do you believe that using advanced construction techniques to build a High-rise structure is the best option?

	Frequency	Percent	Valid percent	Cumulative Percent
Valid yes	45	90.0	90.0	90.0
No	3	6.0	6.0	96.0
Other	2	4.0	4.0	100.0
Total	50	100.0	100.0	

Do you believe that this project's delays are due to government funding and payment issues?

	Frequency	Percent	Valid percent	Cumulative percent
Valid yes	33	66.0	66.0	66.0
No	7	14.0	14.0	80.0
Other	10	20.0	20.0	100.0
Total	50	100.0	100.0	

Do you think that project will be delayed as a result of the late release of the site, drawings and materials?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	39	78.0	78.0	78.0
	NO	8	16.0	16.0	94.0
	OTHER	3	6.0	6.0	100.0
	Total	50	100.0	100.0	

Is the project team heavily reliant on one another for assistance, intelligence, or enforcement to complete their tasks, causing a delay in the completion of the High rise structure?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	33	66.0	66.0	66.0
	NO	11	22.0	22.0	88.0
	OTHER	6	12.0	12.0	100.0
	Total	50	100.0	100.0	

Do you believe the errors in layout caused by incorrect data in drawings lead to further work being done?

	Frequency	Percent	Valid Percent	Cumulative Percent
YES	44	88.0	88.0	88.0
NO	2	4.0	4.0	92.0
OTHER	4	8.0	8.0	100.0
Total	50	100.0	100.0	

Do you believe the project team members and staff lack expertise in the construction of an emergency on Site?

	Frequency	Percent	Valid Percent	Cumulative Percent
YES	37	74.0	74.0	74.0
NO	8	16.0	16.0	90.0
OTHER	5	10.0	10.0	100.0
Total	50	100.0	100.0	

Can you feel there is a lot of uncertainty on the project for the project team members?

Figure 7. Frequency Table

	Frequency	Percent	Valid Percent	Cumulative Percent
YES	31	62.0	62.0	62.0
NO	13	26.0	26.0	88.0
OTHER	6	12.0	12.0	100.0
Total	50	100.0	100.0	

Do you believe that if advanced building techniques were used, any of the above factors will be eliminated?

	Frequency	Percent	Valid Percent	Cumulative Percent
YES	43	86.0	86.0	86.0
NO	3	6.0	6.0	92.0
OTHER	4	8.0	8.0	100.0
Total	50	100.0	100.0	

Do you believe that India's health infrastructure is sufficient to solve the Pandemic problem?

	Frequency	Percent	Valid Percent	Cumulative Percent
YES	9	18.0	18.0	18.0
NO	36	72.0	72.0	90.0
OTHER	5	10.0	10.0	100.0
Total	50	100.0	100.0	

Figure 8. Frequency Table

Do you think that quality of the work would suffer as a result of the fast-track construction?

	Frequency	Percent	Valid Percent	Cumulative Percent
YES	39	78.0	78.0	78.0
NO	8	16.0	16.0	94.0
OTHER	3	6.0	6.0	100.0
Total	50	100.0	100.0	

Do you think the best choice for constructing a High rise building is to use advanced building techniques?

	Frequency	Percent	Valid Percent	Cumulative Percent
YES	46	92.0	92.0	92.0
NO	2	4.0	4.0	96.0
OTHER	2	4.0	4.0	100.0
Total	50	100.0	100.0	

Figure 9. Frequency Table

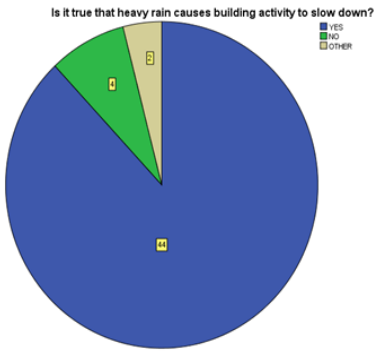


Figure 10(a). Pie Chart

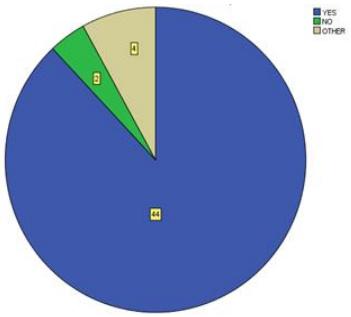
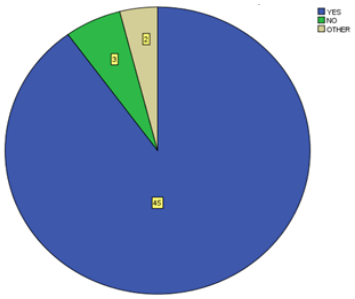


Figure 10(b). Pie Chart

Do you believe that using advanced construction techniques to build a High-rise structure is the best option?



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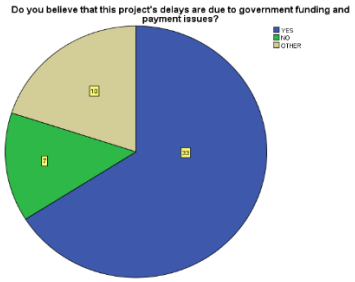


Figure 11(b). Pie Chart

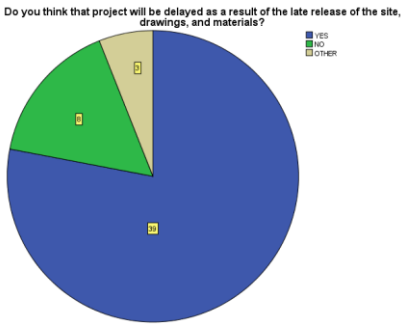
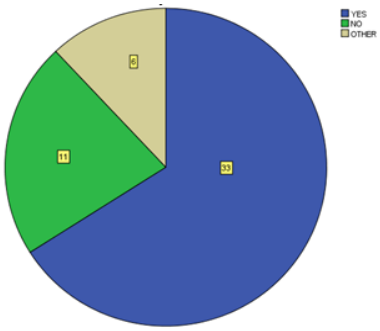


Figure 11(c). Pie Chart

Is the project team heavily reliant on one another for assistance, intelligence or enforcement to complete their tasks, causing a delay in the completion of the High-rise structure?



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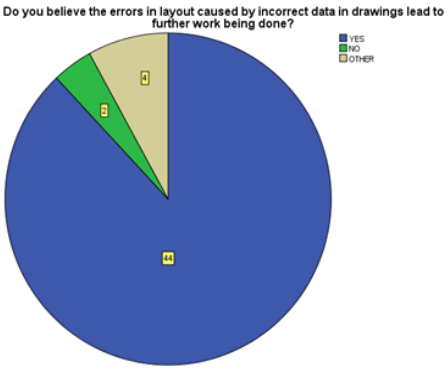

Figure 12(b). Pie Chart

Do you believe the project team members and staff lack expertise in the construction of an emergency on site?

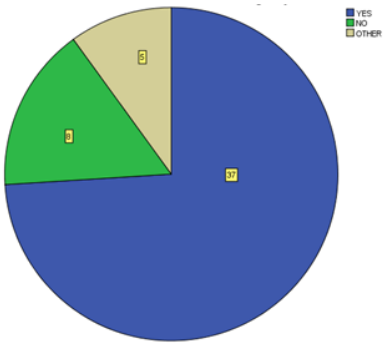

Figure 13(a). Pie Chart

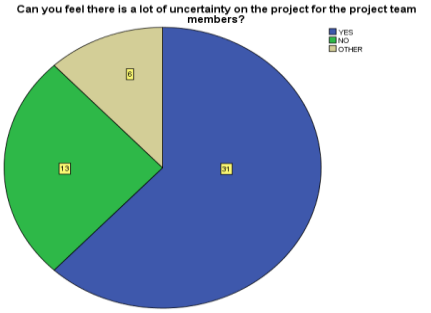

Figure 13(b). Pie Chart

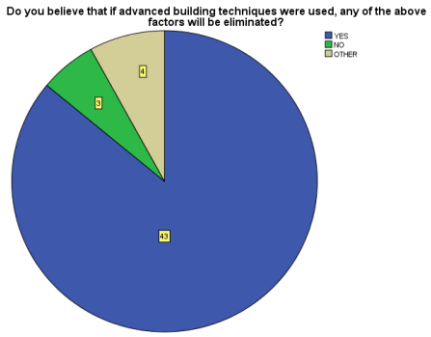

Figure 13(c). Pie Chart

Do you believe that India's health infrastructure is sufficient to solve the pandemic problem?

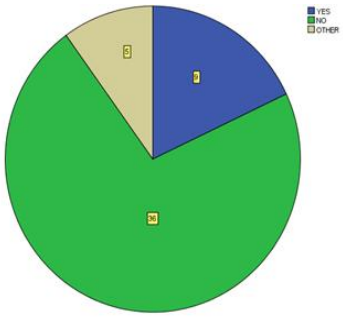

Figure 14(a). Pie Chart

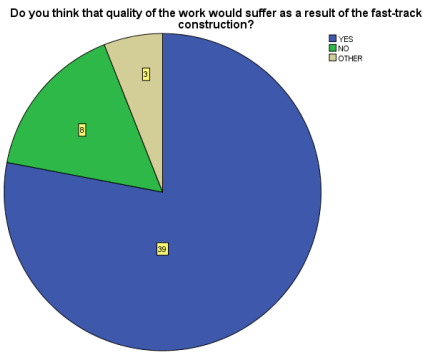

Figure 14(b). Pie Chart

Do you think the best choice for constructing a High-rise building is to use advanced building techniques?

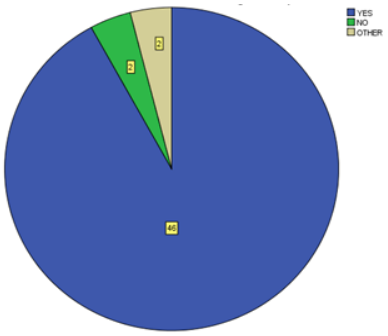

Figure 15(a). Pie Chart

Figure 15(b). Pie Chart

Do you believe that a High-rise building should be built at the start of the pandemic situation on site ?

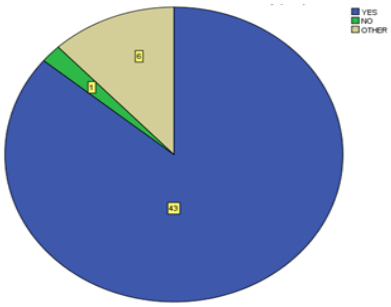

Figure 16. Pie Chart

RII Method

Sr. No.	Questions	YES(N1)	No(N2)	CANT SAY(N3)	Total
1	Do you believe that poor management system contributed to the High rise Structure late completion?	44	2	4	50
2	Is it true that heavy rain causes building activity to slow down?	44	4	2	50
3	Do you believe that using advanced construction techniques to build a High rise structure is the best option?	45	3	2	50
4	Do you believe that this project's delays are due to government funding and payment issues?	33	7	10	50
5	Do you think that project will be delayed as a result of the late release of the site, drawings, and materials?	39	8	3	50
6	Is the project team heavily reliant on one another for assistance, intelligence, or enforcement to complete their tasks, causing a delay in the completion of the High rise structure?	33	11	6	50
7	Do you believe the errors in layout caused by incorrect data in drawings lead to further work being done?	44	2	4	50
8	Do you believe the project team members and staff lack expertise in the construction of an emergency Site ?	37	8	5	50
9	Can you feel there is a lot of uncertainty on the project for the project team members?	31	13	6	50
10	Do you believe that if advanced building techniques were used, any of the above factors will be eliminated?	43	3	4	50
11	Do you believe that India's health infrastructure is sufficient to solve the Pandemic problem?	9	36	5	50
12	Do you think that quality of the work would suffer as a result of the fast-track construction?	39	8	3	50
13	Do you think the best choice for constructing a High rise building is to use advanced building techniques?	46	2	2	50
14	Do you believe that the task of construction management is required to complete the project on time?	46	2	2	50
15	Do you believe that a High rise Building should be built at the start of the Pandemic Situation on Site?	43	1	6	50

Figure 17(a). RII Table

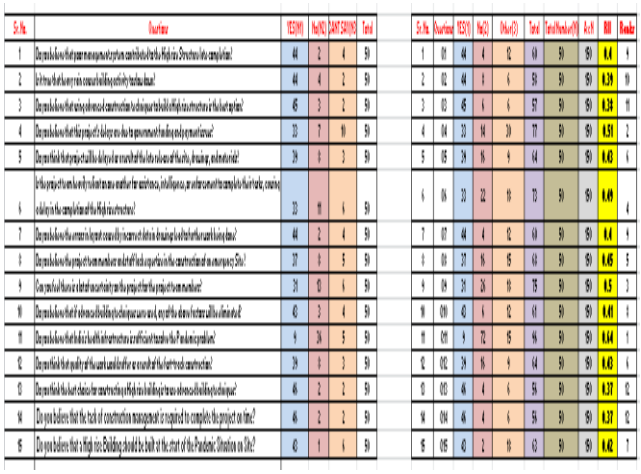

Figure 17(b). RII Table

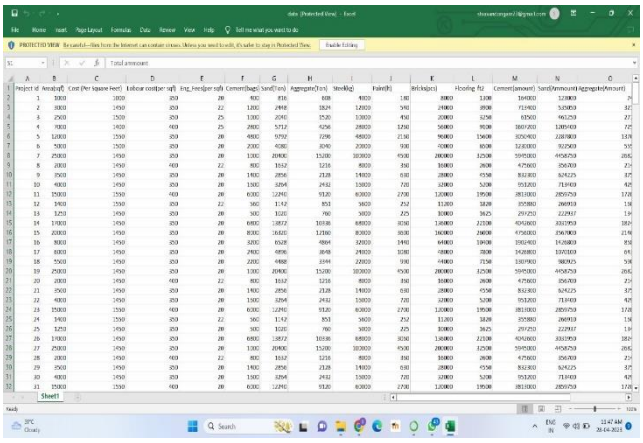

Figure 17(c). RII Table

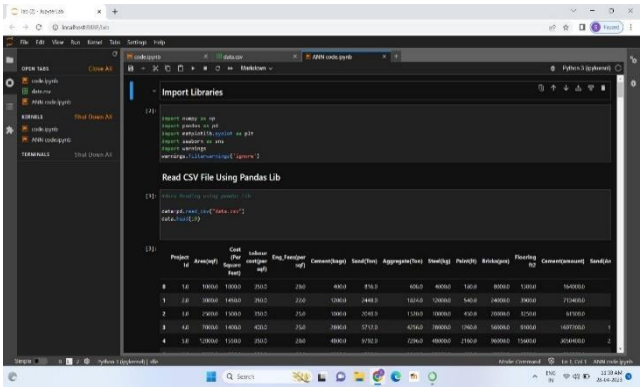

Figure 18(a). ANN Front View

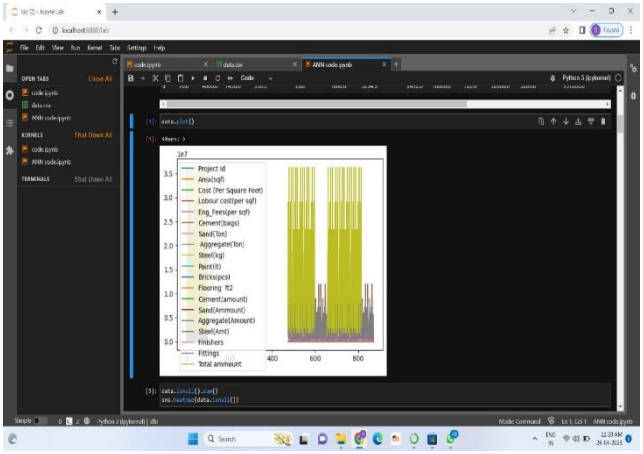

Figure 18(b) ANN Front View

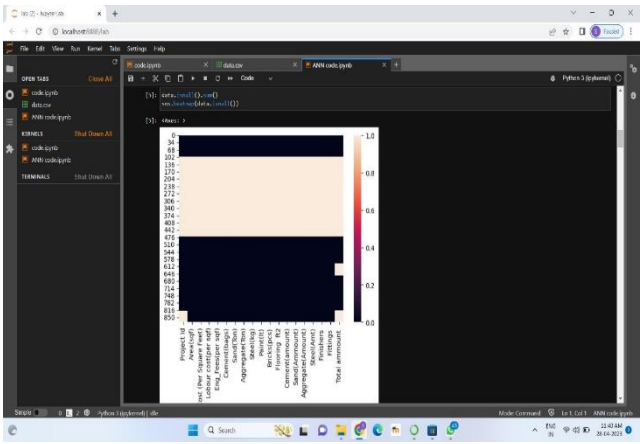

Figure 19. Pre-Processing

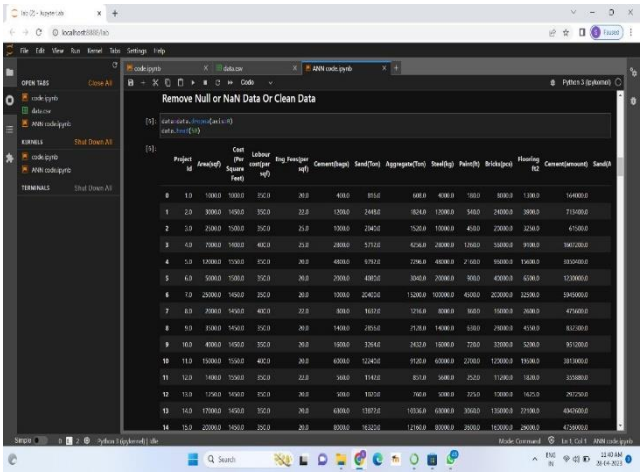

Figure 20. Remove Null/NAN Data/Clean Data

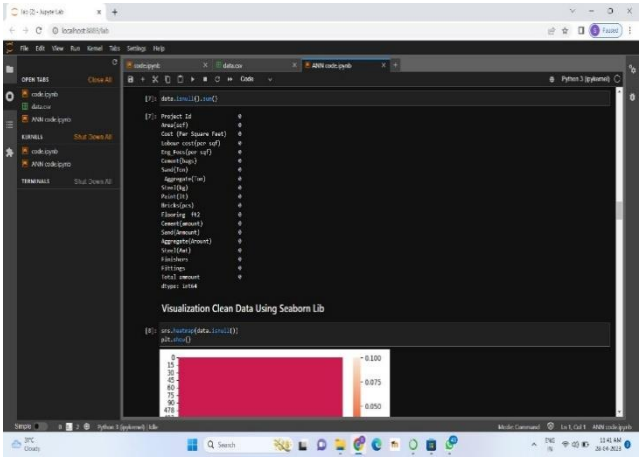

Figure 21. Binary Code

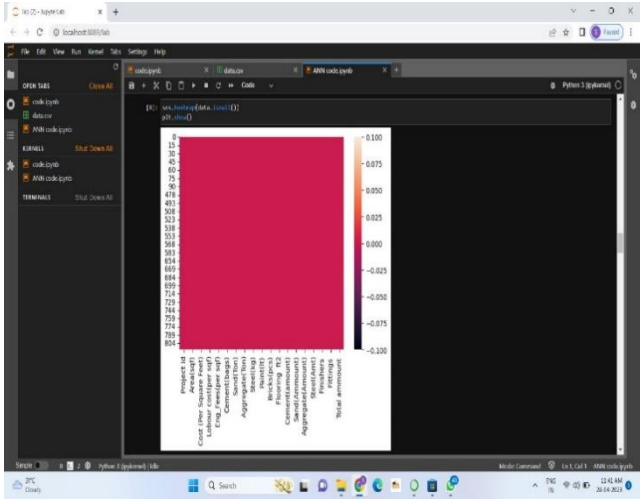

Figure 22. Data Encoding

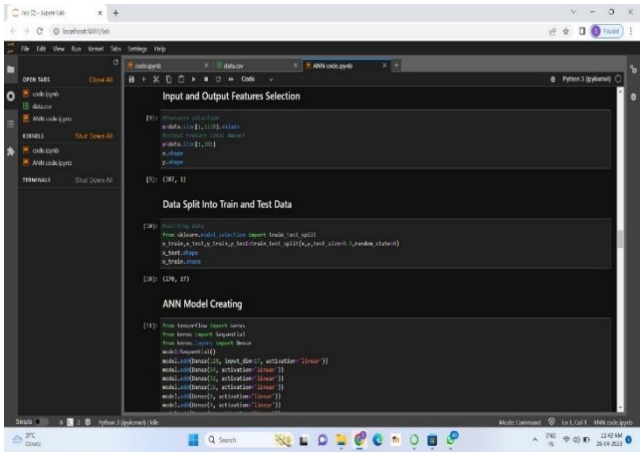

Figure 23. feature selection

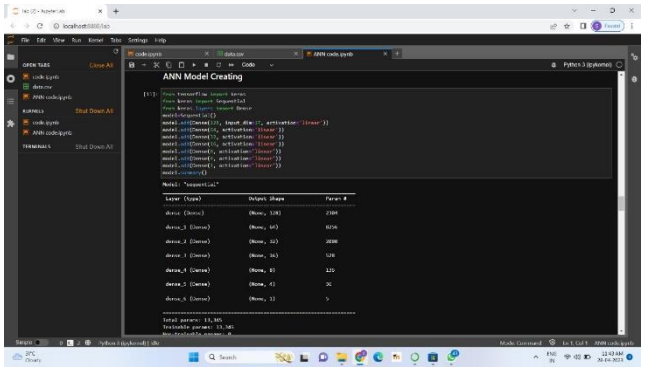

Figure 24. ANN Model Developing

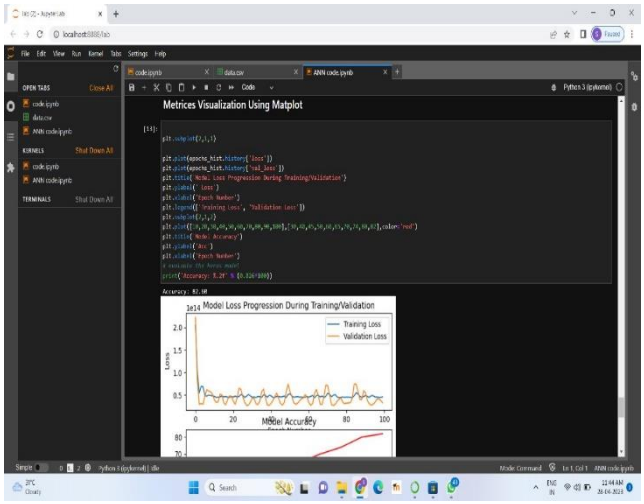

Figure 25. Testing Model

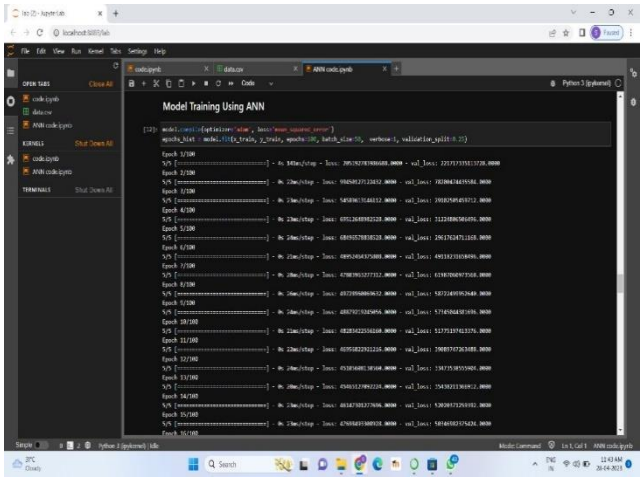

Figure 26. Model Training

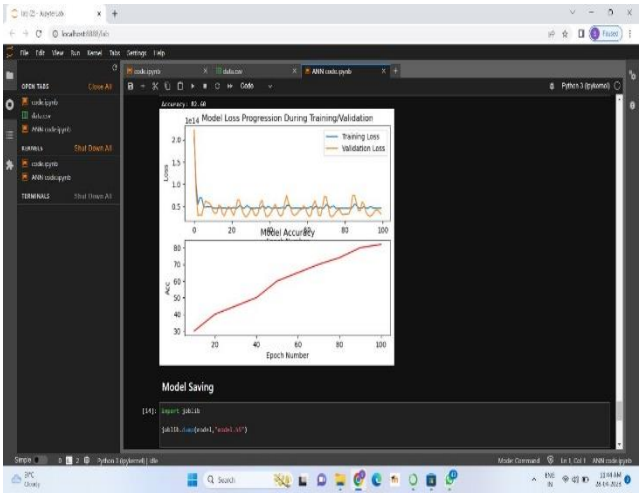

Figure 27. Model Performance & Saving

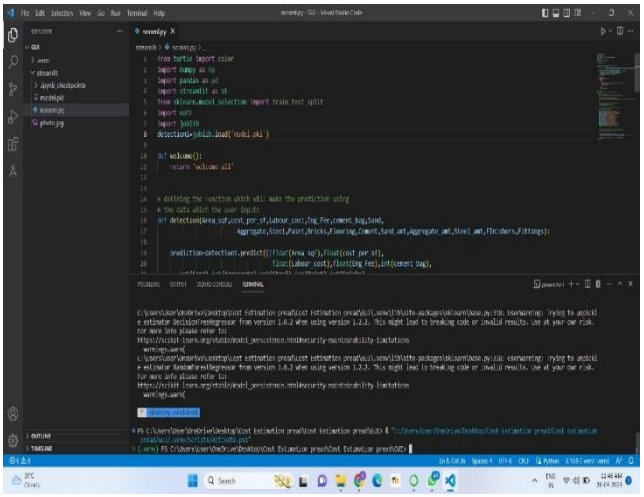

Figure 28. GUI Platform

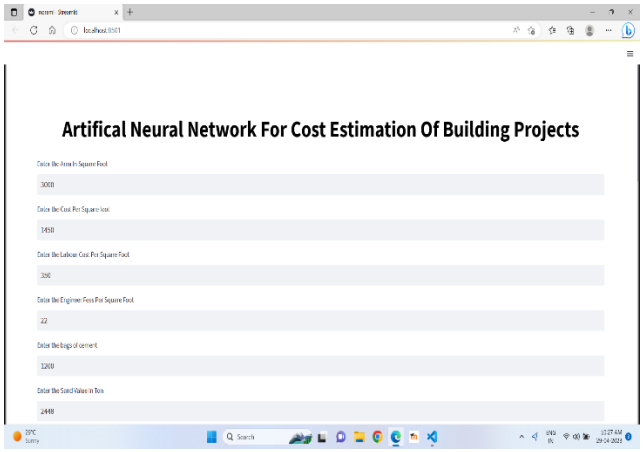

Figure 29. Output of Model of GUI

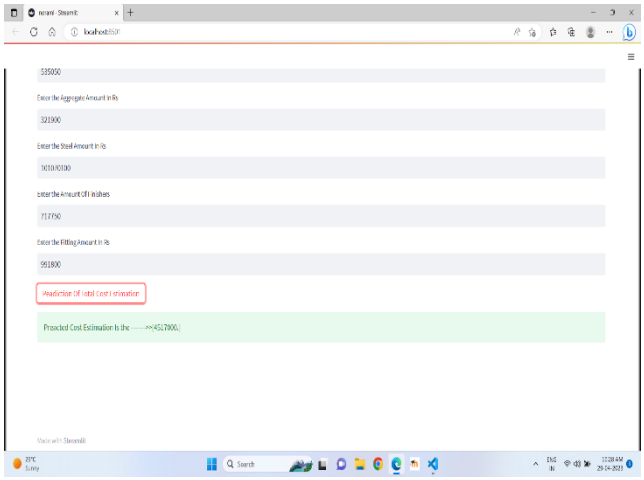

Figure 30. Output

4.CONCLUSION

- The experience of pandemic in the construction industry is not yet over as the learning curve has not completed the circle
- Where such can work, and workspace management, additional design considerations and services to the situation
- A limitation encountered during this research is the minimal number of the data collection when compared with the arrays of construction professionals all over the world. It would be expected that such data could have a larger number of survey participants than the number evaluated.
- Likewise, planning with unforeseen circumstances including other contingency covering that, and the reduction of the on-site work through the use of prefabricated elements.

- Further study could expand to involve more participants so as to explore further updates on the impact of pandemic in the construction industry from mod-2020 onward. Another limitation is the shortage of literature to revert to in-depth for this particular study.
- This is an unprecedented event which caught the entire world unaware and including the ardent risk takers in the construction industry.
- In the end, if these experiences are harmonized, a comprehensive turnaround strategy for contingency plan would be produced
- It seen that for there is increase in the rate for construction materials after pandemic period that before pandemic.
- There is almost 45% increase on an average after pandemic period.

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