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BARRIERS TO THE DIGITALISATION OF THE CONSTRUCTION SECTOR IN INDIA

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Abstract

In the construction sector, digital transformation has emerged as an essential approach that enables companies to improve productivity, speed up operations and complete projects efficiently. This paper examines how digital technology is transforming the Indian construction industry. India has much to gain from digitalisation, given its diverse projects and huge infrastructure needs. A Likert scale was used to collect survey data. According to the study, which used exploratory factor analysis (EFA) to identify the underlying relationships between the measured variables, 3 out of 10 potential barriers to digitalisation in the Indian construction industry were found to exist. To accelerate the integration of digital technologies, the study highlights the importance of creating a supportive ecosystem that goes beyond financial support and includes collaboration between construction companies, technology providers, research institutes and educational institutions.

Key Words: Indian Construction, Digitilisation, EFA,

Introduction

The economy of any nation, including India, is heavily dependent on the construction industry. Research shows that India's construction industry contributes 7.8 per cent to the country's net GDP and multiplies the impact of 200 plus associated companies. The construction industry in India was the second largest recipient of foreign direct investment (FDI) in the fiscal year 2020-2023, with a total of US$35.75 billion received by the industry between April 2005 and March 2022. India's construction sector is expected to develop significantly by 2030, contributing more than 12 of the country's GDP and totalling INR 64.580 billion. While there may be short-term difficulties in some segments of the construction sector, India's medium to long-term development trajectory remains promising. By promoting more efficient operations, increased collaboration and environmentally friendly processes, digitalisation can both maintain and enhance current trends in the design, execution and management of construction projects. According to a new study, the adoption of artificial intelligence and other technologies has a positive impact on circular economy practices.

In response to these digitalisation prospects, the Indian construction sector is rapidly adopting technology, albeit at different rates across different parts of the organisation. While some companies and initiatives are leading the way in using digital technology and creative approaches, others are just getting started. Stakeholders in the Indian construction industry are divided on digitalisation, and some lack the confidence to adopt new technologies. This is in line with the survey, which found that developing digital skills and capabilities across the organisation continues to be the top digital challenge for Indian construction companies. According to the report, many are still confused about how best to position their businesses for digital transformation, and few are struggling to develop a digital investment strategy. Despite the obvious benefits of investing in technology, companies are reluctant to do so. Only four per cent of Indian construction companies are currently undergoing technological transformation, even though most of them have only recently started.

Before these benefits can be fully realised, it is argued that poor countries in particular have a number of STEEP (social, technical, environmental, economic and political) barriers to overcome. Given the importance of the construction industry to India's economic expansion, it is imperative to understand the factors influencing the adoption and use of digitalisation in this country. The Indian construction industry is characterised by a fragmented ecosystem with multiple competitors, a wide range of project sizes and varying levels of technology readiness. It operates in a distinct socio-cultural and economic environment. In order to effectively implement digitalisation and achieve sustainable development, it is important to conduct a comprehensive analysis of the factors hindering its implementation in this particular environment. Therefore, this research is a thorough investigation to advance academic understanding to inform legislators and industry stakeholders on how to effectively adopt digitalisation in India. Through this research, we hope to gain a better understanding of the barriers preventing the widespread adoption of digital technology in the Indian construction sector. The study's conclusions will facilitate evidence-based decision-making when developing targeted initiatives and tactics to promote digitalisation in the Indian construction industry.

Literature Review

Houses, businesses, real estate, infrastructure and other forms of transportation are all part of what the construction sector provides, thus it has always defined everyday life in a number of ways. The broader relevance of construction projects comes with complexity, financial and time limitations, and quality issues that could be addressed through digitalisation. Much previous research has explored the topic of digitalisation and how it relates to the business world. Digitalisation in the construction sector, according to Musarat et al. (2022), is the application of digital technology combined with industrialised engineering methods to increase the sustainability and profitability of construction projects. Carlsson (2018) asserts that understanding digitalisation, also referred to as the 'digital revolution', and is essential for understanding the commercial and industrial trends of the modern era. Digitalization will have a significant impact on the entire corporate world, changing organisational structures, business models, the way companies deal with competition, and affecting profits and productivity. According to Carlsson (2018), digitalisation may also be able to address the growing demand for effective planning, problem solving and decision making. According to Colson et al. (2019), decision-making models have undergone significant changes over time. Fifty to seventy years

ago, human judgement was the primary decision maker (Colson et al., 2019). The author outlines a shift in decision making from being solely 'human', which has led to the increased use of data and digital technology to improve decision making. In recent years, a significant number of studies have been published that provide further detail on the use of digital technology. The aim of Hoßfeld (2017) was to assess the impact of digitisation on organisational decision-making. According to the author, the use of digital technology - especially automated systems - will improve decision-making outcomes by reducing errors in human judgement. The potential of digital technology to address the problem of decision complexity has also been investigated in the past. Alva (2022) pointed out that digitisation is a broad term, often defined by its application environment. It describes how digital technologies are used in business to improve operations and consumer experiences. In a technical sense, it is known as the 'use of tools for innovation and efficiency' According to Qudrat-Ullah et al. (2008) on complexity in decision making, decision makers are now dealing with problems that are harder to solve, more interconnected and occur in ever-changing environments. The authors claim that although it is a regular step taken by organisations, there are several barriers to acquiring new managerial skills (human knowledge) to deal with ever-changing and complicated difficulties. According to Qudrat-Ullah et al (2008), the increasing complexity of managerial decision making can be addressed through new developments in computer technology and the creation of new simulation tools. Many other studies have evaluated the benefits of using digital technology to assist people in the construction sector.

Gamil et al. (2020) claim that digitalisation can help construction companies achieve their goals by, among other things, changing operating methods, enabling timely communication, increasing efficiency through system integration, improving asset productivity and reducing costs.

If the construction industry is to remain competitive and grow steadily, it cannot afford to ignore digital technologies. Today, companies are working with digitally connected technologies at every stage of the value chain. Due to the widespread adoption of digital tools and automation in the construction industry, managers may need to rethink their strategies in light of the technological breakthroughs of Sector 4.0. Management changes are needed in the construction sector to address issues such as an ageing workforce, training and education, resource efficiency, green manufacturing and mass customisation. Significant barriers to digitalisation are believed to have hindered its adoption and prevented the Indian construction industry from realising its full potential. Research by authors such as Bajpai and Misra (2021) and Parwal (2023) shows that the barriers to digitalisation in the Indian construction sector are numerous, ranging from stakeholders' resistance to adopting new technologies to a lack of digital skills within organisations.

Research Gap

Compared to other regions, the Indian construction industry has been slower to embrace digitalisation. The main reason for this delay is that the Indian construction industry is only partially digitised, with most studies focusing on one business area or even one stakeholder group at a time. This has been identified as a significant knowledge gap, which this study aims to fill by conducting a comprehensive investigation that considers barriers across the sector, including architecture, design, engineering, construction and project management. Unlike

many previous studies which have focused on managers/policy makers or end users, this study also recruits participants at all levels within the sector.

Research methodology

Data collection

Based on comprehensive literature review, possible obstacles to digitalization adoption in the construction sector are identified. Based on this, the questionnaire for this research was constructed using these factors. This approach aligns with multiple theories related to technology or innovation adoption including the Technology Acceptance Model (TAM)

Using a Likert scale from 1 to 5, respondents may indicate their level of agreement, disagreement, neutrality, or extreme disagreement on the survey. There are a total of 10 questions in the survey and we ask how much people in the Indian construction industry agree with certain possible obstacles to digitalization.

Methods of Data Analysis

Reliability analysis

The survey data was collected using a Likert scale, hence the most popular metric of internal consistency or reliability, the Cronbach Alpha coefficient, as suggested by Taber, (2018); Hedau (2016), was utilized. This study's data is quite trustworthy and consistent with itself; the Cronbach Alpha coefficient is 0.890.

Exploratory factor analysis

Using exploratory factor analysis (EFA) to identify the underlying connections between the measured variables, the research indicated that 3 out of 10 possible obstacles to digitalization in the Indian construction sector were really functioning as such. Basically, the purpose of the questionnaire is to uncover a set of unspoken ideas that support a number of quantifiable characteristics.

Discussion of result

The primary objective of this study was to determine what obstacles the Indian construction sector faced while trying to digitalize their processes. The study's results were then used to overcome these obstacles. Despite the fact that the survey looked at 10 factors, our analysis shows that after extraction and rotation, the exploratory factor analysis confirmed 3 of those components and grouped them into 3 distinct themes. The scree plot of the analysis is given in Figure 1. The eigenvalue of the data set are given in Table 1.

Table 1: Eigenvalue of Data Set

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
Eigenvalue	7.325	1.738	1.253	0.859	0.216	0.184	0.119	0.078	0.011	0.003
Variability (%)	48.835	11.587	8.352	5.726	1.440	1.228	0.792	0.520	0.073	0.021
Cumulative %	48.835	60.422	68.774	74.500	75.940	77.168	77.960	78.480	78.552	78.574

Source: SPSS Output

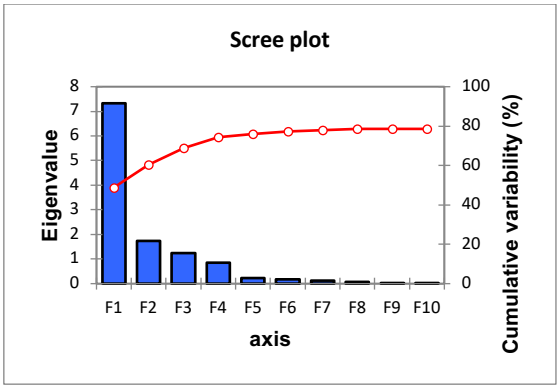

Figure 1: Scree Plot; Source: SPSS output

Socioeconomic, Digital and Geopolitical (SDG). Although the SDG framework offers a broad categorisation of external factors influencing technology adoption and implementation, it overlooks specific nuances and complexities. The details of factor loading are given in Table 2

Table 2: Factor Loading

		F1	F2	F3	F4	Initial communality	Final communality	Specific variance
1	High Initial Investment	0.422	**0.526**	-0.282	-0.120	0.583	0.549	0.451
2	Limited Financial Resources	**0.537**	-0.030	0.008	0.159	0.591	0.315	0.685
3	Insufficient awareness	0.102	0.274	0.297	**0.544**	0.520	0.469	0.531
4	Regional Disparity	**0.610**	-0.184	-0.576	0.292	0.814	0.823	0.177
5	Less Tech-Savvy Workforce	**0.794**	-0.351	0.312	-0.139	0.877	0.870	0.130
6	Fragmentation between industry stakeholders	**0.850**	-0.171	0.173	-0.009	0.905	0.782	0.218
7	Daunting challenges of scalability	0.422	**-0.537**	-0.337	0.342	0.742	0.697	0.303
8	Lack of bespoke solution	**0.886**	-0.026	0.244	-0.175	0.868	0.875	0.125
9	Data security and privacy	0.354	**0.728**	-0.100	0.066	0.602	0.670	0.330
10	Gaps in understanding	**0.846**	0.077	0.096	-0.121	0.848	0.745	0.255

the practical aspect

Source: SPSS Output

As such, this study integrates insights from the few important area of the economy to provide more tailored novel themes for the understanding of challenges. The integration of these frameworks enables this study to establish a balanced picture of the current state of digitalisation within the Indian construction sector with novel themes which is the main purpose of this study. The novel theme names presented in this study highlighted unique dimensions of constraints in the digitalisation of the construction industry in India. This novel theme-naming approach allowed for a granular analysis driven by the need for a comprehensive understanding of barriers to digitalisation of the Indian construction industry beyond the broad categorisation.

Implications of findings

The adoption of a novel framework to name the emerged themes enables the findings from this research to reveal detailed insights that extend beyond basic interpretations, offering substantial implications for researchers, stakeholders, including the government, and the broader population within the Indian construction industry. The varying pace and extent of digitalisation adoption across different segments within the Indian construction sector indicate a need for strategic decision-making, particularly for project management and construction SMEs that are facing resource and knowledge gaps. Policymakers can leverage these insights to refine government programs like “Digital India” and “Smart Cities,” ensuring they address the challenges faced by different segments within the construction industry. This study underscores the key barriers to digitalisation of the Indian construction sector, necessitating an ecosystem fostering innovation, affordable digital solutions, and skill development. Educational and training initiatives, guided by researchers and industry stakeholders, become crucial in addressing identified skill gaps and knowledge limitations, supporting effective technology integration. The acknowledgement of the transformative potential of digital technologies in promoting sustainability within the construction industry by the study’s participants points to an opportunity for researchers and industry leaders to drive innovation and digital technologies in construction in eco-friendly practices. Public awareness and perception play a role in the societal impact of technology integration into construction practices, requiring collaborative efforts to communicate the advantages of digitalisation. This study emphasises the importance of creating a supportive ecosystem beyond financial support, involving collaboration between construction enterprises, technology providers, research institutes, and educational authorities to accelerate the integration of digital technologies. In essence, these implications offer a roadmap for collaborative action, guiding stakeholders, researchers, and policymakers toward strategic steps that will propel the Indian construction industry into a future characterised by efficiency, sustainability, and global competitiveness.

Conclusion

Going forward, there are many exciting opportunities for digital transformation in the Indian construction industry. Construction processes will become even more efficient with the advancement of AI, IoT and automation. Virtual reality (VR) and augmented reality (AR), together, will transform stakeholder engagement and project visualisation. Big data analytics will improve resource allocation and decision making. Sustainable construction methods will

become more common as India looks for green building alternatives. Despite numerous benefits of digitalisation on construction including productivity, improved collaboration, better decision- making, increased safety, and enhanced competitiveness, its adoption has been slowed by some barriers. Using a multi-phase research approach, this study has identified and analysed the critical barriers that hinder the widespread adoption of digitalisation within the Indian construction sector. The study's holistic approach involved conducting a literature review to uncover some potential barriers to digitalisation in the construction sector. The potential barriers identified were then used to construct a questionnaire administered to 50 professionals working within the construction industry in India.

The survey conducted established that the Indian construction sector is willing to move towards the global trend of technology integration into construction procedures. Personalized client requests and sustainable building designs are only two areas that might be transformed by digital transformation, according to several participants. The industry as a whole stands to benefit from increased productivity and new opportunities. While there may be some difference between sectors and firms, the survey does show that digitalization is being more widely used in the Indian construction industry. Engineering and design sectors demonstrate greater proactivity, leveraging financial capabilities and ample resources to embrace digital technologies. In contrast, project management and construction businesses that are characterised by smaller and medium-sized businesses face challenges in resources and knowledge, leading to slower adoption rates. The responses from the study specifically reveal the increasing integration of technologies such as building information modelling (BIM), virtual reality, drones, IoT sensors, and cloud-based project management tools in construction projects. In preparation for the digital transformation journey that the Indian construction sector is about to undertake, this study lays out the obstacles that researchers, policymakers, and industry stakeholders face. With any luck, these findings will help them make sense of the digitalization landscape and reimagine the future of construction in India.

In conclusion, digital technology is rapidly transforming the Indian construction sector. It's a fantastic opportunity for development and progress. Together, we can use these technologies to develop faster, more effectively and with less negative impact on the environment. The Indian construction industry is currently in the midst of a digital transformation journey, which offers immense potential for expansion and innovation. The adoption of digital technologies can help the industry become more globally competitive, sustainable and efficient. Collaboration among stakeholders, ongoing research, and a supportive policy environment are essential to maximise the promise of digitalisation. By embracing digital transformation, India's construction sector can grow and support the country's infrastructure and economic development.

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