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Agile principles' implementation: Enhancing efficiency of construction project time performance in the construction industry in Nigeria

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Abstract
The study examined the implementation and perceived effectiveness of various Agile principles in enhancing construction project time performance in the Nigerian construction industry. The results revealed that some principles, such as top management support and employee empowerment, co-located high-performing teams, test-driven development, collaborative development, and adaptive control, are moderately implemented and considered fairly effective. Top management support and employee empowerment were identified as crucial factors for successful Agile implementation. Co-located teams were found to enhance communication and collaboration, positively impacting project performance. Test-driven development practices help ensure the quality and functionality of construction projects. Collaborative development fosters innovation and improves project outcomes by encouraging teamwork and knowledge-sharing. Adaptive control allows project teams to respond and adapt to changing project requirements and conditions. The study adopted quantitative method in data collection and descriptive statistics in analysing the data. However, there is room for improvement in implementing some of the principles to further enhance project outcomes. The study indicates that the Nigerian construction industry has the potential to benefit from Agile implementation to improve project time performance. However, further research is needed to explore potential challenges and barriers to successful Agile adoption in the Nigerian context and propose strategies to overcome them. By embracing Agile methodologies and fostering a more adaptive and collaborative approach, the Nigerian construction industry can position itself for greater success in delivering projects on time, within budget, and meeting the expectations of all stakeholders involved.

Keywords: Agile principles, time performance and construction industry

Introduction

The construction industry in Nigeria plays a vital role in the country's economic growth and development. However, it has long grappled with challenges related to project time performance, including delays and cost overruns (Adebowale & Smallwood, 2016, November) [1]. In an era of increasing complexity and competition, traditional project management practices have proven insufficient to address these issues effectively. As a response, the concept of Agile implementation has gained attention as a potential solution to enhance the efficiency of construction project time performance in Nigeria.

Agile methodologies, originally derived from the software development realm, have demonstrated remarkable success in various industries worldwide (Chen & Lee, 2022) [7]. Emphasizing collaboration, adaptability, and iterative progress, agile approaches have shown promise in tackling the dynamic and unpredictable nature of construction projects. By breaking down projects into smaller, manageable iterations and engaging stakeholders throughout the process, agile methodologies aim to streamline project delivery and promote effective decision-making (Lappi & Aaltonen, 2017) [16].

This paper aims to explore the potential benefits of Agile implementation in the Nigerian construction industry, with a specific focus on enhancing project time performance. By investigating how Agile principles can be tailored and applied to construction projects, we seek to understand their impact on reducing delays, optimizing resource allocation, and fostering collaboration among project teams and stakeholders.

The study has drawn insights from existing literature, case studies, and practical experiences and presents a comprehensive understanding of Agile implementation in construction. But in further research, there is need to address potential challenges and barriers to successful Agile adoption in the Nigerian context and propose strategies to overcome them.

The findings from this research endeavour to provide valuable guidance to construction firms, project managers, and stakeholders in Nigeria, empowering them to embrace Agile methodologies and enhance the efficiency of construction project time performance. By embracing a more adaptive and collaborative approach, the Nigerian construction industry can position itself for greater success in delivering projects on time, within budget, and meeting the expectations of all stakeholders involved.

1. Problem statement

Time management is important in any construction project. Without proper time management, many problems will occur such as extension of time or time overrun. Some of the researchers describe time overrun as delay and some of them describe that the time overrun is an effect from the construction delay, no matter what it was described, time overrun become the most general problem in construction industry worldwide (Olawale & Sun, 2010). Time overrun occur when the actual progress of a construction project is slower than the planned schedule (Subramani, Sruthi & Kavitha, 2014) [21]. Delay or time overrun will affect all parties involved in the project. It will affect the profits which would be obtained if the project can be completed on the schedule. But due to the time overrun, contractors had to spend

more money on labour, plant and may lose the opportunity to get the next project. Hence, effective time management is very important and crucial to achieve successful completion of construction projects.

Since Lean is an approach that identifies the value inherent in specific products, identifies the value stream for each product, supports the flow of value, lets the customer pull value from the producer, and pursues perfection (Afolabi, 2015; Shehu, 2022) [3, 22]. Lean is doing more with less. Use the least amount of effort, energy, equipment, time, facility space, materials, and capital while giving customers exactly what they want (Suhail Iqbal, 2015) [23] but adopting it is becoming difficult because moving to change is not easy. However, agility is the ability to both create and respond to change in order to profit in a turbulent business environment. Agility is the ability to balance flexibility and stability (Attar & Abdul-Kareem, 2020) [5].

2. Aim and objective

The aim of this paper is to see the agile principles' implementation for enhancing efficiency of construction project time performance in the construction industry in Nigeria with a view to promote the reputation of the construction industry. The objective of the paper is only to identify the current level of agile applicability in the construction industry in Abuja, Nigeria.

Agile in construction

Agile in construction involve discipline of an industry system that integrates management, technology and workforce, making the organisation flexible for a manufacturer to switch over the production of one component to another in a cost-effective manner (Ding, Ferras Hernandez & Agell Jane, 2023) [10]. Agile practices are concrete (daily) actions that implement agile methods; e.g., continuous integration practices include rules to be followed in daily work, such as integrate early and integrate often or integrate at least daily. Agile practices may also be very generic; such as use an on-side customer to refine product requirements. This can be possible by adopting a system that gives the ability to allow a rapid response to follow customers and markets continuously changing requirements, and the modified process design to be executed quickly (KÖSE, 2019) [14].

Agility engineering contains the whole industry system from suppliers, delivery services, construction facilities and all customers tied together via material feed-forward and information feed-back system (Henriksen, 2017) [11]. This system allows quick response to customers and the markets unceasingly changes without expense to decreased quality and increased cost. Before the firm can become agile, they must be lean in all levels. Without mastering lean manufacturing, they cannot expect to become agile (Rajagopal, *et al.*, 2016) [19]. Therefore, it is important to combine the two principles together so as to achieve a substantive outcome in the construction industry. Hence the need to carry out this research on the hybridization of lean-agile principles is high.

Kupiainen, Mäntylä, & Itkonen, (2015) [15] stated that agile principles in building construction should include customer satisfaction by rapid delivery of useful software, welcome changing requirements, even late in development, working software is delivered frequently (weeks rather than months), working software is the principal measure of progress, sustainable development, able to maintain a constant pace, close, daily co-operation between business people and developers, face-to-face conversation is the best form of communication (co-location), projects are built around motivated individuals, who should be trusted, continuous attention to technical excellence and good design, simplicity- the art of maximizing the amount of work not done is essential, self-organizing teams and regular adaptation to changing circumstances. Cheng & Johansen, (2014) [8] attributed that agile principles are not a formal definition of agility, but are rather guidelines for delivering high-quality solutions in an agile manner. At its core, agility entails the ability to rapidly and flexibly create and respond to change in the business and technical domains. Mustafid, Karimariza & Jie (2018) [17] describe that, supply chain agility depends on the following; customer satisfaction, quality improvement, cost minimization, delivery speed, new product introduction, service level improvement and lead-time reduction. Literature on supply chain agility describes the dependence of agility on the characteristics of some performance variables; however, influence of interrelationships among the variables on the supply chain agility has been hardly taken into account (Mustafid *et al.*, 2018) [17].

1. Characteristics of agile approaches

Adut, (2016) [2] states that when organisations become aware of agile ways of working and strive to call them self-agile, there are several characteristics in ways of working when going agile. The first is the people factor. Rigby, Sutherland & Noble, (2018) [20] further described the people factor as "Instead of trying to control thousands of people in large projects, agile approaches focus on how to achieve efficiency in small teams, no matter the size of the actual project itself". This statement goes along with the theoretical basis of this research, which is adaptation of PARETO analysis earlier stated. To achieve this, team members need flexibility in their team roles and the importance of having high autonomy in an informal working environment. The formal communication is usually carried out in a daily gathering for a fifteen-minute, time-boxed, meeting to sort out any problems that arose the day before (Adut, 2016) [2]. This way the team has a better chance of working with the right type of solution given the right type of information. Rigby, *et al.*, (2018) [20] wrote that another important characteristic of being agile is the use of a Time box concept. This means that the time and date (the deadline) supersede the activities, regardless of how many activities have been completed, the short project phase ends on a specific date. Time boxing is therefore the term used to define a certain task within a certain time frame, where the time frame has a specific deadline that cannot be budged. It is supposed to clarify what could actually be achieved in a given time frame.

Kupiainen, Mäntylä, &Itkonen, (2015) [15] stated that agile operation where minimal lead times are required to be able to service volatile consumer demand with high levels of availability. The agile operation has a number of distinguishing features. It is market sensitive with the ability to respond to actual real time changes in demand. Organisations must acquire capacity capability in order to be able to react to possible volatile fluctuations in demand. The use of information technology to share data between buyers and suppliers is crucial for agile supply (Piya, *et al.*,

2020) [18]. This will improve visibility of requirements and reduce the amount of stock held in anticipation of predicted and often distorted demand. Shared information between supply chain partners is necessary to sustain the extended enterprise where collaborative alliances support the exchange of information to enable such activities as joint product development and common systems. Birhanu, Lanka & Rao, (2014) [6] argue that the adoption of the lean principles is appropriate for commodity products where demand can be predicted and agile principles are relevant for innovative products where demand is unpredictable.

2. Agile principles

Agile is a software development approach that emphasizes flexibility, collaboration, and customer-centricity. It is based on a set of guiding principles that provide a foundation for agile methodologies like Scrum, Kanban, and Extreme Programming (XP). The Agile Manifesto, created in 2001 by a group of software developers, outlines these principles and values, which prioritize individuals and interactions, working software, customer collaboration, and responsiveness to change. The twelve Agile Principles are as follows;

i. Top management support and employee empowerment

Top management support is critical for the successful implementation of Agile methodologies in any organization. When leaders endorse and actively promote Agile practices, it sets a clear direction for the entire organization to embrace agility. Additionally, employee empowerment plays a crucial role in Agile implementation (Holbeche, 2019; Crnogaj, Tominc & Rožman, 2022) [9, 12]. Agile principles encourage teams to be self-organizing and make decisions collectively. Empowering employees to take ownership of their work fosters creativity, accountability, and a sense of ownership, which leads to better collaboration and improved project outcomes.

ii. Co-located High-Performing Teams:

Co-located high-performing teams refer to physically collocating members of cross-functional teams in the same workspace. This practice fosters face-to-face communication and collaboration, which is crucial for Agile methodologies. Co-location helps team members build trust, share knowledge, and work together seamlessly, leading to faster decision-making, reduced miscommunication, and increased productivity. The close proximity also allows for quick feedback loops and promotes a strong team culture.

iii. Test-Driven Development (TDD):

Test-driven development is an Agile software development practice that involves writing automated tests before writing the actual code. This approach ensures that code is developed to meet specific requirements and passes predefined tests. TDD helps catch defects early in the development process, promotes better code quality, and ensures that changes to the codebase do not introduce unintended consequences. It also encourages developers to think about the expected behaviour of the code before writing it.

iv. Collaborative development

Collaborative development is a core principle in Agile methodologies. It emphasizes teamwork, open communication, and shared responsibility among team members. Collaborative development encourages stakeholders from different disciplines, such as developers, testers, designers, and product owners, to work together throughout the development process. This collaborative approach fosters creativity, promotes knowledge sharing, and ensures that everyone is aligned with project goals.

v. Adaptive control

Agile projects embrace change as a natural part of the development process. Adaptive control allows teams to respond quickly to changes in project requirements, market conditions, or customer needs. Rather than rigidly sticking to predefined plans, Agile teams use adaptive control to adjust their strategies and priorities based on real-time feedback and insights. This flexibility enables organizations to stay competitive in dynamic markets and deliver products that meet evolving customer demands.

vi. Use of information technologies

Explanation: Agile methodologies are greatly supported by information technologies, including project management tools, collaboration software, and communication platforms. These technologies enable seamless communication and collaboration among team members, even in distributed teams. Agile project management tools help track progress, manage tasks, and visualize project status on boards, fostering transparency and alignment. Information technologies play a crucial role in facilitating real-time decision-making and ensuring that Agile teams stay connected and productive.

vii. Training and education

Explanation: In Agile implementation, ongoing training and education are essential for both management and team members. Management needs to understand Agile principles and practices to support the teams effectively. Team members, on the other hand, require training to become proficient in Agile methodologies and best practices. Proper training ensures that all stakeholders are aligned with Agile principles, understand their roles, and can effectively apply Agile techniques in their work.

viii. Responsive supply chain

Explanation: Agile principles can be extended beyond development to the supply chain. A responsive supply chain involves creating a flexible and adaptable system that can quickly respond to changing customer demands, market trends, and project requirements. Agile organizations collaborate with suppliers and partners to improve the flow of materials, reduce lead times, and ensure that the right resources are available when needed. A responsive supply chain allows Agile projects to be more adaptable and deliver value to customers efficiently.

ix. Visual control

Explanation: Visual control is a practice used in Agile project management to provide a clear and transparent view of project progress. Agile teams often use physical or digital boards to visualize tasks, work in progress, and project status. This visualization enables team members and stakeholders to understand the current state of the project at

a glance, identify bottlenecks, and make informed decisions. Visual control promotes transparency, fosters open communication, and enhances collaboration among team members.

x. Appropriate hardware (Tools and equipment)

Explanation: Providing appropriate hardware, tools, and equipment is essential to support Agile teams' productivity and efficiency. Teams require modern software development tools, collaboration platforms, and hardware that meet their specific needs. This includes powerful computers, communication devices, and other tools that facilitate seamless collaboration and enable Agile practices to be executed effectively.

xi. Knowledge workers

Explanation: In Agile environments, team members are regarded as knowledge workers who possess unique skills, expertise, and creativity. Agile methodologies recognize the value of individual contributions and encourage knowledge workers to take ownership of their work. This approach empowers team members to make informed decisions, continuously improve their skills, and innovate to deliver high-quality products and solutions.

xii. Effective production planning and control systems

Explanation: Agile project management enables effective production planning and control. Agile teams plan their work in short, iterative cycles called sprints, ensuring that deliverables are completed efficiently. These iterative planning cycles allow teams to adjust priorities based on feedback, changing requirements, and project progress. Effective production planning and control systems facilitate resource allocation, task management, and ensure that project goals are met.

xiii. Move from cost to revenue focus

Explanation: Agile methodologies encourage organizations to shift their focus from solely minimizing costs to maximizing revenue and customer value. Agile teams prioritize delivering features that bring value to customers and generate revenue. This shift in focus aligns the team's efforts with business objectives and helps organizations stay competitive in the market.

xiv. Feature-Driven Development (FDD)

Explanation: Feature-driven development is an Agile approach that emphasizes delivering features incrementally and iteratively. Instead of building the entire product at once, FDD focuses on developing one feature at a time. This approach enables quicker delivery of functionality, better risk management, and continuous feedback from stakeholders. FDD provides a structured process for feature development, making it easier for teams to manage the complexity of large projects.

xv. Lessons learned

Explanation: Continuous learning and improvement are fundamental principles in Agile methodologies. Teams regularly reflect on their performance, review the outcomes of each iteration, and identify lessons learned. This retrospective process helps teams celebrate successes, identify areas for improvement, and apply valuable insights to future projects. By embracing lessons learned, Agile teams continuously evolve and enhance their project delivery.

xvi. Leadership and collaboration rather than command and control

Explanation: Agile leadership emphasizes collaboration, coaching, and support rather than a traditional command-and-control approach. Agile leaders facilitate an environment of trust, open communication, and shared decision-making. They empower teams to take ownership of their work and provide the necessary support and resources to help them succeed. Agile leadership fosters a culture of collaboration, where team members feel valued and motivated to contribute their best efforts.

xvii. Rapid design system

A rapid design system is an approach used in Agile product development to accelerate the design phase. It involves creating quick prototypes, mock-ups, and iterative design cycles to gather feedback early and often. This iterative design process helps identify design flaws and improvements, reducing the time required for finalizing product designs. A rapid design system enables faster time-to-market and enhances the product's overall quality.

xviii. Concurrent engineering

Concurrent engineering is a collaborative approach to product development, where teams from different disciplines work simultaneously on different aspects of the project. By involving all relevant stakeholders early in the design process, concurrent engineering reduces lead times and

Methodology

This study tends more towards inductive approach due to its exploratory nature. Also, the study will adopt quantitative method as numerical data will be collected and analysed through survey strategy. The study sample frame includes 65 quantity surveyors, 63 architect, 70 builders and 59 civil engineers, making a total of 257 populations as the sample frame of the study (FCDA Abuja, 2021). To determine the sample size for this study, Krejcie and Morgan’s (1970) table of determining sample size will be adopted. The table indicates that for the population size of 257, sample size of 175 can be used as the minimum. Therefore, the study adopted 175 respondents as the sample size for the study.

The major instrument used for data collection was structured questionnaires which covers the study on investigation. The questionnaire was designed in contemplation of the state of the respondents, simplicity of reading and accomplishment period. The strategy incorporates the use of closed-ended questions. The closed-ended gives option to a respondent ranging from 1 to 5 opinions rating (Likert-style) questions and ranking. This permits the respondents to humbly select one from specified choices. Statistical Package for Social Science (SPSS, version 26) will be adopted for statistical analysis of the data collected from the questionnaire survey.

The results were presented using table. The magnitudes of relationships reported were interpreted using Devarasetty, *et al*., (2020) descriptors, With coefficients >.69 as Very Strong, .50 to .69 as Substantial, .30 to .49 as Moderate, .10 to .29 as weak and .01 to .09 as Negligible. The decision for mean ranking was taken based on the rating scale shown below by Ishiyaku (2016):

Very low (VL) = 0.00 ≤ Mean < 1.49,
Low (L) = 1.50 ≤ Mean < 2.49,
Moderate (M) = 2.50 ≤ Mean < 3.49,
High (H) = 3.50 ≤ Mean < 4.49 and
Very high (VH) = 4.50 ≤ Mean < 5.00

Result presentation

The result of Agile principles; implementation in achieving construction project time performance in the study area based on five-point measurement scale was presented in Table 7. Top management support and employee empowerment with the mean score of 3.38 was ranked 1st, co-located high performing team with the mean score of 3.35, ranked 2nd, test driven development with mean score of 3.35, ranked 3rd, collaborative development with mean score of 3.35, ranked 4th and adaptive control with mean value of 3.31 was ranked 5th.

Furthermore, the use of information technology with mean value of 3.30 was ranked 6th, training and education with the mean value of 3.27, ranked 7th, responsive supply chain with mean value of 3.23, ranked 8th and visual control with mean value of 3.22 was ranked as the 9th. Appropriate hardware (tools and equipment) with mean value of 3.22 was ranked as 10th in the table, knowledge workers with mean score of 3.21, ranked 11th, effective production planning and control systems with the mean score of 3.19, ranked 12th, move from cost to revenue focus with the mean score of 3.17, ranked 13th, feature driven development with the mean score of 3.16, ranked 14th and lessons learned with the mean score of 3.15, ranked 15th.

Table 1: Results of agile principles implementation

Agile Principles	Mean	Std. Deviation	Rank	Level
Top Management Support and Employee Empowerment	3.38	.995	1	3.2333 Moderately high
Co-located high-performing teams	3.35	.933	2	
Test driven development	3.35	.840	3	
Collaborative Development	3.35	.818	4	
Adaptive Control	3.31	.993	5	
Use of Information Technologies	3.30	1.000	6	
Training and Education	3.27	1.074	7	
Responsive Supply Chain	3.23	.925	8	
Visual control	3.22	.952	9	
Appropriate Hardware (Tools and Equipment)	3.22	.923	10	
Knowledge Workers	3.21	1.005	11	
Effective Production Planning and Control Systems	3.19	.972	12	
Move from Cost to Revenue focus	3.17	.907	13	
Feature driven development	3.16	1.027	14	
Lessons learned	3.15	.994	15	
Leadership and collaboration rather than command and control	3.12	.984	16	
Rapid Design System	3.11	1.095	17	
Concurrent Engineering	3.09	1.170	18	

Finally, leadership and collaboration rather than command and control had the mean value of 3.12 and was ranked 16th, rapid design system with the mean score of 3.11, ranked 17th, concurrent engineering with the mean score of 3.09, ranked 18th, proper database management and system integration with the mean score of 3.08, ranked 19th. Therefore, in the study area, the level of agile principles' implementation in achieving construction project time performance was 3.2333 which is moderate on the rating scale.

Discussion of result

The results of the study indicate the level of implementation and perceived effectiveness of various agile principles in achieving construction project time performance in the study area. The principles are ranked based on their mean scores, with a higher mean indicating a higher level of implementation and effectiveness.

Top Management Support and Employee Empowerment received the highest mean score of 3.38, indicating that it is moderately implemented and perceived as fairly effective in the study area. The presence of top management support and empowering employees is crucial for successful Agile implementation as stated by (Ahimbisibwe Cavana & Daellenbach, 2015) [4] in research conducted in New Zealand. Co-located high-performing teams received a mean score of 3.35, indicating a moderately high level of implementation and effectiveness. It was opined by (Ahimbisibwe Cavana & Daellenbach, 2015) [4] that, co-located teams can enhance communication, collaboration, and overall project performance.

Test-driven development has a mean score of 3.35, this principle is also implemented at a moderate level. Test-driven development helps ensure the quality and functionality of the construction project. Collaborative Development received a mean score of 3.35 as well, suggesting that collaborative development practices are moderately implemented and effective. Collaboration among team members and stakeholders fosters innovation and improves project outcomes and it was supported by (Horowitz, *et al*., 2017) [13]. Adaptive Control received a mean score of 3.31, indicating a moderate level of implementation and effectiveness. Horowitz, *et al*., (2017) [13] opined that, adaptive control allows project teams to respond and adapt to changing project requirements and conditions.

The study suggests that several agile principles are moderately implemented and perceived as fairly effective in enhancing construction project time performance in the study area. However, there is room for improvement in implementing some of the other principles to further enhance project outcomes.

Conclusion and recommendations

The findings of the paper reveal that several agile principles are being implemented at a moderate level in the construction projects within the study area, with varying degrees of effectiveness. The highest mean scores were observed for Top Management Support and Employee Empowerment rated at 3.38. While agile principles are showing some positive impact on construction project time performance, there remains significant potential for improvement. This recommends that while current practices are moderately effective, there is need for deeper integration and refinement of these agile principles to further enhance project outcomes.

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References

1. Adebowale O, Smallwood J. A review of factors affecting construction labour productivity in developed and developing countries. In: 5th Construction Management Conference, 2016, 168-176.
2. Adut J. Applying agile approaches in public construction and civil engineering projects: A study to identify opportunities for a more flexible project management process: 2016.
3. Afolabi A. The effect of entrepreneurship on economy growth and development in Nigeria. The Effect of Entrepreneurship on Economy Growth and Development in Nigeria,2015:3(2):1-17.
4. Ahimbisibwe A, Cavana RY, Daellenbach U. A contingency fit model of critical success factors for software development projects: A comparison of agile and traditional plan-based methodologies. J Enterp Inform Manag,2015:28(1):7-33.
5. Attar M, Abdul-Kareem A. The role of agile leadership in organisational agility. In: Agile Business Leadership Methods for Industry 4.0. Emerald Publishing Limited: 2020.
6. Birhanu D, Lanka K, Rao AN. A survey of classifications in supply chain strategies. Procedia Eng,2014:97:2289-2297.
7. Chen CY, Lee JC. Comparative effects of knowledge-based antecedents in different realms of CMMI-based software process improvement success. Comput Stand Interfaces,2022:81:103599.
8. Cheng Y, Johansen J. Operations network development: internationalisation and externalisation of value chain activities. Prod Plan Control,2014:25(16):1351-1369.
9. Crnogaj K, Tominc P, Rožman M. A conceptual model of developing an agile work environment. Sustainability,2022:14(22):14807.
10. Ding B, Ferras Hernandez X, Agell Jane N. Combining lean and agile manufacturing competitive advantages through Industry 4.0 technologies: an integrative approach. Prod Plan Control,2023:34(5):442-458.
11. Henriksen SM. Collaborative robots–a process technology strategy to enable Leagile manufacturing. [master's thesis], 2017.
12. Holbeche LS. Shifts in organizational culture when implementing agility. J Creat Value,2019:5(2):124-138.
13. Horowitz CR, Shameer K, Gabrilove J, Atreja A, Shepard P, Goytia CN, *et al*. Accelerators: sparking innovation and transdisciplinary team science in disparities research. Int J Environ Res Public Health,2017:14(3):225.
14. Köse BÖ. Recent agile requirement engineering practices in IT projects: A case analysis. Bus Manag Stud Int J,2019:7(4):1776-1805.
15. Kupiainen E, Mäntylä MV, Itkonen J. Using metrics in agile and lean software development–A systematic literature review of industrial studies. Inf Softw Technol,2015:62:143-163.
16. Lappi T, Aaltonen K. Project governance in public sector agile software projects. Int J Manag Proj Bus,2017:10(2):263-294.
17. Mustafid, Karimariza SA, Jie F. Supply chain agility information systems with key factors for fashion industry competitiveness. Int J Agile Syst Manag,2018:11(1):1-22.
18. Piya S, Shamsuzzoha A, Khadem M, Al-Hinai N. Identification of critical factors and their interrelationships to design agile supply chain: Special focus to oil and gas industries. Glob J Flexible Syst Manag,2020:21:263-281.
19. Rajagopal P, Azar NAZ, Bahrin AS, Appasamy G, Sundram VPK. Determinants of supply chain responsiveness among firms in the manufacturing industry in Malaysia. Int J Supply Chain Manag,2016:5(3):18-24.
20. Rigby DK, Sutherland J, Noble A. Agile at scale. Harv Bus Rev,2018:96(3):88-96.
21. Subramani T, Sruthi PS, Kavitha M. Causes of cost overrun in construction. IOSR J Eng,2014:4(6):1-7.
22. Shehu AA. Lean principles: An approach for improving construction project time performance (CPTP) in some Nigerian construction industries. Garu Acad J, 2022, 2(2).
23. Iqbal S PE, PfMP, PMP, PMI-SP, MIRM, *et al*. Leading construction industry to lean-agile (LeAgile) project management. In: PMI Global Congress proceedings, 2015, 1-10.