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FACTORS AFFECTING IMPLEMENTATION OF DIGITALIZATION IN INDIAN CONSTRUCTION INDUSTRY

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Abstract - *Digitization is an inevitable process for the prosperity of companies. In the construction industry, the pace of entry is low for adaption technologies. Acceleration depends on many factors, as well as on the level of development of information and communication technologies. The report examines the major prime factors affecting the digitization of construction companies in the Indian Construction Sectors. Through, literature review and factors recommended by experts were considered to categorize the factors. Almost 40 factors, were identified, analyzed and ranked considering SPSS software. The survey implemented a quantitative approach over a questionnaire survey conducted midst construction professionals such as Engineer, Contractors and Architects in the Ahmedabad, Gujarat, India. Suitable descriptive statistical tools were utilized and analyze the data collected, also done graphical view and check reliability test in SPSS. Major construction processes, most of which are visible, include construction cost planning, cost control, preliminary cost estimation and analysis of the building system. Furthermore, the most noteworthy benefits to be derived from digitization in the industry include saving time in the delivery of construction projects, increasing productivity, speeding up work, increasing document quality, simpler working methods and speeding up response time. The aim of this research paper is to review literature in the identification of technologies used in line with digitalization, as well as to investigate potential barriers and factors that influence the implementation of digital technologies in the Indian Construction Sectors. On the basis of the results of the analysis, barriers and future needs are discussed. The results also show that acceptance can help improve the image of the industry.*

Key Words: **Digitization, construction industry, digital technologies, future challenges, Digital transformation, SPSS.**

1. INTRODUCTION

Digitalization has become a popular concept throughout the world today because of its ability to create operational efficiency, productivity, and new possibilities. Industries like the banking, manufacturing, and retail industries have all accepted and turned into a new approach for ensuring competitive efficiency and productivity by taking the advantages of digitalization forward (Osunsanmi et al., 2018). Although the use of this obviously beneficial technology has been embraced by these other industries, the construction industry still has to fully embrace it in providing its services. This failure to exploit the inherent benefit of digitalization has artificial the industry significantly, particularly in evolving nations, as no most important revolution is manifest inside their construction industry (Castagnino et al. 2016). Earlier, the devices and software had a human constraint in them so they failed in accuracy and precision. There is hardly 1% progress into the construction business in the last decade. The growth rate of the manufacturing industry has increased by 3.6% in the construction trade, the productivity of worker-related to the construction trade has remained flat. In Digitalisation, BIM (Building Information Modelling), AI (Artificial Intelligence), VisiLean, Cloud Computing, Robotics, Internet of Things, Mobile Computing are included.

Utilization digitalization extremely benefits construction developments in several aspects. As a Pandemic COVID-19 is principally spreading in our country so, now the work place is going to be digitalised, more or less 40-50 percentage of work is allot to employ as a part of work from home so in upcoming decade the use of Digitalization will impact a construction industry work, such as Structural work, Clash detection, Architect work, Earned value management, Building information Modelling. Furthermore, to utilize digitalization for monitoring at construction site and save the time and resources such as engine oil and save the planet from pollution. Utilization All Digitalisation methods/tools are useful and several ways but there are several factors affect the Digitalisation such as productivity, Human Behaviour, Clearance. These are a few of the factors which are affecting it. In this dissertation topic, discuss the factors and their possibility to affect digitalization and review from the construction industry sectors' professionals such as Architect, Contractors, Engineers, and Local Suppliers. In this method of Digitalisation, the whole importance was on exact inferences. Making precise inferences is occasionally a portion of being a rational mediator, for the reason that one way to act reasonably is to reason understandably to the conclusion that a given achievement shall accomplish one's aims, and then act on that conclusion.

1.1 OBJECTIVE

There are mainly two objectives of this research work. First is to study the factor affecting digitalization in

construction industry and to analysis the top most factor using the method of principal component method in SPSS.

1.2 LITERATURE REVIEW

Literature was collected, studied, analysed and sorted So many publications. After sorting the papers and publication which were relevant to the topic where zeroed down. Furthermore, these papers & publications which were sorted to the relevancy of the current topic. Many other sources such as techno social platform (Quora, LinkedIn), books were referred.

Here, the key factors influencing the digitalisation in construction industry which imparted their effect directly or indirectly. Many methods of analysis, such as DEMATEL method, Reliability Index method, Reliability test method, Theoretical, ranking method, navigation and military strategy, triangulation, System Literature Review Method, Case study, where studies, analysed and concluded by researchers.

Exposure was made to the method employed for data collection and analysis. Generally, for questionary survey, there were mainly two types of data analysis, Quantitative survey and Qualitative.

Certain consideration, such as Focused just on challenges and problems as well as introduced some technology, There is no practical adoption, focused on one country and Risk is a complex construct and this research may not have addressed every aspect of BIM project risk, The research paper was focused only theory, Focussed mainly on supply chain and not construction effectively, Human Behaviours and psychology of the work is not consider.

Till date factor analysis is not employed in the research work. Factors that are affected for implementation of digitalisation in construction, analysis needs to be employed as it is a method of data reduction in SPSS. Along with iteration to minimize the errors.

2. METHODOLOGY

2.1 Data collection

Numerous obstacle occurred during the collection of data such lock down, unavailability of contractor, resource limitation. So, an online questionnaire was floated to the contractors and engineers and the people linked with government bodies. A total of 100 questionnaire were circulated out of which 89 responses were submitted which means the response rate was 89%.

2.2 Data analysis

The data analysis carried out with the aid of experts and surveys, using the appropriate methodology, using the data collected through literature review and current scenario. Analysis was done on SPSS (statistical package for the social science)

The data gathered usually means an action plan that can be challenged in terms of research goals and can be divided into two types: quantitative approach and qualitative approach. In this research paper, Quantitative survey is implemented for data collection.

Quantitative survey: Quantitative survey questions are characterized as analytical questions that are used to obtain in-depth insights from respondents about a topic of survey research. The responses received for these quantitative survey questions are analyzed, and based on this quantitative data a research report is generated. Such questions are at the center of a survey and are used for collecting numerical data to determine statistical results.

Some information collected about the technologies and concepts:

- **Building Information Modelling (BIM):** BIM is a methodology to collaborate all construction sectors on one cloud platform.
- **Internet of things (IoT) & Internet of Services (IoS):** In this technology, All types of works done, transfer information, knowledge, and data through a network without human interaction.
- **Product Lifecycle Management (PLM):** PLM refers to the treatment of a decent as it travels through the normal phases of its item life: advancement and presentation, development, development/soundness, and decrease. This taking care of includes both the assembling of the great and its promoting.
- **Cloud Computing:** It is that all working data and information is to be saved, managed, and proceeded on the cloud platform, instead of the personal local computer.
- **Mobile Computing:** It is that all data such as the voice, information for construction work and video, and the like, are transferred for moving devices like Mobile phones, Laptops via the internet or local server.
- **Augmented Reality (AR) & Virtual Reality (VR) & Mixed Reality:** It is the term accustomed portray a three-dimensional, computer made condition that might be investigated and connected with by a private. That individual seems to be a bit of this virtual world or is submerged within this condition and whereas there, will management queries or play out a progression of activities. MR is the consequence of mixing the physical world with the advanced world. Mixed Reality is the following development in human beings, computers, and condition association and opens expectations that before now we're limited to our minds.

- **Robotics:** is an interdisciplinary part of building and science that comes with mechanical coming up with, electronic coming up with, knowledge building, software system engineering, and others.
- **Radio Frequency Identification (RFID):** It is the use of radio-frequency through utilized and the gathering of data placed on a label to an object.
- **Big Data:** It is the larger data scale from the Past to current working data which are stored and managed, collected from the sites, clients, and stakeholder which are connected to the construction sector.
- **3D Printing:** It is the technology in which three dimensional created any objects such as mould which are economical for construction.
- **Smart Factory:** It may be a manufacture solution during an efficient way should be to satisfy the requirements of nowadays market, and gains integration between the various industrial & non-industrial partners who construct dynamic, and really often and virtual organizations.
- **Human Computer Interaction (HCI):** It is a multitasking sector to study on the plan of computers innovations & especially, the interaction between PC and Pupils.
- **Modularisation:** It is that off-site construction means is that Project is divided into areas and build up separately and then connected the stepwise for completing construction projects.
- **Cyber-Physical Systems (CPS) & Embedded Systems (ES):** CPS is the combination of the internet, computer work, and physical activities. ES includes all types of software and hardware which is used in the electrical equipment and mechanical tools.
- **Artificial Intelligence (AI**): It is that Robots with a brain which is working like a human and detect errors and take decisions themselves.
- **Geographic Information System (GIS) & Global Positioning System (GPS)**: GIS is the tool for easy wat to detect geographical info in maps and that info is utilized in their projects. GPS is the tool to identify locations as well as environmental conditions on the Earth.

2.3 Questionnaire Design:

The questionnaire was generated by seeing the related pieces of literature/research papers in the sector of digitalization of Construction Company. The engineer discusses the questionnaire is shown in below. The generated questionnaire was validated with experts for clearness, easy use, and value of the data that could be gathered. The questionnaire survey is divided into three parts. The first part consists of general data like type of company, experience; Cost of their project. And the second part covers up the technologies and concepts which are useful for the implementation of digitalization in construction. The third part consists of factors of implementation of digitalization in the construction project.

Liker scale is used to rank the importance of each factor. This ranges from 1 to 5.

1: Disagree
2: Less agree
3: Agree
4: Strongly agree
5: Very strongly agree

2.4 Sample size determination

The Construction Companies were targeted for the survey. For a representative population statistical sample, the formula shown below.

$$ss = \frac{Z^2 * p * (1-p)}{C^2}$$

Where,
Z = Confidence value (Z=1.96 (95% Confidence level))
P = % picking a choice, convey as decimal (0.5)
C = Confidence interval, convey as decimal (0.1)

$$\text{new ss} = \frac{ss}{1 + \frac{ss - 1}{Pop}}$$

When population = population 204

(Source: https://www.fundoodata.com/citiesindustry/4/57/list-of-construction-infrastructure-companies-in-ahmedabad)

New sample size = 66

2.5 Questionnaire survey

As prescribed earlier questionnaire was made to analyse opinion of professionals. This questionnaire survey was conducted online (Google Form) as well as offline (Hard copy). 69 responses are collected in the google form where 20 responses are gathered in physical survey. Number of valid responses are carried out at the time of analysis.

Number of disseminate questionnaires	Total Respondent respondents	Total valid respondents
100	89	89

2.6 Frequency analysis from questionnaire

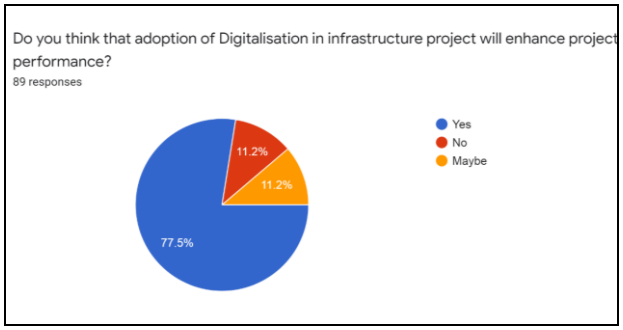


Fig. Fig. 1 Review of adoption digitalization

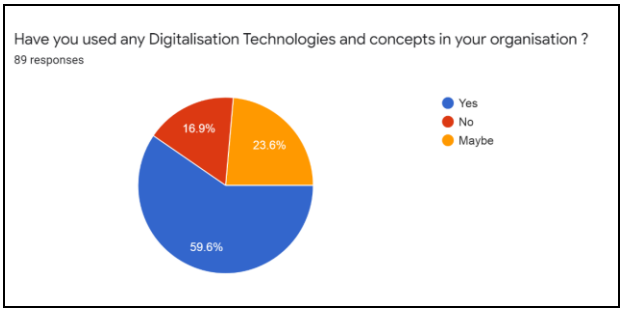


Fig. 2 Usage of Digitalization Technologies and concepts in organization

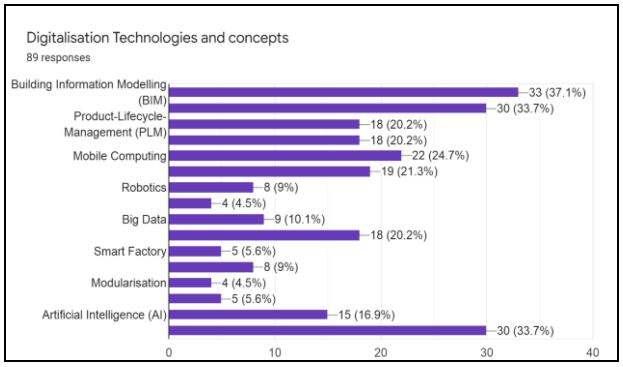


Fig. 3 Awareness of Digitalization Technologies and concepts

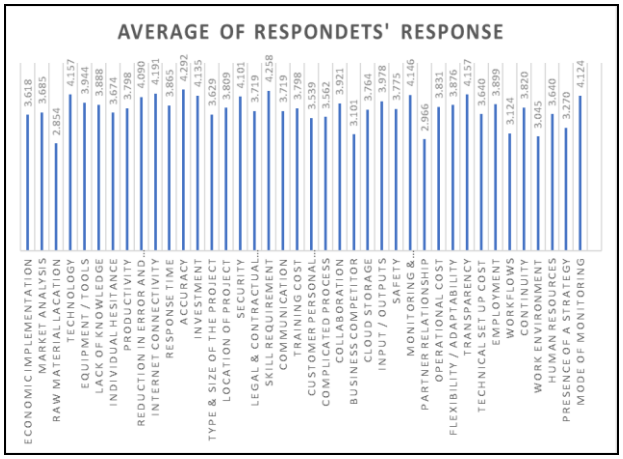


Fig. 4 Average of Respondent response

2.7 STATISTICAL ANALYSIS THROUGHT SPSS SOFTWARE

Analysis is completed by the SPSS (Statistical Package for the Social Sciences) software to analysis the questionnaire responses with Reliability analysis and different factor analysis done with the help of graphical method and matrix tables. In the SPSS Software, Descriptive Analysis, Total Variance, Correlation table is calculated easy way and their result is accurate. These analyses have determined that the all the questions in survey form are given that analysis result to identify each question response. This will help me to find out the result of my survey.

2.7.1. Reliability analysis in SPSS:

Reliability mentions to the degree which a system comes up with accurate out-puts when measurements are replicated many times. The study of reliability is called the measurement of reliability. Investigation of reliability is calculated by getting the proportion of systemic variability in a measure, which might be achieved by determining the correlation of scores derived from dissimilar scale administrations. Thus, if the correlation in the reliability analysis is strong, the scale produces steady outputs and is therefore accurate.

Assumptions:

- It should be uncorrelated to errors.
- The coding should have the same value in the products.
- Assignments of subjects are presumed randomly in the Split Half Test.
- The findings should be independent from one another.
- Variances can be considered equivalently in the Split Half test.

Table 1: Reliability Statistics output from SPSS

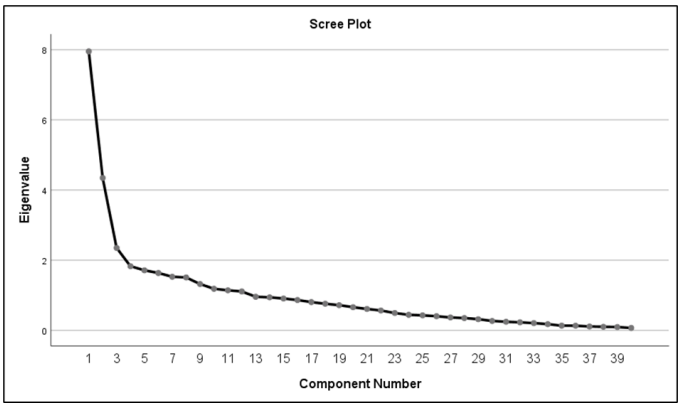
Reliability Statistics

Cronbach's Alpha	Number of Items
.884	40

≥ 0.8 < 0.9: good reliability,

2.7.2. Scree plot in SPSS

A scree plot illustrations the eigenvalues on the vertical axis and number of factors on the Horizontal axis. It generally shows a descending bend. Where the slant of the bend is obviously levelling off (the "elbow) shows the quantity of elements that ought to be created by the investigation. Shown in Graph 1.



Graph 1: Scree plot

2.7.3. Descriptive Statistics SPSS

Mean: These are the average of the variables utilized in the correlational analysis.

Standard Deviation: These are the standard deviations of the variables utilized in the correlational analysis.

Analysis (N): This is often the amount of cases utilized in the correlational analysis.

From, listing down Top 10 factors, Software naming known as SPSS was used. In SPSS the preliminary method used for factor analysis. The secondary method for factor analysis was principal component method. In Principal Component Method Descriptive table was generated which include the mean of the rating field by the respondent and provided the result. The top 10 factors highlighted. As shown in the table 2

Table 2: Descriptive Statistics output in SPSS

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Economic_Implementation	3.65	0.92	89
Market_Analysis	3.71	0.86	89
Raw_Material_Location	2.91	1.36	89
Technology	4.19	0.85	89
Equipment_and_Tools	3.96	0.81	89
Lack_of_knowledge	3.90	1.15	89
Individual_hesitance	3.66	0.87	89
Productivity	3.81	0.89	89
Reduction_in_Error_and_Rework	4.09	0.90	89
Internet_Connectivity	4.19	0.82	89
Response_Time	3.89	0.86	89
Accuracy	4.28	0.78	89
Investment	4.15	0.82	89
Type_and_Size_Project	3.62	0.78	89
Location_of_Project	3.82	0.91	89
Security	4.09	0.95	89
Legal_and_Contractual_Modification	3.71	0.81	89
Skill_Requirement	4.27	0.85	89
Communication	3.73	1.01	89
Training_cost	3.81	0.96	89
Customer_Personal_Factor	3.56	1.14	89
Complicated_Process	3.56	1.03	89
Collaboration	3.94	0.97	89
Business_Competitor	3.16	1.36	89
Cloud_Storage	3.81	0.95	89
Inputs_and_Outputs	3.98	0.93	89
Safety	3.76	1.16	89
Monitoring_and_Maintenance	4.15	0.87	89
Partner_Relationship	2.99	1.29	89
Operational_Cost	3.85	0.99	89
Flexibility_and_Adaptability	3.87	0.89	89
Transparency	4.16	0.81	89
Technical_setup_cost	3.63	0.97	89
Employment	3.91	1.06	89
workflows	3.18	1.35	89
continuity	3.82	0.89	89
Work_Environment	3.09	1.27	89
Human_Resources	3.69	1.06	89
Presence_of_Strategies	3.28	1.31	89
Mode_of_Monitoring	4.12	0.82	89

2.7.4. KMO and Bartlett's Test

Kaiser Meyer Olkin Measure of Sampling Adequacy: This measurement varies between 0 & 1, and close to value to 1 are best. A value of 0.6 is a suggested nominal.

Bartlett's Test of Sphericity: The tests the valueless proposition that the correlation matrix is a determine matrix. A unit matrix is matrix during which all of diagonal elements are 1 and every one off diagonal elements are 0. You want to decline this invalid theory.

Overall, these tests provide a nominal standard which should be passed before a principal components analysis (or an element analysis) should be shown.

Table 3: KMO and Bartlett's Test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.657
Bartlett's Test of Sphericity	Approx. Chi-Square	1665.558
	df	780
	Sig.	.000

2.8 RANKING OF THE FACTORS

Table 4: Factors Ranking

FACTORS	RANK
Accuracy	1
Skill Requirement	2
Internet Connectivity	3
Technology	4
Transparency	4
Monitoring & Maintenance	5
Investment	6
Mode of Monitoring	7
Security	8
Reduction in error and rework	9
Input / Outputs	10
Equipment / Tools	11
Collaboration	12
Employment	13
Lack of knowledge	14
Flexibility / Adaptability	15
Response time	16
Operational Cost	17
Continuity	18
Location of project	19
Productivity	20
Training Cost	21
Safety	22
Cloud Storage	23
Legal & Contractual Modification	24
Communication	24
Technical Set up cost	24
Market Analysis	25
Presence of a strategy	25
Individual Hesitance	26
Human Resources	27
Type & Size of the project	28
Economic Implementation	29
Complicated Process	30
Customer Personal Factor	31
Workflows	32
Business Competitor	33
Work Environment	34
Partner Relationship	35
Raw Material Location	36

3. CONCLUSIONS:

From the above data collection and data analysis, we can conclude: The top factors influenced the use of certain technology. With more accurate technology comes, the project gets delivered more precisely. The response rate was 89 % and the scoring varied from respondent to respondent despite having same turnover and working for same type of project. Bigger companies were aware about the technology and its important influence of the industry rather than small companies who knew but rather not adapt due lack of knowledge. The main aim is to add value to operations in construction, and overall help in life cycle of a project. Respondents were aware about the general software and technology but were not able to utilize it in real life project. Software such as BIM (Building Information Modelling) clash detection is helpful to prevent delays but will only be helpful when the LOD (Level of Detailing) is sufficient. To fulfill this strong team with good experience and knowledge is needed.

Many respondents said it's about how you want to implement a project and depending on that the technology be used. Many a time's respondents were not even aware about the technology and even if they knew they argued about its implementation in construction industry. Many of the above-mentioned technologies are currently used globally whereas our nation's just up to using BIM and clash detection. This is because of the unawareness regarding technology or insufficient knowledge of the technology. Improper or misguided knowledge of technology demotivated some of the respondents to use the certain technology but with proper guidance and knowledge, one can easily achieve and use the technology as per his skill. Respondents mainly focused on accuracy and precision that a technology can provide. Initial invest for setup the technology was a concern as there is an uncertainty such that a technology may fail. Need latest awareness regarding monitoring and maintenance. If the technology needs to be established then what about security of the device. Reduction of error at early and planning stage

Table 5: Top 10 Factors

Accuracy	Software may induce accuracy at ease as it may be easy to make changes at finger tips.
Skill Requirement	It makes one aware about the skill required to execute a plan in a better way.
Internet Connectivity	Without internet any of the software or technology cannot be used or be implemented as it may be unnotified the user
Technology	Time to time update is necessary as the latest version may induce more accuracy.
Transparency	It may be bringing transparency as any change in planning or drawings will be immediately notified to other causing mitigation of delay.
Monitoring & Maintenance	Monitoring is essential to keep the work as per record and planning. Maintenance is required for better functionality of the technology.
Investment	Is the money spent behind a particular technology worth and if it is then what is the time required to recover the expense of technology?
Mode of	The platform through which

Monitoring	monitoring is don is essential as it may induce the degree of ease of work and changes needed
Security	It is needed to avoid the theft or hacking of the system as many valuable documents are at risk.
Reduction in error & Rework	With detailing comes accuracy and thereby reducing the error and with pre-planning comes reduction in rework as one will be aware about the consequences.
Inputs/Outputs	The better is the input then best is the output. As the detailing of input increases so the precision in output increases.

4. RECOMMENDATIONS

- Lot of queries for the mentioned technology. Put up a small explanation regarding the technology.
- Easy elaboration so anyone can understand. A bit easy language such it does not become a barrier.
- Explain the respondent how, where and why the technology can excel their service. Explain the features and specification of the technology.
- Questions be such that any respondent must be aware about that particular technology to the point question Ask question as per the market requires i.e. converse about the technology which currently being used in our nation. Be aware about the recent advances made in technology with respect to the market.
- How can one score if he/she is not aware about the technology. Be thoroughly experience regarding the technologies

5. FUTURE SCOPE

In the study, factor analysis was done in limited area named Ahmedabad region. One can conduct the same for larger region such as state, country as well as continent due to the awareness about, which type of cutting-edge technologies are used for improving digitalisation in the construction sector and make it easily adaptable as well as transparent to all the stakeholders which are connected to construction project.

Furthermore, Factors that are written in the questionnaire is the area of my knowledge with the help of literature. In future, one can do research on other factors which are affecting the construction industry directly or indirectly.

This extend the scope of research in the field of digitalisation in construction industry to make it even more effective, efficient and workable.

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