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Evaluating the Impact of Digital Tools on Agile and Lean Construction Practices

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Abstract: The construction industry continues to face challenges related to inefficiency, resource waste, and limited adaptability to dynamic project requirements. This study investigates the integration of Agile Project Management (APM) and Lean Construction (LC) principles through digital technologies to enhance project performance. By leveraging tools such as the Internet of Things (IoT), Big Data Analytics, and Enterprise Resource Planning (ERP) systems, the research aims to bridge gaps in traditional construction project management practices. A mixed-methods approach was adopted, combining survey data from 105 construction professionals with qualitative insights from industry experts. The findings indicate that digital integration significantly improves process efficiency, reduces project complexity, and enhances cost control and client satisfaction. However, gaps in digital competence and organizational readiness remain key barriers to effective adoption. The study proposes an integrated Lean–Agile digital framework to support sustainable, responsive, and performance-driven construction project delivery, offering practical guidance for digital transformation in construction management.

Keywords: *Agile Project Management (APM); Lean Construction (LC); Digital Integration; Resource Optimization; Stakeholder Collaboration*

1. Introduction

The goal of project management is to satisfy all stakeholders by implementing projects efficiently and effectively. It advocates for a mix of organisational and project-based perspectives, minimising bureaucracy and aligning management practices with project demands. The approach must be lean, agile, and goal-driven, with a focus on adaptability and communication[1]. Agile construction focuses on continual improvement, cooperation, and responsiveness by breaking down large projects into smaller sections and prioritising depending on customer input [2]. Agile uses iterative incremental sprints, in which teams complete tasks, demonstrate progress, and react promptly. It blends planning and documentation with flexibility, in accordance with Project Management Institute standards[3]. Agile is great for continuous product development and on-time project delivery [4]. Agile's iterative development cycle enables teams to swiftly adapt and react to changing project needs, promoting ongoing collaboration and project optimisation[5].

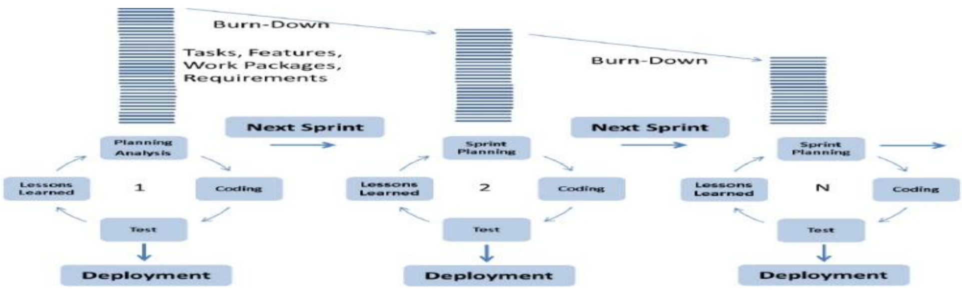

Fig 1. Iterative Nature of Agile

Lean is a quality improvement and waste-reduction mindset that originated in manufacturing. Its goal is to enhance the working environment by reducing waste, which increases quality, manufacturing time, and cost [6]. Excess paperwork, planning, meetings, revisions, and multitasking are all examples of waste in project management, and Lean PM aims to reduce them. While Agile attempts to maximise software development, Lean seeks to improve end-to-end manufacturing value streams [7]. Work is managed and prioritised using lean technologies including Value Stream Mapping, A3 Thinking, and Kanban[8] .

History of Lean Construction: The origins of Lean concepts may be traced back to the early twentieth century, with Henry Ford's Model T and the construction of the Empire State Building, which was completed ahead of time and under budget. Toyota invented Lean in manufacturing after WWII, and it has subsequently been used in building, such as the quick 15-day construction of the T-30 Hotel in China.

Integration of Agile and Lean

Combining Agile and Lean methods creates a robust project management framework that unites the flexibility of Agile with the focus on efficiency found in Lean [9]. Agile's iterative development and feedback from customers complement Lean's principles of continuous improvement and elimination of waste. Such integration increases overall project productivity, simplifies process, and speeds up delivery [10]. By integrating these approaches, teams can react faster to changing requirements and foster a culture of ongoing improvement, thus delivering projects on time and to client requirements .

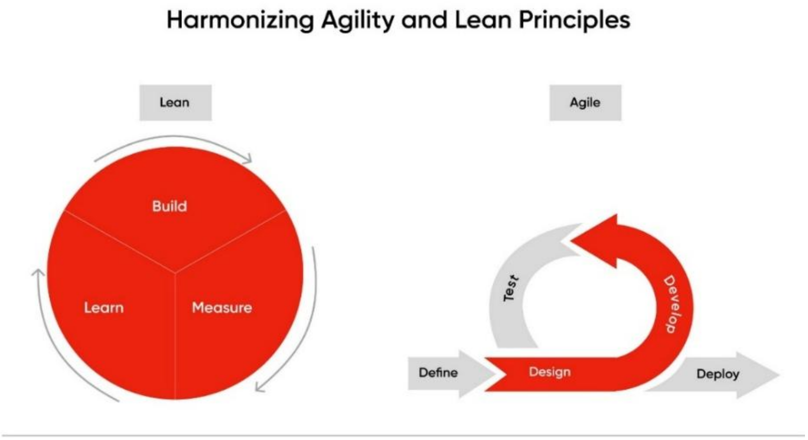

Fig 2. Harmonizing Agility and Lean Principles

An integrated approach integrating Lean and Agile concepts would be more useful to project management. Agile's iterative technique reduces time to market, allows for rapid response to changing demands, and fosters improved cooperation and communication, all of which help meet shifting needs. Lean ideas boost efficiency by reducing waste and simplifying operations [11]. Two pairs improve project transparency, risk management, and stakeholder satisfaction. Simplified processes, shorter lead times, and a culture of continuous improvement assist project managers in enabling teams to generate high-quality products with greater speed and responsiveness, aligning projects with project objectives and exceeding client expectations[12] . This study investigates the integration of Lean Construction (LC) and Agile Project Management (APM) with digital technology to improve project outcomes like as cost, schedule adherence, and client satisfaction. The research aims to overcome gaps in conventional construction project management by merging IoT, Big Data Analytics, and ERP systems to optimise performance using hybrid techniques. The research also creates an integrated framework for the deployment of these technologies, providing practical guidelines for digital transformation in building projects[13] .

Despite the demonstrated efficiency of Agile Project Management (APM) and Lean Construction (LC) approaches in sectors such as software development and manufacturing, their systematic implementation in the construction industry is restricted, especially in terms of digital integration [14]. Traditional project management techniques often fail to handle the dynamic, unpredictable, and risky character of current construction projects, resulting in inefficiencies, cost overruns, and schedule delays. Although Agile methods provide flexibility through iterative planning and rapid response, and Lean principles emphasise waste reduction and process optimisation, their combined application in construction has not been thoroughly investigated or supported by structured digital frameworks, particularly in multi-project environments. Existing research does not provide complete models for efficiently integrating Agile and Lean processes with digital technologies capable of real-time collaboration, data-driven decision-making, and performance monitoring[15]. In response to these gaps, this research will look at the major enablers and impediments to the digital integration of Agile and Lean techniques in construction projects . It specifically aims to measure the influence of digital integration on key project performance objectives such as cost efficiency, time management, and client satisfaction. In addition, the research identifies the digital tools and technology that most efficiently support Agile-Lean integration, thereby giving empirical insights to drive the adoption of digitally enabled, performance-oriented construction project management techniques[13].

2. Literature Reviews

Lean and Agile approaches to project management have gained popularity in recent years. Several research have looked at the reciprocal interactions of these approaches and how they might be used to improve project performance. Malla (2024) utilised Interpretive Structural Modelling (ISM) to develop a conceptual model after analysing the hybrid Lean-Agile system (HLAS) used in the construction sector. She found collaborative data platforms, project management tools, and instructional teams to be among the most important facilitators of effective integration. This paradigm provides a systematic method that might help in the adoption of HLAS, especially in developing nations. Hamerski et al. (2024) also combined Lean Production and Agile Project Management in multi-project environments, focusing on Last Planner System (LPS) and Scrum integration. Scrum for constraint reduction and integrated look-ahead planning sessions are two new methodologies that assist close the supervision gap between client-side project management and supplier-side production. Badran et al. (2024) investigated the impact of Lean and Agile project management in the construction sector on crucial performance measures such as time, money, quality, customer satisfaction, innovation, and responsiveness. According to their results, APM boosted innovation and responsiveness but decreasing cost performance, while LPM improved quality, cost, and customer happiness. This identifies the sophisticated use of several methods based on the individual project objectives. Similarly, Pitagorsky (2006) advocated for flexible and expandable approaches that satisfy project-specific requirements and compliance criteria when addressing Agile and Lean project management concepts.

Raji et al. (2021) investigated how digital technologies, namely Industry 4.0 technology, may be better integrated with Lean and Agile techniques. The ISM-based study highlighted cyber-physical systems, IoT, cloud computing, and big data analytics as important drivers of Lean and Agile methodologies in contemporary building management. This link explains how digital technology make Lean and Agile approaches more efficient. Jalali Sohi et al. (2016) investigated Lean and Agile approaches to complexity management in construction projects and found that these strategies significantly enhanced project performance in terms of time and cost savings by lowering project complexity. Cruz et al. (2020) painstakingly compiled a corpus of data comparing Agile, Lean, and traditional project management methodologies. They concluded that, despite Lean's well-known advantages, Agile techniques are more popular; Lean still has some acceptability challenges. According to Kashikar et al. (2016) and Chathuranga et al. (2023), deeply established obsolete processes and a lack of training are among the barriers to Agile and Lean adoption in the construction sector. While these strategies may increase project delivery and efficiency, their widespread use is hampered by these challenges. Jalali Sohi et al. (2016) also emphasised the tight relationship between Lean and Agile techniques in terms of project complexity, hence supporting both approaches as useful tools for improving project outcomes. Felizardo Lima et al. (2023) propose a sustainable project management model, emphasising the need of socio-technical models and key soft skills (CSSs) in implementing Lean Project Management in the Industry 4.0 scenario. Kineber et al. (2024), on the other hand, discovered that dynamic project optimisation has the greatest impact on APM adoption. They focused on the primary success factors (CSFs) involved in the implementation of Agile Project Management (APM) on residential construction projects across Nigeria.

Lean Thinking's use in sectors other than construction is also being investigated. focusing on project efficiency and waste avoidance, comparable to construction. Rodrigues et al. presented a conceptual framework for applying Lean Thinking to IT project management in 2023. Dong et al. (2024) provided a more in-depth assessment of Agile Project Management, which differs from software-specific Agile approaches and conventional project management methodologies. Pasęski et al. (2021) investigated how Lean and Agile principles may be applied to ready-mix concrete supply in the construction business. They discovered that, despite their differences, both strategies may improve project performance by increasing flexibility and saving time. AbuKhamis et al. (2022) investigated the potential of Lean and Agile to solve project management difficulties in non-profit organisations, proposing that combining the two approaches would improve monitoring and project goal alignment. When these studies are combined, they show the growing importance of Lean and Agile approaches in enhancing the effectiveness and performance of building projects. Despite certain implementation obstacles, effective implementation in diverse architectural settings relies on the dynamic convergence of digital technologies, the mapping of critical enablers, and the demand for correctly developed approaches based on project objectives.

Table 1. Comparative Table for Agile vs Lean

Criteria	Agile	Lean
Flexibility	High (iterative cycles and continuous feedback)	Moderate (focus on process optimization)
Waste Reduction	Moderate (focus on customer collaboration)	High (emphasis on waste elimination)
Client Satisfaction	High (adaptation to customer feedback)	High (efficiency leads to cost savings)
Time Management	Flexible (based on iterations)	Strict (focus on schedule adherence)

3. Methodology

The research used a mixed-methods approach to investigating how Agile Project Management and Lean Construction ideas interacted with digital technologies in the construction industry. The approach was divided into many tiers, with a focus on digital inclusion, beginning with a comprehensive literature assessment to identify the theoretical underpinnings and current applications of Agile and Lean methodologies in the construction sector. This technique helped to discover essential ideas, offer models, and identify gaps in the area of research. The next step was to gather qualitative data via semi-structured interviews with project managers, construction specialists, and digital platform experts. These sessions helped participants understand the benefits and practical problems of combining Agile and Lean ideas with digital technology. In-depth case studies of building projects that used online platforms to implement these concepts were also examined in order to discover best practices and lessons learned. To provide a fair representation across all professions and experience levels in the construction business, a sample size of 105 respondents was chosen. This scale provides adequate statistical power to uncover significant differences in the usage of digital technologies and Agile-Lean integration. Semi-structured interviews were conducted with fifteen digital technology professionals and construction project managers. Each interview, which lasted around 45 minutes, was led by a protocol that focused on the challenges and benefits of merging Lean and Agile methodologies with digital technologies in the construction business.

The quantitative data was collected by a survey questionnaire issued to 105 team members and construction project managers. The study gathered information on the acceptance, efficacy, and challenges of merging digital technology with lean and agile techniques. Data analysis used both descriptive and inferential statistical tools to identify patterns, correlations, and trends. Analysing both quantitative and qualitative data revealed a path for the use of digital technology in Agile and Lean project management. The assistance is in the form of best practices for project execution and instructions for training team members for digital platforms. Case studies from projects that used digital technology with Lean and Agile methodologies were selected to give a diverse variety of practical examples to support the findings. To provide comprehensive coverage of the sector, projects were chosen from a range of sizes and geographic regions. Focus groups with practitioners and project managers were conducted to verify the guideline's applicability and relevance. Because each subject provided informed permission, ethical standards were observed throughout the research, ensuring anonymity and voluntary participation.

4. Data Analysis

The data analysis study evaluates the research findings of incorporating Agile Project Management and Lean Construction into the construction sector using contemporary digital technology. Quantitative and qualitative data were analysed. To identify patterns and associations, quantitative analysis used SPSS software for descriptive statistics (mean, standard deviation, percentage) as well as inferential approaches (correlation, regression, ANOVA). Qualitative data from interviews and case studies were thematically analysed to identify key themes, challenges, and digital integration best practices. Such evaluations provide insight into what drives the adoption and effectiveness of Agile and Lean methodologies in construction, and are utilised as the foundation for the digital integration architecture proposed.

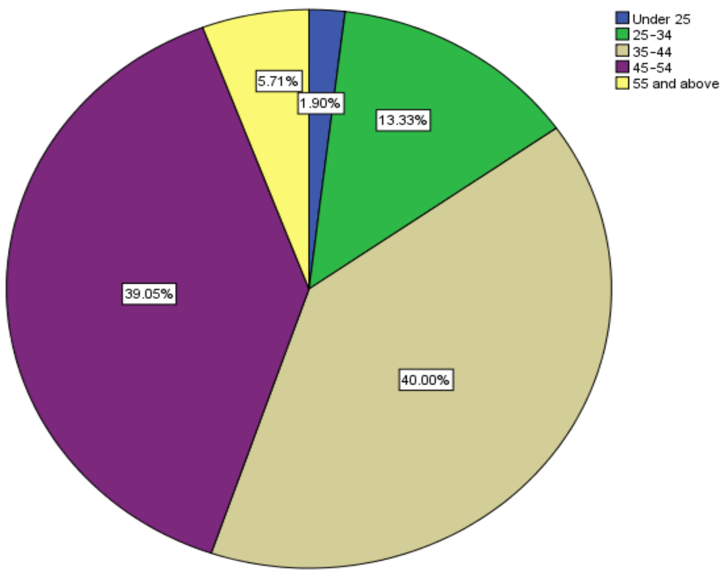

Fig 1. Age wise distribution respondent

The bulk of respondents are aged 35-44 years (40%) and 45-54 years (39%), accounting for 79% of the sample, demonstrating a preference for middle-aged individuals. Smaller categories include individuals aged 25-34 (13.3%), under 25 (1.9%), and 55+ (5.7%). The 36.2% of indifferent answers show that a significant proportion of respondents are still unclear about the usefulness of digital technologies in Lean and Agile adoption. This might be attributed to varied degrees of familiarity with digital technologies or organisational preparedness. Further research into this neutral response group may provide insights into the impediments to complete acceptance.This demonstrates a concentration of responders in mid-career phases, with low representation from younger and older age groups.

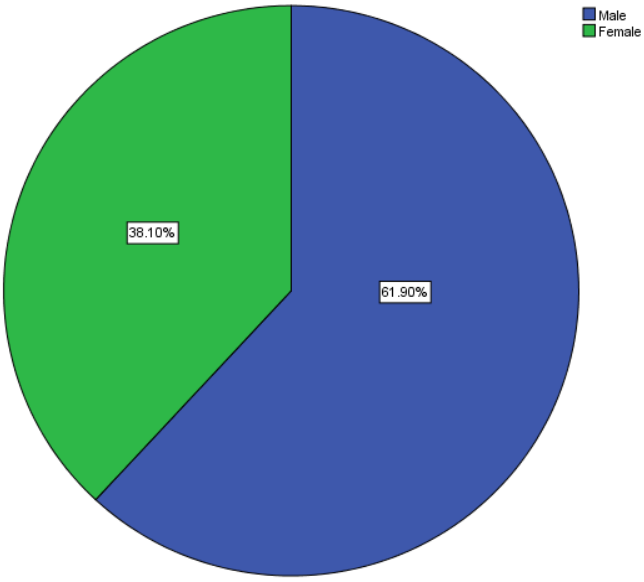

Fig 2. Gender wise distribution respondent

The gender distribution of respondents shows that males constitute the majority, representing 61.9% of the total sample, while females make up 38.1%. This indicates a notable gender imbalance in the study, with male participants being more prominent than females. The representation suggests that the research context or subject matter may involve higher participation or relevance for males, although a significant proportion of females are also included, ensuring some level of diversity in the perspectives gathered

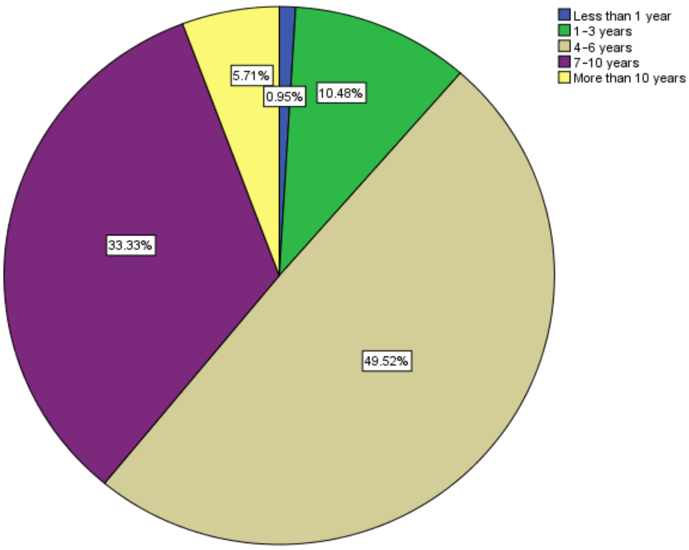

Fig 3. Years of Experience in Construction Industry

Nearly half of the respondents (49.5%) have 4-6 years of experience, and 33.3% have 7-10 years, indicating a focus on mid-level experience. Smaller proportions have 1-3 years (10.5%), more than 10 years (5.7%), or less than 1 year (1.0%). This suggests the study captures insights primarily from those with moderate to significant experience.

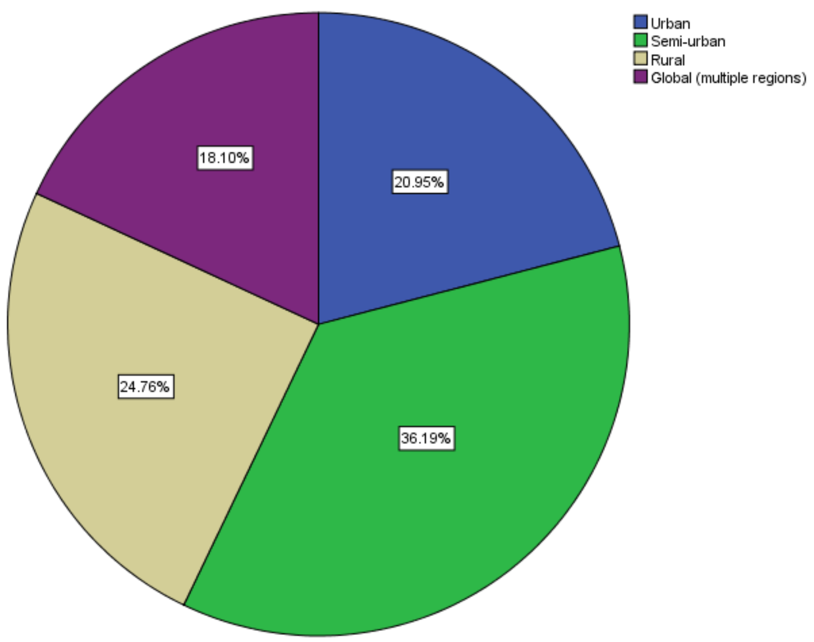

Fig 4. Geographical Location of Projects

Most respondents work in semi-urban areas (36.2%), followed by rural (24.8%) and urban (21.0%) locations. A smaller proportion (18.1%) handle global projects. This shows a diverse sample with strong representation from semi-urban and rural areas, while also including insights from urban and international projects.

Table 2. Reliability Statistics

Cronbach's Alpha	N of Items
.745	26

The reliability statistics show that the Cronbach's Alpha value is 0.745, based on 26 items. This indicates a moderate level of internal consistency for the scale used in the study, as a Cronbach's Alpha value above 0.7 generally suggests that the items within the scale are reliably measuring the same underlying construct. The value of 0.745 is considered acceptable for research purposes, signaling that the items in the survey are sufficiently consistent to produce reliable results.

Table 3. One-Sample Test

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
1. Age	40.133	104	.000	3.33333	3.1686	3.4980
2. Gender	29.000	104	.000	1.38095	1.2865	1.4754
3.Educational Qualification	42.865	104	.000	2.78095	2.6523	2.9096
4.Role in the Organization	32.033	104	.000	2.56190	2.4033	2.7205

5.Experience in Construction	43.763	104	.000	3.32381	3.1732	3.4744
6.Familiarity with Agile and Lean Principles	20.098	104	.000	2.52381	2.2748	2.7728
7.Level of Digital Competence	29.590	104	.000	2.50476	2.3369	2.6726
8. Type of Projects Typically Handled	33.535	104	.000	2.75238	2.5896	2.9151
9. Organization Size	37.524	104	.000	2.16190	2.0477	2.2762
10.Geographical Location of Projects	24.223	104	.000	2.40000	2.2035	2.5965

The one-sample test results show that all variables, including age, gender, educational qualification, role in the organization, years of experience, familiarity with Agile and Lean principles, level of digital competence, type of projects handled, organization size, and project geographical location, have statistically significant mean differences from zero. The t-values vary from 20.10 for familiarity with Agile and Lean concepts to 43.76 for years of construction industry experience, and all p-values are less than 0.001, suggesting high statistical significance. This implies that the mean values for all of these variables are considerably different from zero, indicating that the sample contains useful information on each facet. The 95% confidence intervals for each variable reinforce the dependability of these results by showing positive ranges for the mean differences, indicating that the values are consistently above zero throughout the sample.

Oneway

Table 4. ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
11. How 4 do you find the digital implementation of Agile and Lean principles in your projects?	Between Groups	2.999	3	1.000	1.298	.279
	Within Groups	77.763	101	.770		
	Total	80.762	104			
12. To what extent are Agile and Lean principles supported by digital tools in your organization?	Between Groups	1.910	3	.637	.852	.469
	Within Groups	75.481	101	.747		
	Total	77.390	104			
13. The use of digital tools for Agile and Lean principles has simplified project management processes.	Between Groups	1.837	3	.612	.831	.480
	Within Groups	74.410	101	.737		
	Total	76.248	104			
14. The integration of Agile and Lean principles digitally has reduced complexity in project workflows.	Between Groups	.848	3	.283	.373	.773
	Within Groups	76.580	101	.758		
	Total	77.429	104			

The ANOVA findings show that no statistically significant differences exist between the groups for any of the claims on the digital implementation of Agile and Lean principles in building projects. All four questions had p-values (Sig.) larger than 0.05, precisely 0.279, 0.469, 0.480, and 0.773, indicating that the mean differences between the groups are not significant. This suggests that respondents, regardless of group categorisation, usually see the digital application of Agile and Lean concepts in the same way across these characteristics, with no significant variance in replies. The ANOVA tests revealed no statistically significant differences between groups for any of the factors associated with digital tool deployment ($p > 0.05$). This implies that opinions of digital tool efficacy are rather consistent across demographic and organisational categories. However, the lack of significance should be evaluated in light of possible external influences, such as differences in tool implementation tactics and team training.

Findings

The results emphasise the benefits of digital integration in project management, with 75.2% agreeing that it streamlines procedures, enhances efficiency, and decreases complexity. Digital technologies also help to boost customer satisfaction (68.1%) and reduce costs (75.2%), highlighting their importance in improving project results. However, a digital competence gap was observed, with 56.2% of respondents reporting a lack of required abilities among certain team members, hurting Agile and Lean implementation. The availability of appropriate digital technologies is critical, but team competency and organisational preparedness are also important considerations. Statistical analysis shows that demographic parameters such as age, education, and experience impact the use of digital technologies, and the survey's reliability was validated with a Cronbach's Alpha of 0.745. ANOVA studies revealed that, although there is universal agreement regarding the benefits of digital tools, their effectiveness varies according to tool type, team experience, and project complexity. Additionally, educational qualifications and role-specific criteria, as well as geographical and organisational considerations, influence the extent to which digital technologies and Agile/Lean principles are implemented to construction projects.

Conclusion

This research illustrates that digitally integrating Agile Project Management (APM) and Lean Construction (LC) concepts improves construction project efficiency, cost management, flexibility, and stakeholder satisfaction. The results demonstrate that digital technologies like IoT, Big Data Analytics, and ERP systems are crucial for streamlining project processes, eliminating waste, and allowing real-time decision-making. By combining Agile's flexibility with Lean's emphasis on process optimisation, the suggested hybrid method provides a strong foundation for managing the rising complexity of modern construction projects.The empirical findings show that digital-enabled Lean-Agile implementation is seen positively across all demographic and organisational groupings, with acceptable reliability metrics supporting this perspective. However, the report also highlights important hurdles, such as gaps in digital competence, reluctance to change, and variable degrees of organisational preparation, that may restrict the full realisation of these advantages. To guarantee successful technology adoption, address these difficulties via focused training, continual learning, and strong management support. Overall, the research adds to the building project management literature by offering empirical data and a practical methodology for digitally integrating Lean-Agile principles. By connecting technical capabilities with human and organisational aspects, construction companies may achieve more sustainable, responsive, and competitive project delivery in an increasingly digital world.

References

[1] K. Y. Kulakov, A. K. Orlov, and V. S. Kankhva, "Evaluation of lean manufacturing tools and digital technologies effectiveness for increasing labour productivity in construction," *Systems*, vol. 11, no. 12, p. 570, Dec. 2023, doi: 10.3390/systems11120570.

[2] S. Singh and K. Kumar, "A study of lean construction and visual management tools through cluster analysis," *Ain Shams Eng. J.*, vol. 12, no. 1, pp. 1153–1162, Mar. 2021, doi: 10.1016/j.asej.2020.04.019.

[3] S. A. Ahmed and M. M. Eltahir, "The impacts of applying the agile approach in construction projects: A case study of two construction

projects," Dec. 2025, doi: 10.5281/ZENODO.18080689.
[4] [4] J. Chukwunweike and O. E. Aro, "Implementing agile management practices in the era of digital transformation," *World J. Adv. Res. Rev.*, vol. 24, no. 1, pp. 2223–2242, Oct. 2024, doi: 10.30574/wjarr.2024.24.1.3253.
[5] T.-Y. Hsieh, Y.-M. Yang, H.-W. Tai, and K.-T. Cheng, "The interplay of digital transformation, organizational agility, and knowledge management in optimizing construction project management," *Buildings*, vol. 15, no. 21, p. 3884, Oct. 2025, doi: 10.3390/buildings15213884.
[6] T. Y. Smith A, "Lean thinking: An overview," *Ind. Eng. Manage.*, vol. 4, no. 2, 2015, doi: 10.4172/2169-0316.1000159.
[7] D. Banáš and H. H. Chovanová, "Agile manufacturing vs. lean manufacturing," *Res. Pap. Fac. Mater. Sci. Technol. Slovak Univ. Technol.*, vol. 31, no. 52, pp. 58–67, Jun. 2023, doi: 10.2478/rput-2023-0007.
[8] F. AbuKhamis and A. Abdelhadi, "A critical analysis of agile and lean methodology to fulfill the project management gaps in nonprofit organizations (NPOs)," *Appl. Sci.*, vol. 12, no. 11, p. 5467, May 2022, doi: 10.3390/app12115467.
[9] G. Diem, "Agile and traditional project management: Comparing agile, traditional and hybrid project management practices," 2021, doi: 10.13140/RG.2.2.28830.05442.
[10] H. Yang and D. Wang, "Application of lean–agile hybrid methods in complex construction project management," *Buildings*, vol. 15, no. 13, p. 2349, Jul. 2025, doi: 10.3390/buildings15132349.
[11] A. J. Sohi, M. Hertogh, M. Bosch-Rekveldt, and R. Blom, "Does lean & agile project management help coping with project complexity?," *Procedia - Soc. Behav. Sci.*, vol. 226, pp. 252–259, Jul. 2016, doi: 10.1016/j.sbspro.2016.06.186.
[12] C. Koudriachov, C. Tam, and M. Aparicio, "Success with agile project management: Looking back and into the future," *J. Syst. Softw.*, vol. 226, p. 112428, Aug. 2025, doi: 10.1016/j.jss.2025.112428.
[13] F. Moreno *et al.*, "Agile project management in the pre-construction stage: Facing the challenges of projectification in the construction industry," *Buildings*, vol. 14, no. 11, p. 3551, Nov. 2024, doi: 10.3390/buildings14113551.
[14] F. Albuquerque, A. S. Torres, and F. T. Berssaneti, "Lean product development and agile project management in the construction industry," *REGE*, vol. 27, no. 2, pp. 135–151, Apr. 2020, doi: 10.1108/REGE-01-2019-0021.
[15] A. Tezel, L. Koskela, and Z. Aziz, "Current condition and future directions for lean construction in highways projects: A SMEs perspective," *Int. J. Project Manag.*, vol. 36, no. 2, pp. 267–286, Feb. 2018, doi: 10.1016/j.ijproman.2017.10.004.
[16] I. O. Raji, E. Shevtshenko, T. Rossi, and F. Strozzi, "Modelling the relationship of digital technologies with lean and agile strategies," *Supply Chain Forum*, vol. 22, no. 4, pp. 323–346, 2021, doi: 10.1080/16258312.2021.1925583.
[17] O. Famoti *et al.*, "A practical model for agile project management to streamline engineering delivery in energy projects," 2025.
[18] A. Kashikar, D. Mehta, B. Motichandani, and P. D. Chaitanya, "A case study on agile and lean project management in construction industry," *IOSR J. Mech. Civ. Eng.*, vol. 13, no. 4, pp. 31–39, 2016, doi: 10.9790/1684-1304013139.
[19] A. N. Dugbartey and O. Kehinde, "Optimizing project delivery through agile methodologies: Balancing speed, collaboration and stakeholder engagement," 2025, doi: 10.30574/wjarr.2025.25.1.0193.
[20] C. Jin, "Agile in construction projects," 2017.
[21] S. Chathuranga *et al.*, "Practices driving the adoption of agile project management methodologies in the design stage of building construction projects," *Buildings*, vol. 13, no. 4, pp. 1–19, 2023, doi: 10.3390/buildings13041079.
[22] G. Garcés *et al.*, "Systematic review of lean construction: An approach to sustainability and efficiency in construction management," *J. Infrastruct. Preserv. Resil.*, vol. 6, no. 1, pp. 1–28, 2025, doi: 10.1186/s43065-025-00119-1.
[23] B. F. Lima *et al.*, "A socio-technical framework for lean project management implementation towards sustainable value in the digital transformation context," *Sustainability*, vol. 15, no. 3, 2023, doi: 10.3390/su15031756.
[24] J. C. Ferreira, "Agile approaches in project management," 2019.

[25] M. Padalkar, S. Gopinath, and A. Kumar, "Using agile in construction projects: It's more than a methodology," in *Proc. POMS 27th Annu. Conf.*, 2016, pp. 70–71.
[26] A. Cruz, A. Tereso, and A. C. Alves, "Traditional, agile and lean project management: A systematic literature review," *J. Mod. Project Manag.*, vol. 8, no. 2, pp. 86–95, 2020, doi: 10.19255/JMPM02407.
[27] I. E. Olagbaju, "AI in project management: Enhancing efficiency, decision making, and risk management," *J. Artif. Intell. Mach. Learn. Data Sci.*, 2025.