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UNPACKING AGILE PROJECT MANAGEMENT IN INDIAN CONSTRUCTION: ADOPTION BARRIERS, INDUSTRY READINESS AND SUSTAINABILITY VIEWPOINT

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ABSTRACT

The construction industry faces mounting challenges in controlling the complexity, size, and dynamic nature of contemporary projects. Conventional project management approaches lack the flexibility and adaptability to address these challenges. Agile Project Management (APM) has been proposed as an alternative, with a focus on flexibility, teamwork, and iterative development. This present research examines the impediments to APM adoption through a systematic literature review and a questionnaire survey with industry experts. The impediments identified were grouped into four categories: Organizational Barriers, Team and Collaboration Barriers, Process and Communication Barriers, and Technical and Integration Barriers. The data gathered were analyzed using statistical methods, including descriptive analysis, Cronbach's alpha for reliability analysis, and the Relative Importance Index (RII) for ranking key factors. The results identify deficiency in agile expertise, complex interdisciplinary coordination, and client resistance to agile transition as the foremost challenges. Among all the barrier groups, the Team and Collaboration barriers group possesses the maximum RII score, which means the most critical issues in cross-functional coordination and communication. In spite of the limited experience of the respondents with APM, there is a distinct recognition of its need for the efficiency of projects and the improvement of outcomes. Additionally, the current study also discusses the sustainability aspect of APM in construction. The research concludes that effective APM adoption in construction is contingent on focused interventions, including specialist training programs, organizational reorganization, and hybrid project management models integrating agile principles and conventional milestone-based methods.

Keywords: *Agile Project Management; Construction Challenge; Implementation Barriers.*

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1. INTRODUCTION

Construction is a vital economic sector, central to employment generation and infrastructure. It provides jobs for more than 180 million individuals and contributes approximately 10% to 13% GDP of any nation. Urbanization and population growth stimulate demand for megaprojects, hence boosting the sector. However, megaprojects are generally faced with large uncertainties and complexities (Pitsis et al., 2018). Industry fragmentation causes coordination issues and communication delays, hence necessitating more adaptive project management to enhance responsiveness and efficiency.

India's construction sector is growing at a fast pace, with a projected growth of 11.2% in 2024 to INR 25.31 trillion, boosted by urban development and infrastructure growth. Some of the significant projects are Bharatmala, Chenab Bridge, Mumbai Trans Harbour Link, and the Mumbai-Ahmedabad High-Speed Rail (MAHSR) project. The need for sustainable infrastructure and housing for the common man is on the rise, putting pressure on the construction companies to move in a timely and efficient manner. NITI Aayog reports that more than 70% of the infrastructure projects are delayed and over-budget due to ineffective planning and inflexible implementation. The sector also has its hierarchical culture and resistance to change, which are not conducive to new project management methods (Wilson, 2018). Therefore, there is an increasing need for adaptable and collaborative methods to enable the team to respond to the evolving project requirements.

Conventional project management techniques, especially the waterfall technique, have been extensively used in the construction industry but lack the dynamic nature of mega projects. The techniques follow a linear and sequential strategy where phases of the project (planning, design, execution, and closure) are fixed at the initial stage, and it is challenging to change once the execution stage has begun. Thus, when unexpected issues occur, such as material shortages, design changes, or unexpected site conditions, the inflexibility results in delays in the project, cost overrun, and inefficiencies (Moshood et al., 2024). To address these challenges and weaknesses of the traditional project management approaches, the construction industry seeks new project management systems that emphasize flexibility, collaboration, and continuous improvement (Levitt, 2011). Agile Project Management (APM), originally developed in the software sector of the 21st century, has drawn considerable attention as an effective tool to enhance flexibility, stakeholders' collaboration, and risk management in construction (Ciancarini et al., 2022). Agile tools such as Scrum and Kanban emphasize strong emphasis on iterative planning, ongoing updating of project objectives, and effective management of workflow, which makes them most suitable for complicated and uncertain construction environments (Sudipta, 2021).

Though APM has been effectively applied in IT, manufacturing, and product development, its use in construction, particularly in India, is still in its infancy (Kashikar et al., 2016). Identifying India-specific barriers is useful for effective implementation of agile project management in Indian megaprojects construction. The present study, therefore, aims to explore and analyse potential barriers to adopting APM in the construction megaprojects, particularly in the Indian context. Through literature review, expert opinions, and survey-based statistical analysis, the present research explores APM's implementation challenges, and the appropriate project management approach needed to propel construction megaprojects.

2. LITERATURE REVIEW

The word agility is derived from the Latin word 'agere', which means "to drive, act," implying a sense of ownership, and the ability to drive something forward (White, 2013). Other definitions mention "ready ability to move with quick, easy grace" (Kerievsky, 2023). Additionally, the definition refers to having a quick, resourceful and adaptable character. According to the Project Management Body of Knowledge (PMBOK), agile is an iterative approach to incremental delivery of value and responding to shifting requirements. According to White (2013), agility has three characteristics important to project management in this new business world:

- Sense of ownership and authority,
- Quick and easy changes of direction, and
- Resourceful and adaptable

2.1 TRADITIONAL PROJECT MANAGEMENT APPROACH AND ITS CHALLENGES

The Traditional Project Management (TPM) or Waterfall model is a linear and sequential approach as shown in the Figure 1 of project management with a strict structure and approach, and sequential project life-cycle planning (Mohammed & Karri, 2020).

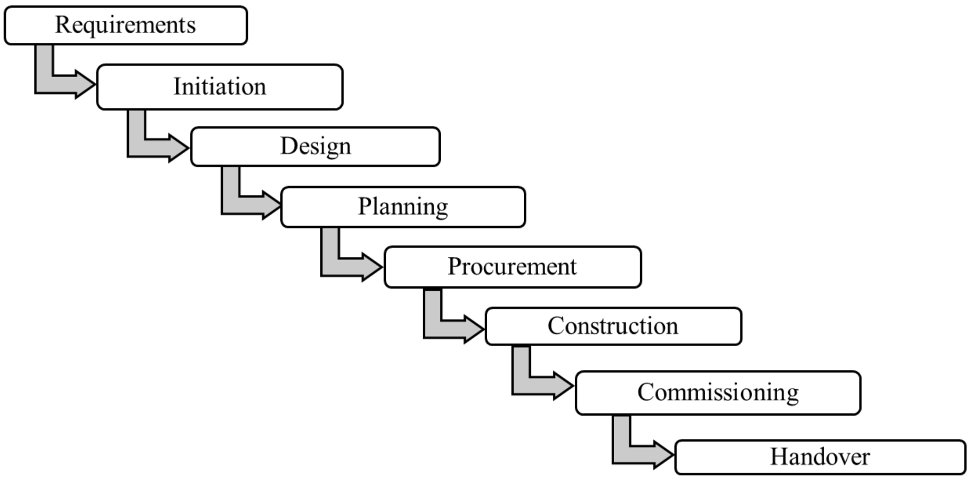


Figure 1: Traditional project management

This model has been faulted for its shortcomings in handling contemporary projects. Its greatest weakness is inflexibility, which hinders the ability to accommodate new requirements or environments. Additionally, TPM lacks provisions for fostering cooperation among stakeholders in a project, which is a requirement for big, multidisciplinary projects. Reliance on extensive documentation brings inefficiency, devouring time and resources without increasing agility. TPM also lacks in risk management due to its sequential nature, which does not leave space for iterative evaluation and adjustments. These flaws stress the need for more cooperative and adaptable approaches, such as APM, to handle the changing needs of contemporary construction projects.

2.2 POTENTIAL OF AGILE PROJECT MANAGEMENT IN CONSTRUCTION AND ITS APPLICABILITY

Limited literature has examined the suitability of APM for application in construction projects (Mohammed & Karri, 2020; Dallasega et al., 2019). Stare (2014) points out that some APM practices can be implemented even in traditionally managed projects, although great obstacles still exist for their implementation in the construction stage. In the Indian context, researchers found that APM can minimize time overruns in megaprojects by dividing work into smaller, manageable pieces, enhancing delivery reliability in an industry where almost 90% of government infrastructure projects experience delays.

The application of APM tools such as daily scrum can enable subcontractors to set day-by-day objectives and monitor progress. Mohammed and Karri (2020) illustrated that sprint planning resolves delays effectively, as evidenced by a case study on the construction of a 2-BHK flat. Likewise, other studies revealed that Agile enhances planning, scheduling, and motivating the team and diminishes uncertainty in projects. APM has shown the potential to reduce delays by 70% to 80%, drawing on case studies in Kerala and Tamil Nadu. It was also found agile strategies for dealing with client-initiated changes and price variations of materials, highlighting their function in improving flexibility and risk management in construction projects. While all these studies indicate the implementation and usefulness of APM practices in the construction industry, systemic, full-scale, and sustainable implementation of APM remains a challenge.

2.3 AGILE AND SUSTAINABILITY

APM offers a paradigm shift in the facilitation of sustainability in the construction industry through the utilization of iterative feedback loops, adaptive planning, and collaborative stakeholder engagement. Linear traditional approaches, such as the waterfall model, are likely to hinder sustainability initiatives since they are rigid in their timelines and offer little scope for improving resource efficiency or reducing waste during project execution. In contrast, APM's emphasis on self-correcting teams and continuous improvement aligns with the dynamic demands of sustainable construction, thus allowing real-time adjustments to energy efficiency targets, material reuse practices, and societal equity measures. Empirical studies reveal that APM frameworks, such as Scrum, not only enhance productivity but also foster environmental consciousness—a primary consideration in an industry that is responsible for 40% of global energy consumption. APM practices, therefore, foster sustainability in the construction industry.

2.4 FACTORS IMPEDING THE IMPLEMENTATION OF AGILE PROJECT MANAGEMENT (APM) IN CONSTRUCTION

Though there are considerable and larger benefits of implementing APM, there are several obstacles to the construction industry's adoption of APM, especially in developing nations such as India. Systematic literature review and interviews with industry experts were conducted to identify the factors impeding the implementation of APM revealed 18 critical factors. The identified factors and their respective sources are summarized in Table 1, providing a detailed reference for understanding the barriers to APM implementation.

Table 1: Identified barriers

No.	Factors	Sources
1	Resistance within organization	Hansenne & Hibner (2011)
2	Insufficient leadership support	Input from industry experts
3	Lack of training	Fazal-Baqaie & Engels (2016); Ciric et al., (2018)
4	Lack of resources	Input from industry experts
5	Complex interdisciplinary coordination	Stare (2014)
6	Absence of cross-functional teams	Xu (2009)
7	Deficiency in agile expertise	Ozorhon et al. (2022)
8	Client collaboration challenges	Nerur et al. (2005);
9	Client resistance to agile transition	Hansenn & Hibner (2011)
10	Continuous stakeholder engagement	Hohl et al. (2018)
11	Alignment of client requirements with agile processes	Fazal-Baqaie & Engels (2016); Ciric et al., (2018)
12	Iterative planning difficulties	Nuottila et al. (2016)
13	Efficient data management	Graudone & Kirikova (2023); Marnada et al. (2022)
14	Integration of agile sprints with traditional milestones	Input from industry experts
15	Software integration challenges	Fazal-Baqaie & Engels (2016); Ciric et al., (2018)
16	Documentation and reporting management	Graudone & Kirikova (2023); Marnada et al. (2022)
17	Quality assurance integration	Nuottila et al. (2016)
18	Adherence to regulatory compliance	Taylor (2016)

3. METHODOLOGY

A comprehensive literature review was conducted to explore available research on APM in construction. The barriers identified in the literature review are contextualised to the Indian context through expert interviews. Questionnaire survey data collection is then utilized to assess industry-related issues. Collected data are analysed using statistical methods, i.e., descriptive statistics, Cronbach's alpha, and Relative Importance Index (RII), to rank the identified barriers. The research process is illustrated in Figure 2, which depicts the methodological framework of the study.

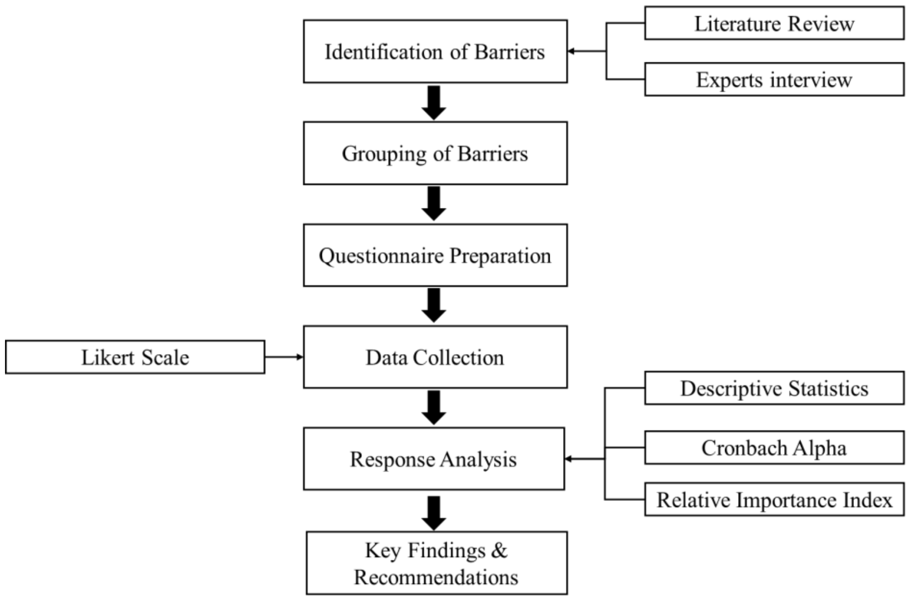


Figure 2: Flow of Research

3.1 DATA COLLECTION

To facilitate data collection for this research, a questionnaire survey was utilized to ascertain and quantify the main drivers of the implementation of APM in heavy civil infrastructure projects. The survey was carried out on a 10-point Likert scale to provide an in-depth analysis of the main challenges as well as industry perceptions in applying APM. The survey was specifically crafted to capture diverse feedback, including the respondents' expertise in APM, relevant certifications, real-world application of APM in projects, and their perspectives on the necessity of APM in the Indian construction sector. To obtain credible and industry-related data, the survey was circulated among the targeted set of agile experts, senior project planning experts, and mid-level project planning experts. 53 responses were obtained, which provided us with a robust set of data to further analyse.

3.1.1 Demographics of respondents

The respondents' designations were categorized into three primary groups: Senior Roles, Mid-Level Roles, Technical Roles, and Other Roles based on their responsibilities and level of involvement in project management processes.

Senior roles include General Manager, Technical Director, Sr. Manager Planning, etc, Mid-Level roles include Project Manager, Planning Manager, Senior Consultant, etc, Technical roles include Construction Manager, Sr. Engineer, Tunnel Supervisor, etc. Other roles include Academicians, Sr. Research Associate (R&D), etc.

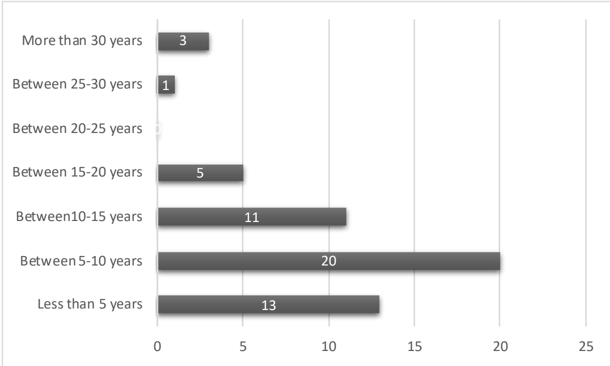


Figure 3: Experience level of respondents

The participants who responded to the survey were classified according to the number of years of working experience, which is presented in Figure 3. The average experience of the respondent is 10.5 years in project planning and APM practices.

3.2 DATA ANALYSIS

For the analysis of the data received in the questionnaire survey, three major types of statistical approaches have been used as follows.

3.2.1 Descriptive Statistics

Descriptive statistics is responsible for summarizing and defining the main characteristics of a dataset, giving a brief and clear description of the collected data. Descriptive statistics are particularly important in the identification of patterns, trends, and distributions of the data, thus becoming part of the analytical process of this study (Loeb et al., 2017). Providing a general summary of the data, descriptive statistics set the foundation for deeper inferential analysis and the creation of useful knowledge.

3.2.2 Cronbach Alpha

Cronbach's Alpha is a statistical measure used to evaluate the internal consistency and reliability of a survey instrument, particularly for scales such as Likert scales.

Cronbach's Alpha is calculated using the formula:

$$\alpha = \frac{N \times \bar{c}}{\bar{v} + (N-1) \times \bar{c}} \qquad Equation\ (1)$$

Where: N = Number of items in the scale, $\bar{c}$ = Average covariance between item pairs, $\bar{v}$ = Average variance of individual items

3.2.3 Relative Importance Index

The Relative Importance Index (RII) method is a statistical tool used to rank factors based on their relative importance as perceived by respondents (Johnson & LeBreton, 2004).

The RII is calculated using the formula:

$$RII = \frac{\sum W}{A \times N} \qquad Equation\ (2)$$

Where: W: The weight assigned to each response (based on a Likert scale), A: The highest weight in the scale, N: The total number of respondents. The RII value ranges from 0 to 1, where higher values indicate greater relative importance.

4. RESULTS AND DISCUSSIONS

To initiate the data analysis of the questionnaire survey responses, a reliability test was conducted to determine the Cronbach's Alpha value.

Table 2: Reliability test

Section	Number of items	Reliability (Cronbach's Alpha)
Organizational	5	0.763
Team and Collaboration	5	0.728
Process and Communication	5	0.827
Technical and Integration	5	0.841
All Items	20	0.918

The results indicated that the Cronbach's Alpha for individual groups as well as the overall dataset exceeded 0.7, confirming the internal consistency and reliability of the collected data.

4.1 Ranking of Barriers Impeding Agile Implementation

The present study identifies 20 critical factors influencing the challenges in APM adoption in construction through a comprehensive literature review and expert consultations. These factors have been systematically categorized into four key groups: Organizational Barriers, Team and Collaboration Barriers, Process and Communication Barriers, and Technical and Integration Barriers, as outlined in Table 3.

Table 3: Ranking of barriers

ID	Item	RII	Group rank	Overall rank
Organisational Barriers				
OR1	Resistance within organization	0.658	5	*15*
OR2	Insufficient leadership support	0.666	4	*14*
OR3	Lack of training	0.734	1	*6*
OR4	Rigid organizational hierarchies	0.705	2	*10*
OR5	Lack of resources	0.673	3	*12*
Team and Collaboration Barriers				
TC1	Complex interdisciplinary coordination	0.756	2	*2*
TC2	Absence of cross-functional teams	0.737	4	*4*
TC3	Deficiency in agile expertise	0.771	1	*1*
TC4	Client collaboration challenges	0.735	5	*5*
TC5	Client resistance to agile transition	0.745	3	*3*
Process and Communication Barriers				
PC1	Continuous stakeholder engagement	0.724	1	*7*
PC2	Alignment of client requirements with agile processes	0.684	2	*11*
PC3	Iterative planning difficulties	0.635	4	*18*
PC4	Risk identification and management	0.605	5	*20*

ID	Item	RII	Group rank	Overall rank
PC5	Efficient data management	0.669	3	*13*
Technical and Integration Barriers				
TI1	Integration of agile sprints with traditional milestones	0.715	1	*8*
TI2	Software integration challenges	0.709	2	*9*
TI3	Documentation and reporting management	0.658	3	*16*
TI4	Quality assurance integration	0.637	4	*17*
TI5	Adherence to regulatory compliance	0.611	5	*19*

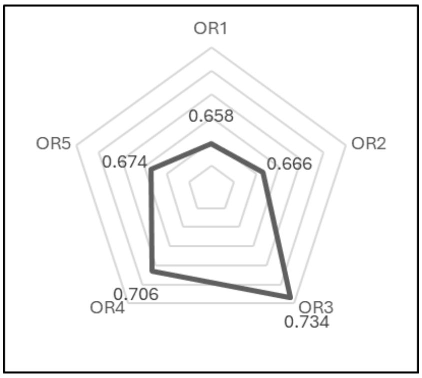
The RII findings reveal the most critical issues in implementing APM in construction projects, which closely corroborate with the literature. The highest-ranked issue, Deficiency in Agile Expertise (RII: 0.772), highlights the imperative requirement of skilled individuals. Elseknidy et al. (2024) stated that the lack of experienced practitioners is a significant challenge, which requires specialized training and knowledge transfer programs to bridge the gap. Similarly, Complex Interdisciplinary Coordination (RII: 0.757) reflects the challenge of managing multi-disciplinary teams and workflows. Studies emphasized that coordinated working across disciplines is necessary but challenging in the context of advanced construction projects.

Client Resistance to Agile Transition (RII: 0.745) and Collaboration Challenges (RII: 0.745) necessitate the education of stakeholders in agile processes. Absence of Cross-Functional Teams (RII: 0.738) indicates conventional models that do not support empowered, collaborative teams necessary for APM (Elseknidy et al., 2024). Lack of Training (RII: 0.734) necessitates training programs to develop competency and confidence in agile practices. Technical concerns are significant, with Agile Sprints integration (RII: 0.715) and Software Integration (RII: 0.709) capturing the need for hybrid solutions to balance agile and traditional milestones. Studies pointed out real-time collaboration tools to bridge the gaps. Organizational issues such as Rigid Hierarchies (RII: 0.706) hinder APM flexibility, prompting Elseknidy et al. (2024) to recommend structural reforms to improve agility. Resource constraints, data management, and regulatory compliance are areas that reflect technical issues that require strategic attention. The findings corroborate the global literature's perspective that technical and cultural issues must be addressed to achieve successful APM implementation in construction.

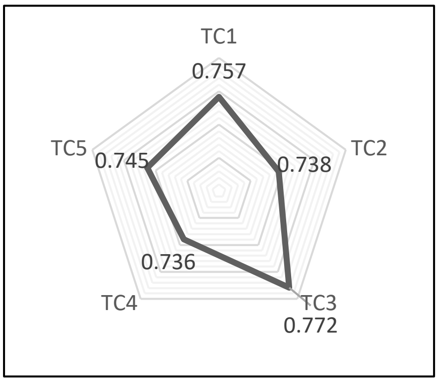
4.2 COMPARATIVE GROUP-WISE ANALYSIS OF BARRIERS

In Figure 4(a), the Organizational Barriers category shows moderate RII values, ranging from 0.658 (OR1) to a peak of 0.734 (OR3). Figure 4(b) highlights the Team & Collaboration barriers, with consistently higher RII values—most notably TC3 (0.772) and TC1 (0.757). These results underscore the critical importance of interdisciplinary collaboration, communication flow, and stakeholder engagement as central enablers of agile integration. Figure 4(c) illustrates the Process and Communication challenges, with the highest RII for PC1 (0.725), emphasizing the need for aligning agile processes with existing project workflows. In Figure 4(d), Technical and Integration barriers such as TI1 (0.715) and TI2 (0.709) point to significant challenges in synchronizing traditional planning systems with agile methodologies, especially in large-scale projects. Together, the radar charts enable side-by-side comparison of the four barrier categories, clearly demonstrating that Team and Collaboration issues (Figure b) are perceived as the most critical group, followed by Technical Barriers. This visual analysis reinforces the need for strategic efforts to improve team coordination, cross-functional communication, and integration frameworks to facilitate APM adoption in construction projects.

4.3 CURRENT SCENARIO OF THE INDIAN CONSTRUCTION INDUSTRY ON AGILE PROJECT MANAGEMENT APPROACH

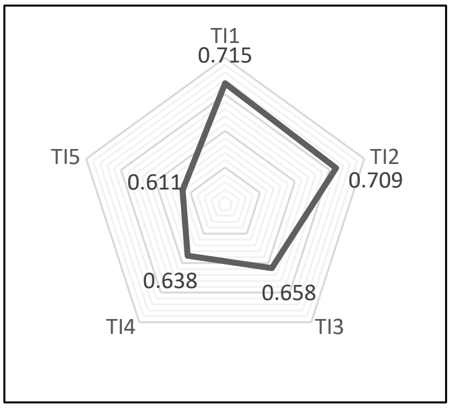


(a)



(b)

(c)



(d)

Figure 4: Radar Chart (a) Organisational (b) Team and collaboration (c) Process and communication (d) Technical and integration

The result of the survey from Figure 5 (a) indicates that 72% of the respondents had no exposure to APM at any time, while only 28% of the respondents had any type of exposure. Similarly, Figure 5 (b) indicates that 83% of the respondents are not certified in APM, while 17% of the respondents are certified. These results indicate a lack of awareness and systematic training in APM among the professionals working in the construction industry. This scenario indicates the need for systematic APM training programs and combined industry initiatives to enhance awareness and application in the Indian construction industry. The results of the survey presented in Figure 5 (c) indicate that there is a high perceived need for APM application in the construction industry, as 58% of the respondents agreed and 19% strongly agreed on its importance and a vast 19% of respondents remained neutral, while a tiny minority of 2% disagreed or strongly disagreed, indicating some hesitation or lack of awareness. Though there is awareness, the practice of effective usage of APM in real construction projects is lacking, as in Figure

5 (d), 72% of respondents indicated no application, and only 28% confirmed its application. The findings indicate the urgent need for industry-wide efforts for the facilitation of the use of APM through systematic training, awareness building, and pilot application in construction projects.

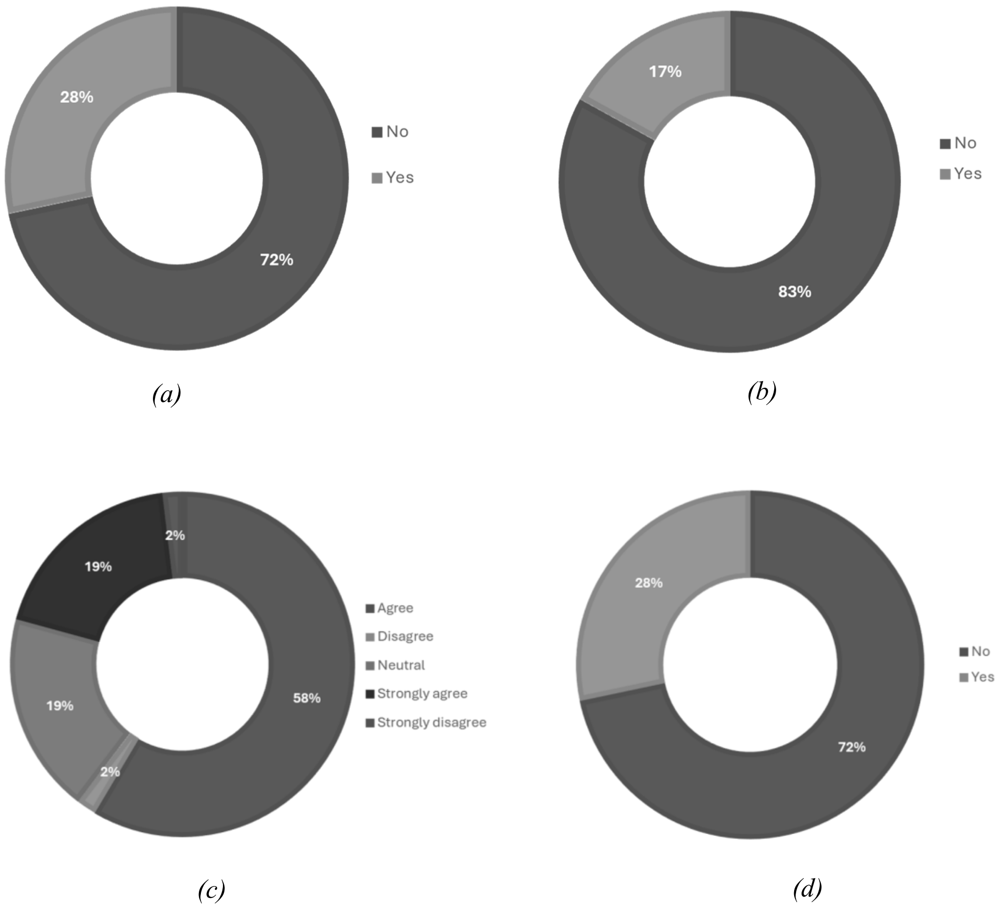


Figure 5: (a) Experience in APM (b) Certifications in APM (c) Necessity of APM implementation (d) Application of APM in live project

5. SUSTAINABILITY IMPLICATIONS

APM is a valuable approach to enhancing sustainability within the construction sector through facilitating flexibility, teamwork among stakeholders, and efficient resource use. The Agile Building Adaptation (AgiBuild) model, for instance, facilitates planning approaches centered on users and responsive, thus allowing construction teams to adapt more effectively to changing circumstances and facilitating innovation and enhanced performance in building adaptation processes—factors key to delivering more sustainable construction results (Ng et al., 2023). The present research, which indicates challenges in implementing APM within large-scale civil infrastructure projects, indicates that the absence of agile expertise, inadequate interdisciplinary collaboration, and resistance to change are among the most daunting challenges. Such challenges also reflect significant challenges in attaining sustainable project delivery, where agility and responsiveness to changing needs are of utmost importance. APM fosters a culture that is supportive of ongoing learning and iterative development, thereby making it highly effective in meeting the dynamic and changing nature of sustainability goals in the construction industry. Since sustainability requires ongoing compliance with environmental regulations, societal expectations, and technological advancements, Agile's emphasis on frequent feedback mechanisms, shared planning, and prompt decision-making offers a framework that supports the tripartite model of sustainability—economic, environmental, and social considerations (Moshood et al., 2024). The findings of this study significantly emphasize that Team and Collaboration Barriers, which have been reported as the largest challenge among all groups, are not only adverse to the practice of APM but also prevent the integration of sustainability goals that involve interdisciplinary collaboration and open communication. Moreover, the fragmented character of construction projects—characterized by heterogeneous sources of data, isolated teams, and diverse stakeholder needs—requires a project management paradigm that is adaptive but structured. APM, through its iterative nature and adaptive planning loops, is especially apt to enable sustainability initiatives across all stages of projects. The incorporation of agile methods into construction planning can enable teams to quickly overcome material inefficiencies, design changes, or regulation updates, thereby enhancing both project results and sustainability performance. To this end, the present research highlights that overcoming the hindrances to APM not only enables more efficient implementation of agile methods but also provides the potential to integrate sustainability as an integral operating objective within construction project management.

6. CONCLUSIONS

The study brings out discussions in relation to the use of APM in large-scale civil infrastructure projects in the face of its commonly known theoretical advantages. The study recognizes that organizational resistance, combined with a lack of suitable training programs, prevents extensive use of APM, thus limiting its practical use in the industry. Strong leadership commitment is found to be a critical factor in overcoming resistance to change, building a culture of flexibility, and driving innovation in organizations. One of the most important critical hindrances to APM implementation is the absence of real-time coordination among cross-functional teams, highlighting the importance of formal agile activities, including daily stand-ups, to facilitate synchronization and workflow effectiveness. Additionally, stakeholder participation is a conventional issue, primarily because of hierarchical structures that restrict dynamic communication. These can be resolved by moving towards more inclusive and flexible communication systems that facilitate active participation by all stakeholders. Lastly, the study emphasizes that scaling APM for large-scale complex infrastructure projects requires a hybrid approach—one that combines Agile's iterative flexibility with the milestone-driven stringency of traditional project management. A balanced approach can close the gap between structured implementation and agility, and APM can be both feasible and effective for large-scale construction projects. These also emphasise the need for a hybrid framework that complements agile methodologies and tools with a waterfall approach for better project efficiency.

Although this research is carried out with a limited dataset, particularly in the context of the Indian context, the data is collected with targeted project planning and agile experts and acts as a solid starting point for understanding APM adoption issues in construction megaprojects. Similar studies can be conducted in other geographical contexts to confirm or modify the outcomes of this study. Also, since the study largely records perceived barriers and not actual steps of implementation in the real world, future work using case studies and longitudinal measures can extend these results to present a more comprehensive picture of APM's construction impact.

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